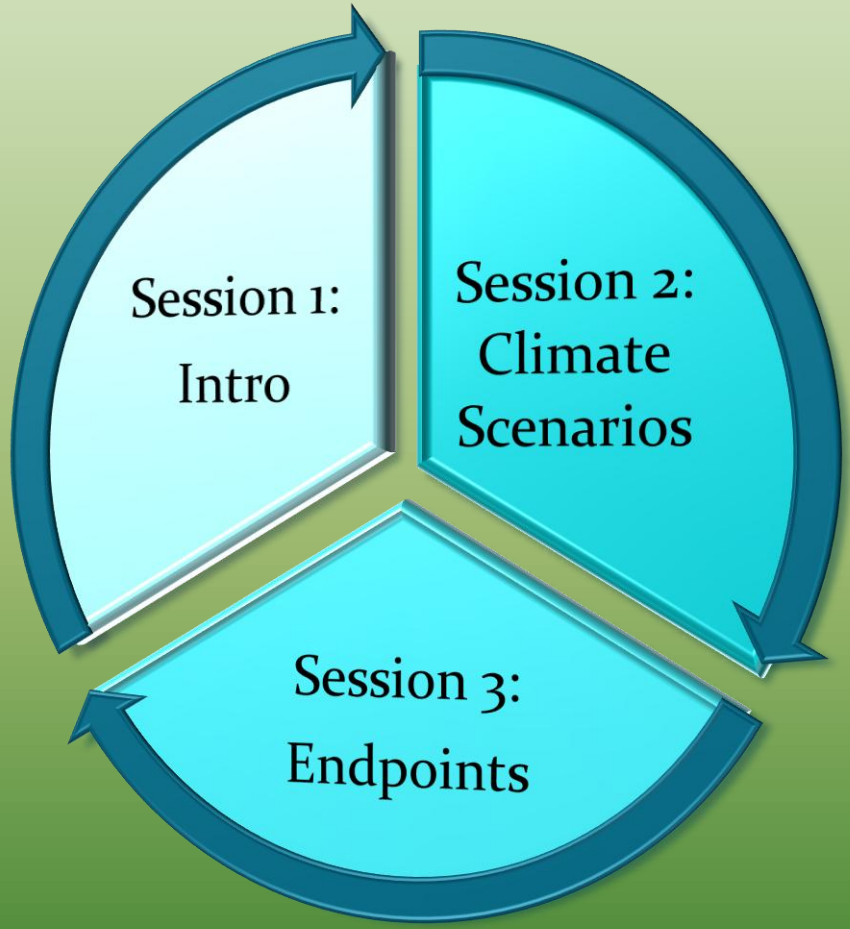


Session 2: Climate Scenarios

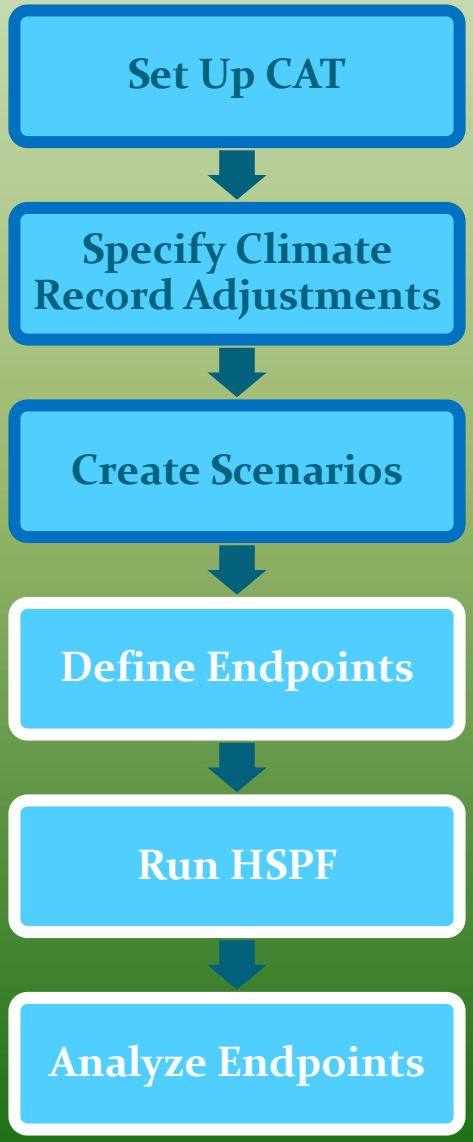
Session 2: Climate Scenarios

Part A
- Sources of Climate Data

Part B
- Adjustments to Precipitation and Air Temperature

Part C
- Creating a Climate Scenario

Part D
- Exercises



Session 2: Climate Scenarios

Session 2: Part A

Sources of Climate Data

Sources of Climate Data

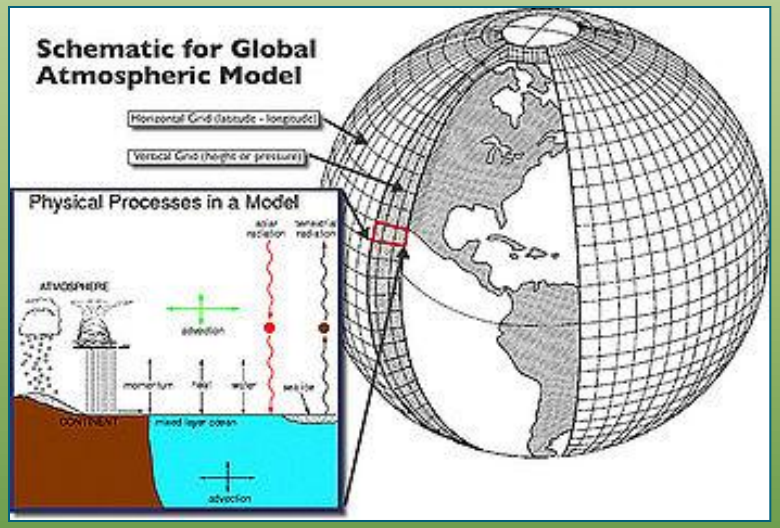
- Historical and paleo-extreme events
- Observed trends
- Global and regional scale climate models

Data requirements will vary depending on assessment goals.

General Circulation Models (GCMs) and Regional Climate Models (RCMs)

- **GCMs and RCMs-- represent physical processes in the atmosphere, ocean, cryosphere and land surface**
- **The most advanced tools currently available for simulating the response of the global climate system to increasing greenhouse gas concentrations**

General Circulation Models (GCM)



- **GCMs depict the climate using a three dimensional grid over the globe, typically having a horizontal resolution of between 250 and 600 km**

Intergovernmental Panel on Climate Change (IPCC)

- IPCC website provides a wealth of scientific information and products including links to the 2007 Fourth Assessment Report. http://www.ipcc.ch/
- IPCC gives guidance on developing scenarios and conducting climate change impact assessments.
- IPCC Data Distribution Centre (DDC): http://www.ipcc-data.org/

Criteria for Selecting Climate Scenarios

- Consistency with global/regional projections
- Physical plausibility
- Applicability in impact assessments
- Representation of data
- Accessibility

Climate Scenario

- 'Scenario' - a possible or plausible future, not necessarily a probable future
- IPCC Task Group on Data and Scenario Support for Impacts and Climate Analysis (TGICA)
- Three different types of scenarios
  - Synthetic
  - Analogue
  - Model-based

Synthetic Scenario

- **Climate attributes are changed by a realistic but user-driven amount**
- **Often according to a qualitative interpretation of climate model simulations for a region.**

Example: user-driven adjustments of historical temperatures by 1, 2, 3, and 4°C and historical precipitation by 5, 10, 15, and 20% could be applied in various combinations to create synthetic change scenarios.

Analogue Scenarios

- Constructed by identifying recorded climate regimes which may resemble the future climate in a given region.
- These records can be obtained either from the past (temporal analogues) or

  from a different region at the present time (spatial analogues).

Model-based Scenarios

- **Developed using output from modeling experiments with General Circulation Models (GCM) and Regional Climate Models (RCM)**

- **Simulate the response of the global climate system to increasing greenhouse gas concentrations.**

Scenario Components

- **Arithmetic adjustment(s) to baseline temperature and/or precipitation record**

  Example: **A single climate change scenario with three scenario components**

  1. **Increased precip during winter months**
  2. **Decreased precip during summer months**
  3. **Uniform annual increase in air temperature**

CAT imposes no constraints on the type and magnitude of changes made.

Monocacy Watershed Case Study

- **Climate change projection data acquired from Penn State University's Consortium of Atlantic Regional Assessments project (CARA; http://www.cara.psu.edu/)**

- **CARA provided spatially referenced data from climate modeling experiments using seven GCM models**

Scenario Analysis
Monocacy Case Study

- **Synthetic scenarios - to understand important system properties, e.g., thresholds and non-linear behaviors**
- **Model-based scenarios - created by applying change statistics (deltas) from each CARA model projection to an user-defined base period of historical, hourly temp and precip data (1984 to 2000) from 8 NCDC weather stations**

Session 2: Part B

Record Adjustments

Record Adjustments

Two Options:

- Full record -- affects all years within the historical time period

- Partial record – affects only a selected set of years with the historical time period

Precipitation and Temperature Adjustments

Any one or more of these types of adjustments can be combined to create more complex climate change scenarios

- **Universal adjustments**

  Example: the same adjustment made to data from multiple weather stations

- **Selective adjustments**

  Example: temp and precip from different locations within a watershed are modified independently

Five Options for Adjusting Precipitation

- Apply multiplier to full record
- Apply seasonal multiplier
- Modify partial record
- Represent storm intensification
- Add or remove storm events

Adjustments are for amount, NOT type of precipitation. HSPF uses air temp to determine type.

Option 1: Full Record Multiplier

- Assumes precipitation will change (increase or decrease) in a uniform way throughout the year.
- Stand-alone manner or as one component of a more complex scenario including additional adjustments.

Example of a relevant analysis: **Evaluate the impact of a uniform 20% increase in precipitation on watershed endpoints.**

Option 2: Seasonal Multiplier

- Assumes precip will change in the specified way only during certain times of year for each year in the record
- BASINS CAT enables the selection of one month or any combination of months.

Example of a relevant analysis: Evaluate the impact on watershed endpoints of a uniform 20% seasonal increase in precipitation during the months of June, July, and August for each year of the record.

Option 3: Partial Record Modification

- **Assumes that precipitation will change only during certain years within the full record**

Example of a relevant analysis: **Evaluate the effect of climate change-induced drought by decreasing by 20% all precipitation values occurring within the driest water year or years contained within the record.**

Option 4: Represent Storm Intensification

- **Apply a constant multiplier to all events within a specified event size class.**

***Example of a relevant analysis*: Evaluate the impact of a 10% increase of annual precip occurring within the largest 20% (defined by total storm volume) of the storms or only in events that are among the lowest 90% defined by total storm volume.**

The Synoptic Analysis Tool available within BASINS can be used to characterize precipitation events.

Option 5:
Add or Remove Storm Events

- **Storm events are randomly added or removed to represent changes in the frequency of events**

***Example of a relevant analysis*: Evaluate the impact of increasing precip volume by 10% by adding randomly-timed rainfall events with an average intensity greater than 0.1 inches per hour.**

Three Options for Adjusting Temperature

- Add or subtract a constant to a
  1. full record
  2. specific season
  3. partial record

Whenever an adjustment is made to a historical air temperature, the potential PET record must be regenerated.

Option 1:
Full Record

- **A constant change in air temperature is added or subtracted from each value in the full record.**

***Example of a relevant analysis*: Evaluate the impact of a uniform 2°C increase in air temp on watershed endpoints.**

Option 2: Specified Season

- **A constant change in air temp is added or subtracted from values within a user-specified season each year of the full record.**

Example of a relevant analysis: **Evaluate the impact on watershed endpoints of a uniform 2°C increase in air temperature during the cool months (November through April) and a uniform 4°C increase during the warm months (May through October)**

Option 3: Partial Record

- A constant change in air temperature is added or subtracted only from values within a user-specified time period (years) within the full record.

Example of a relevant analysis: Evaluate the effect that a uniform increase of 3°C has on drought conditions occurring within the driest water year contained within the simulation period.

Using CAT with other Models

Exporting climate change scenarios as ASCII text files:

1. **Single adjustment record – export as an ASCII file independent of running the HSPF model.**
2. **Multiple adjustments record -- complete an HSPF model run first, then export resulting record as ASCII files.**

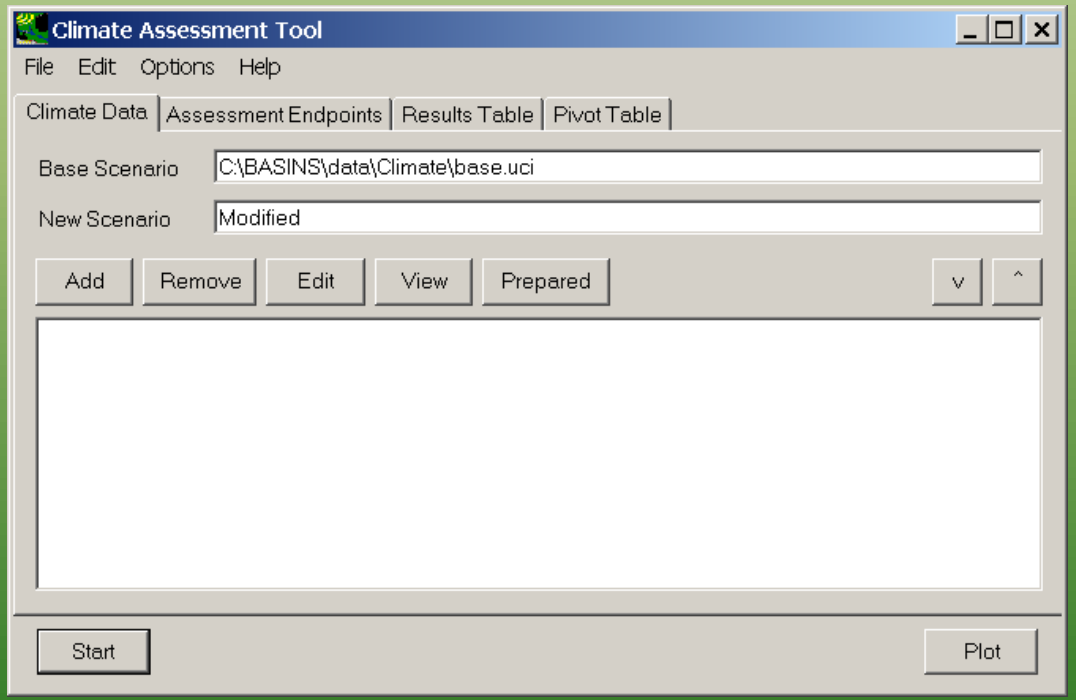
Session 2: Part C

Creating a Climate Scenario

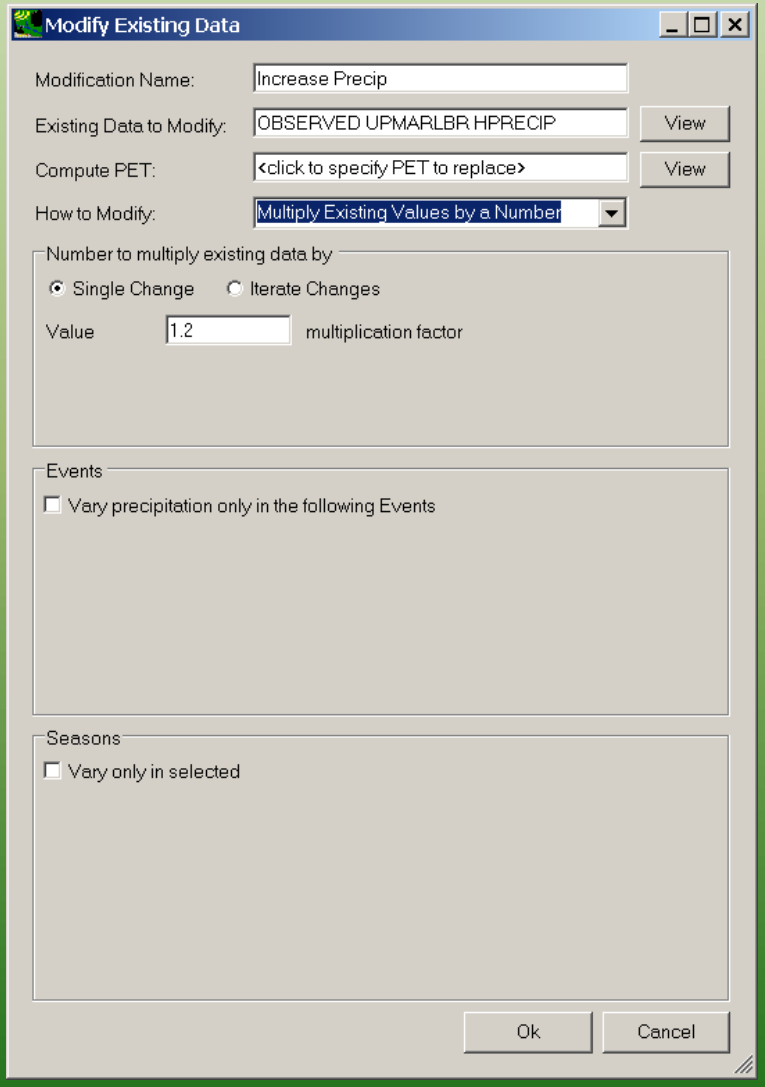
Climate Data Tab

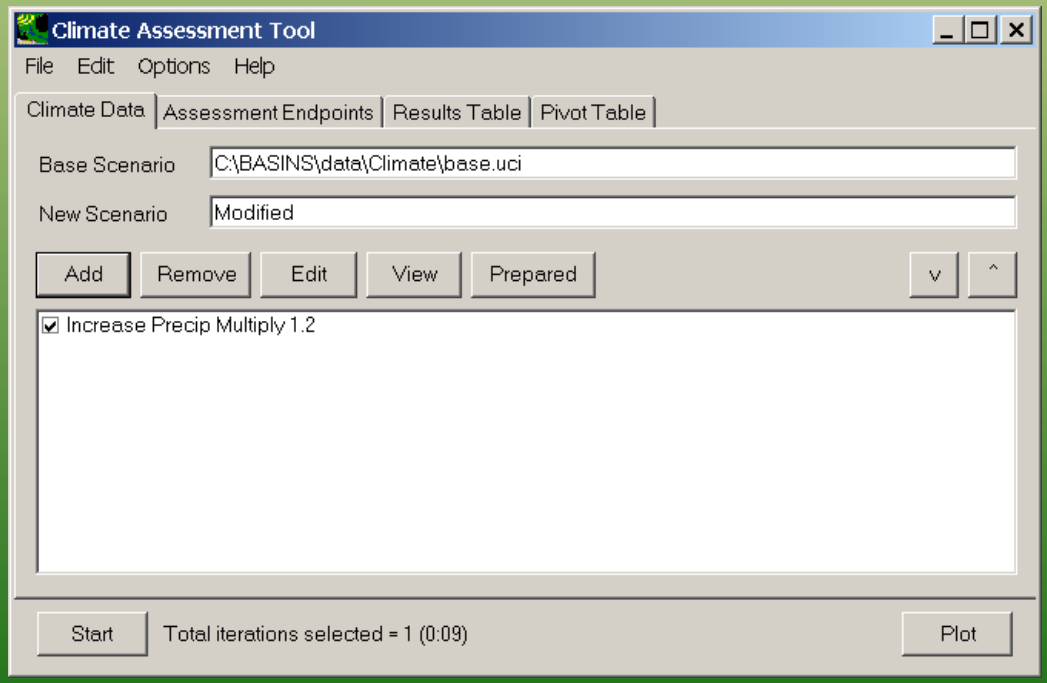
To manage changes to input time series data:

1. Select existing input time series
2. Make record adjustments

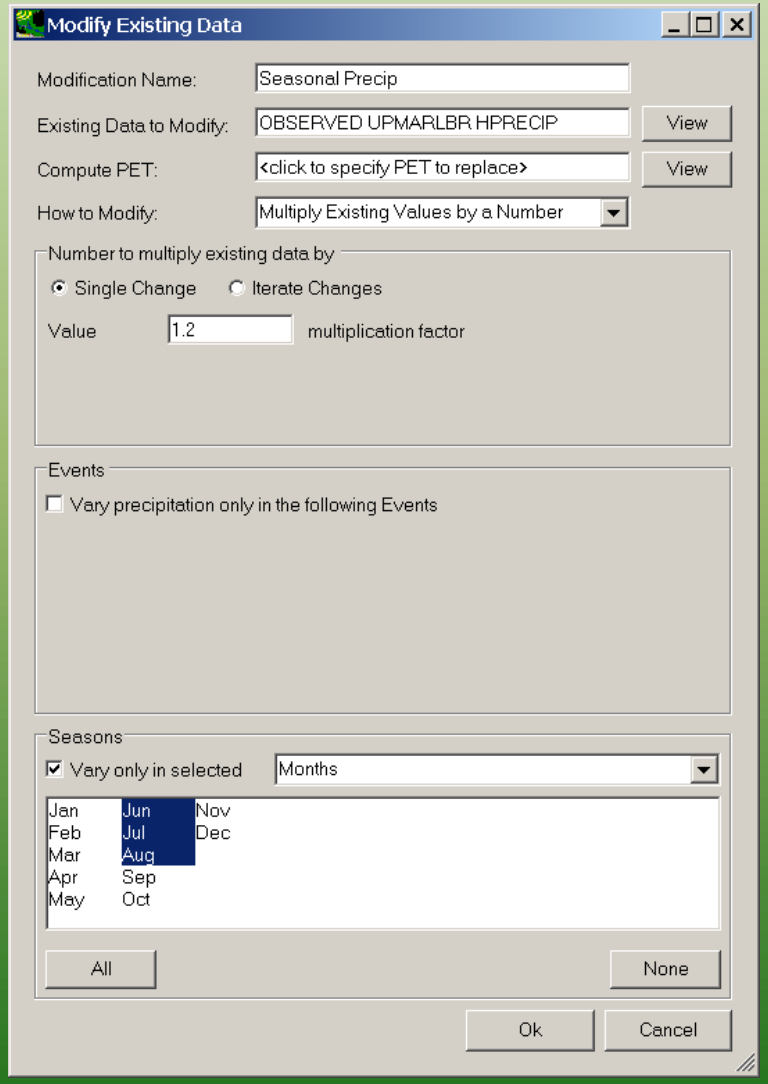


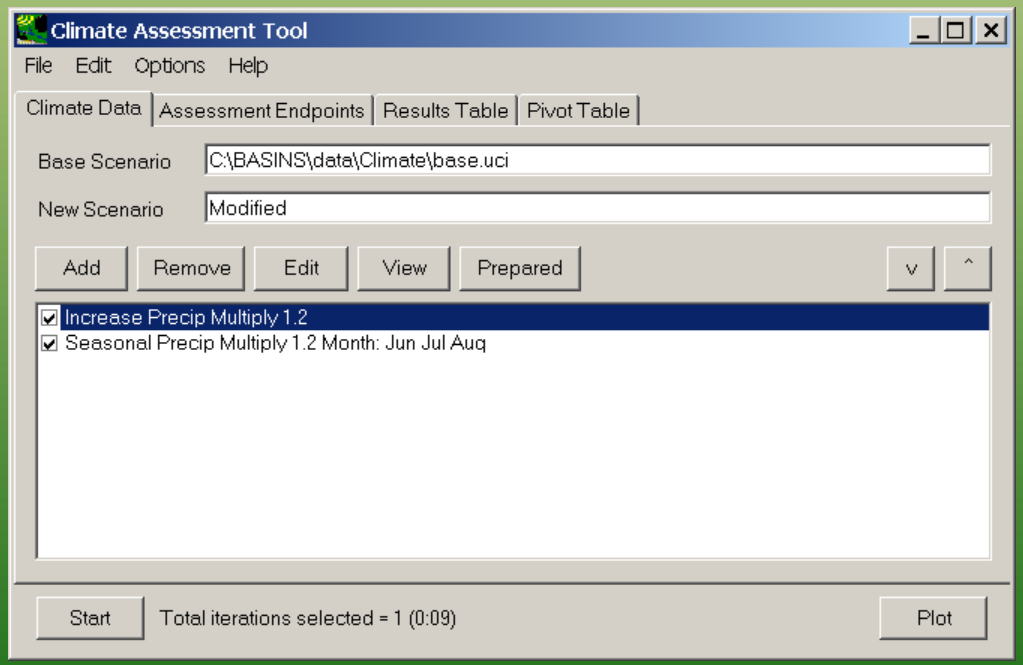
Example Record Adjustment 1: Apply Multiplier to Full Record



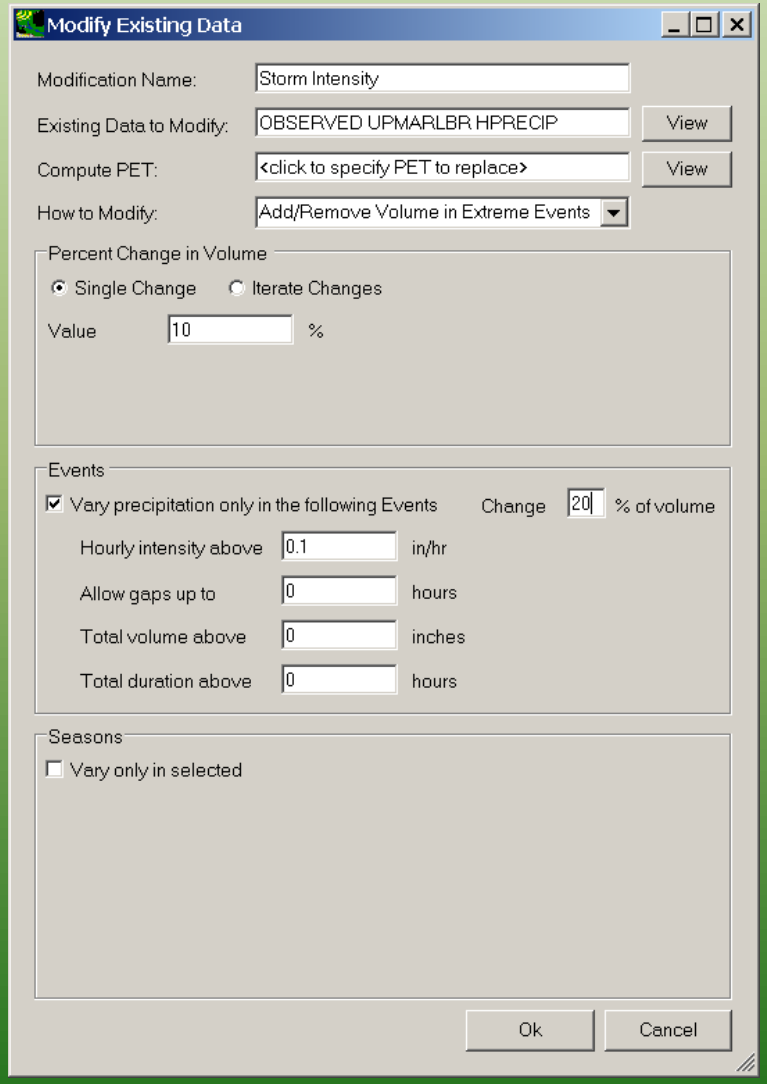


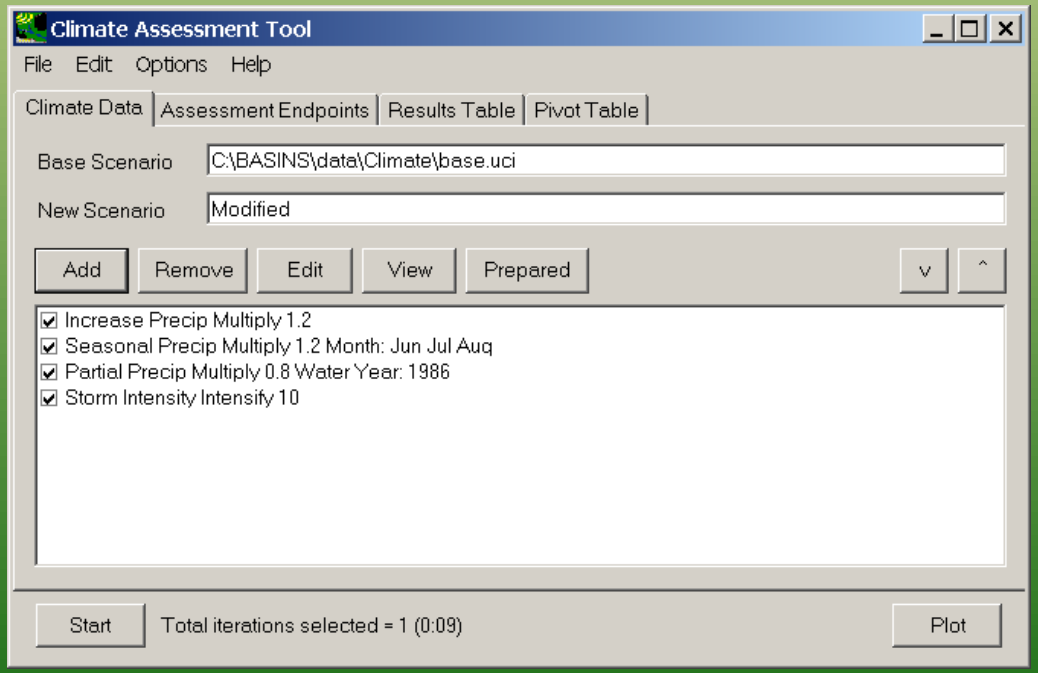
Example Record Adjustment 2: Apply Seasonal Multiplier



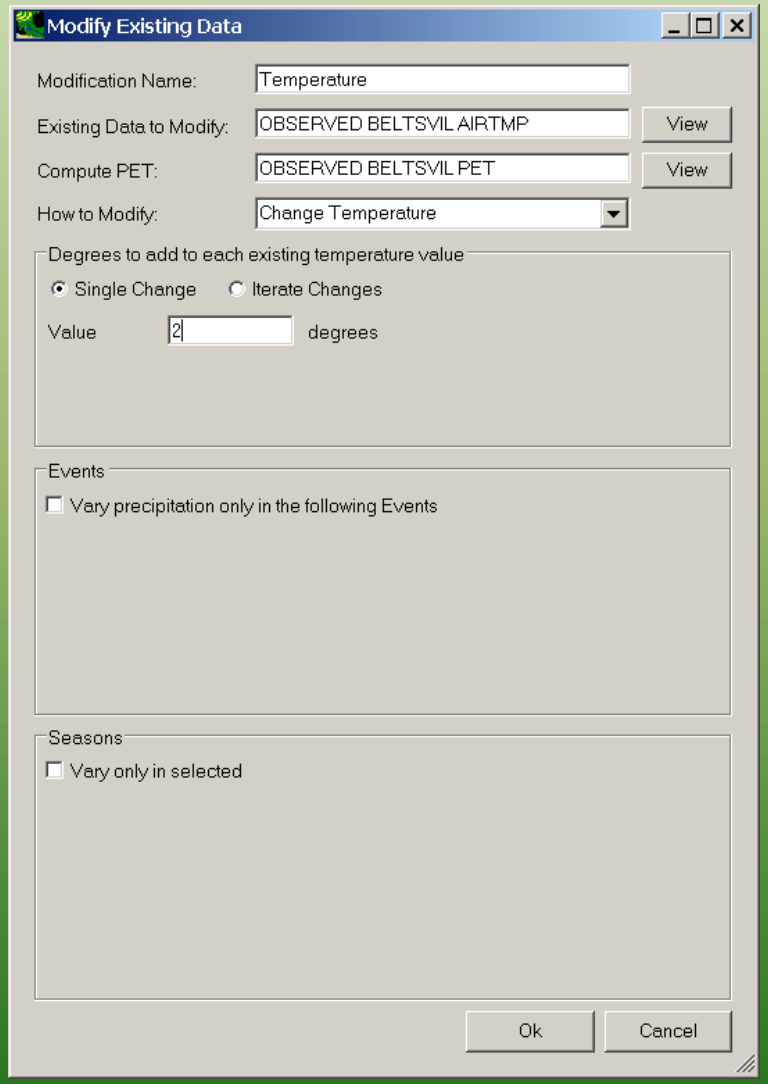


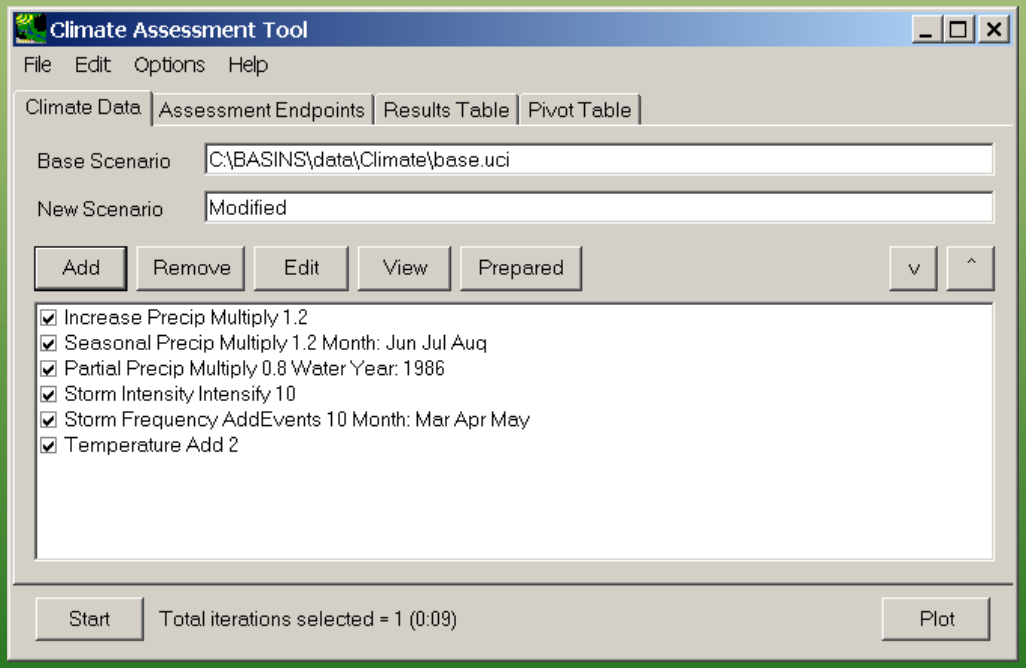
Example Record Adjustment 3: Represent Storm Intensification



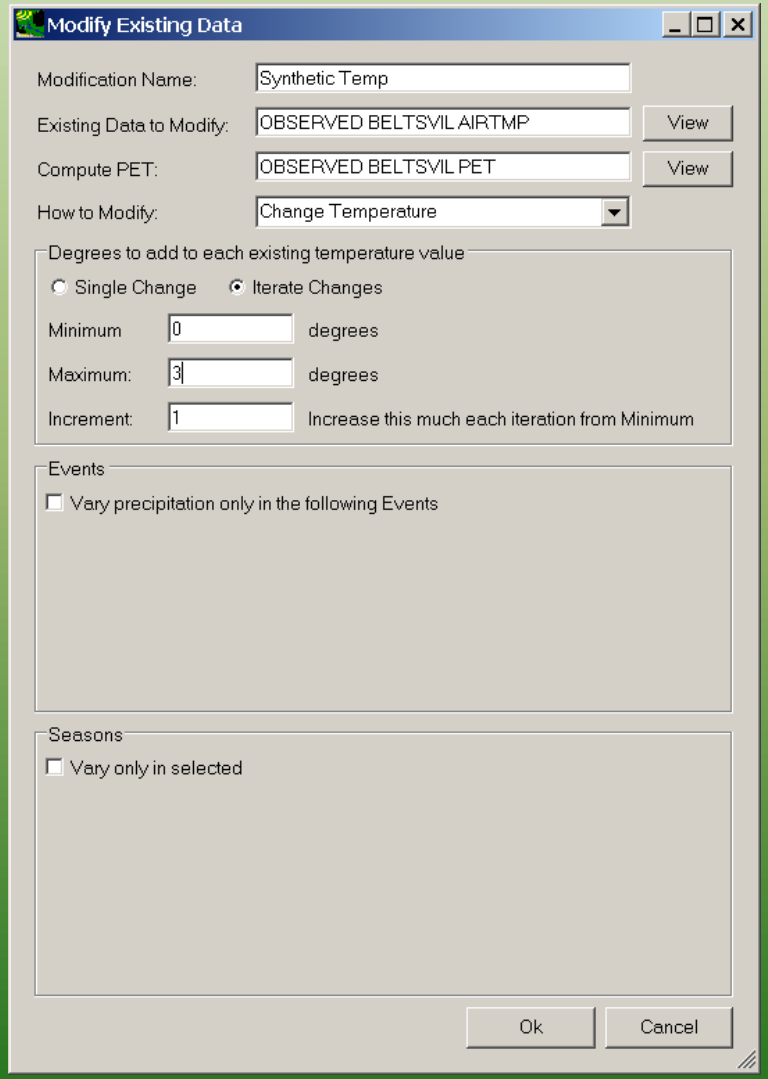


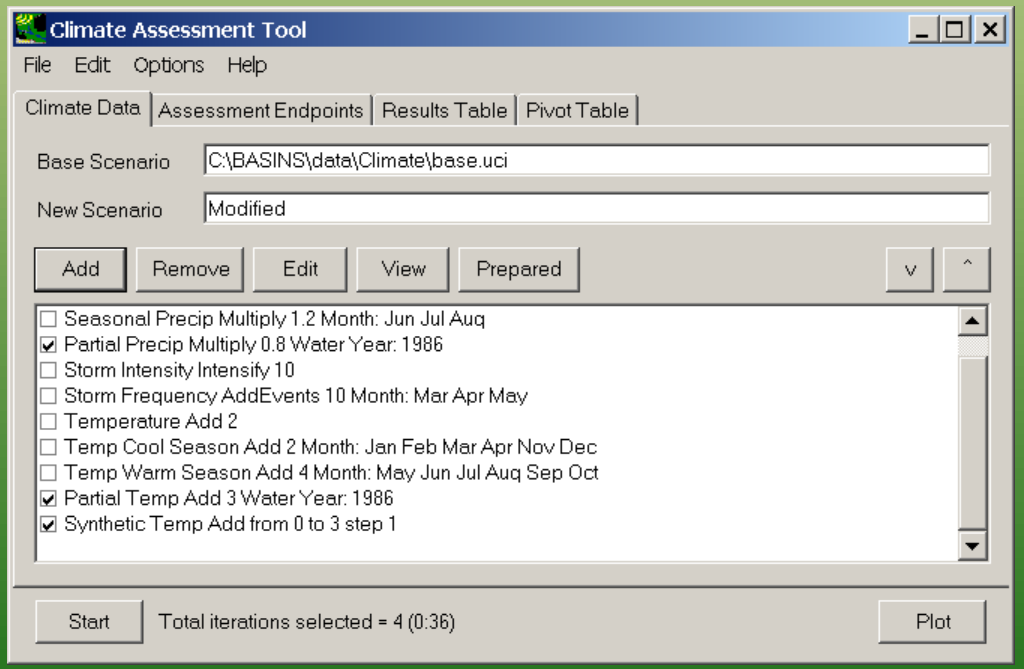
Example Record Adjustment 4: Add a Constant



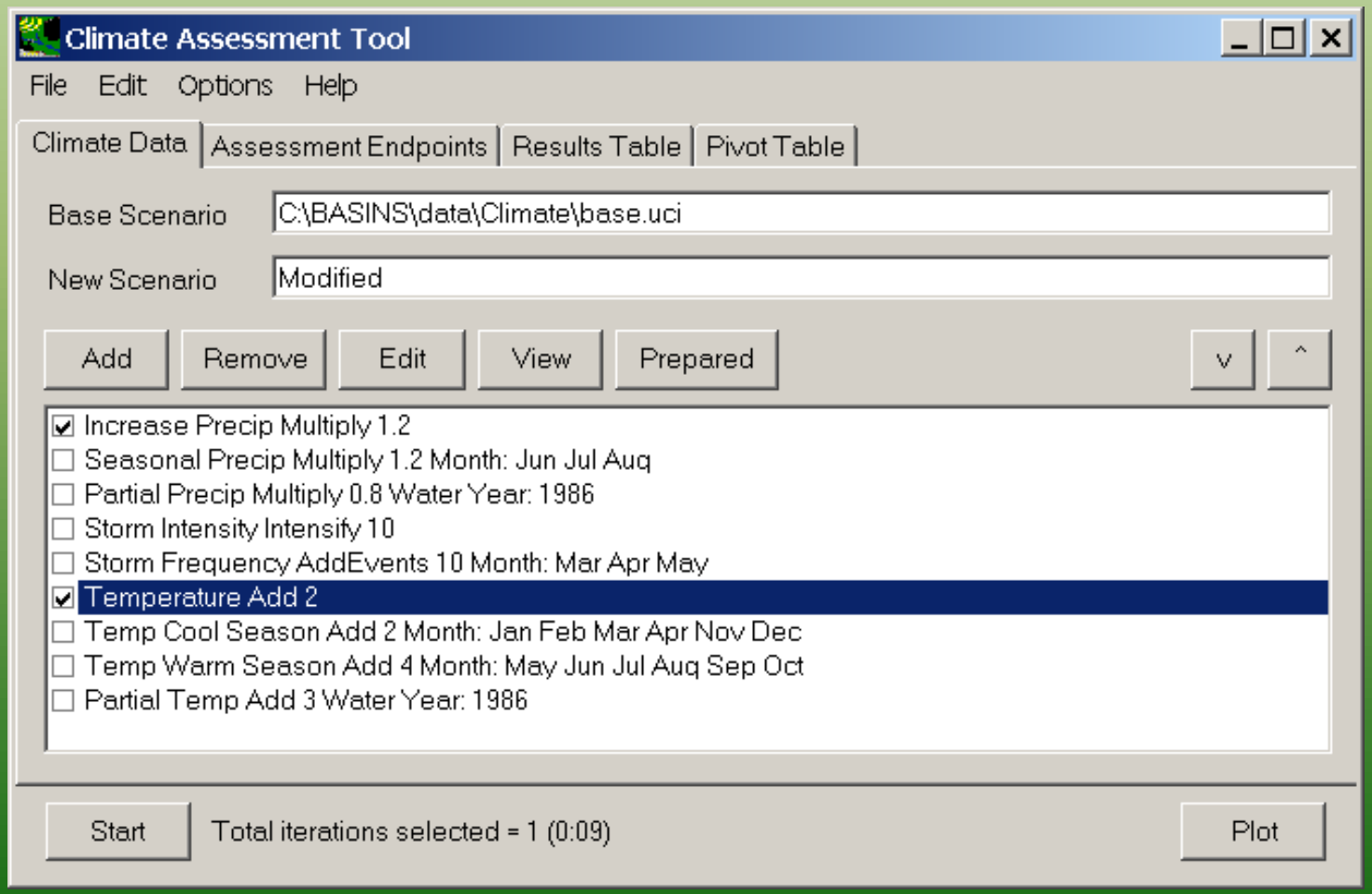


Example Record Adjustment 5: Iterative Changes





Constructing a Climate Change Scenario



Session 2: Part D

Exercise C1 and C2

Exercise C1

- How do I adjust historical precipitation records to represent potential climate changes?
- How do I adjust historical temperature records to represent potential climate changes?

Exercise C2

- **How do I use these record adjustments to create climate scenarios in BASINS CAT?**