Examples and Applications of SAC-SMA Modifiers

Adapted from information from NERFC

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This document provides a general overview of the Sacramento Soil Moisture Account Model (SAC-SMA) modifiers, or "mods", available within the Community Hydrologic Prediction System (CHPS).

Mods make run-time adjustments to the states, time series, or parameters within the model. Making mods may be necessary for a number of reasons in the forecast process:

- Model assumptions are not always valid. For instance, unit hydrograph theory assumes a uniform distribution of precipitation in space and time, which is typically not true.
- Data quality issues can frequently require real time adjustment. Ideally, these should be caught prior to the hydrologic forecast; however, real time adjustments are not always feasible.
- Models cannot completely represent all physical conditions.
- Adjustments may be necessary to match river flows.
- Information from water partners (e.g., reservoir release information) may be provided by a reservoir operator to override the operating rules on which the model is based.

A number of mods are available to the forecaster at run time. Depending on the model used to generate the forecast and data type in a time series, mods may not always be available.

RRICHNG

The RRICHNG mod adjusts the precipitation forcing time series used by the Sacramento model. This time series is not typically the MAP time series but is the RAIM (rain + melt) time series produced from the snow model.

Warm season - RAIM and MAP should be equivalent, as the snow model cannot do any processing.
Cool season/melt periods - RAIM is usually greater than MAP.
Cool season/snow accumulation periods - RAIM will often be zero, while MAP will have a positive value.
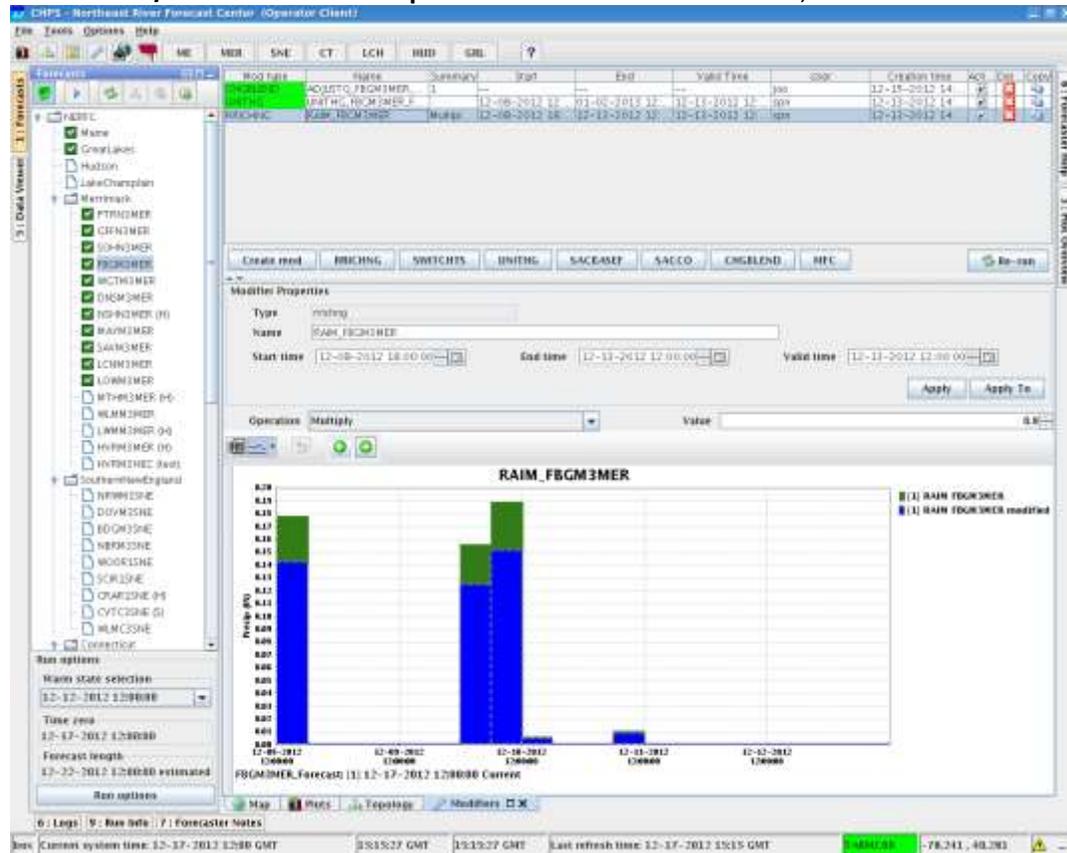
Apply three types of operations to generate the RRICHNG mod:

1. adjust the time series directly, via the table or graphically
2. apply a multiplier
3. apply an additive value

For **Multiply** or **Add** operations, you must set a value. RRICHNG must specify both a start and end time for which the mod is applied. A valid time is also necessary, particularly for mods made for future times.
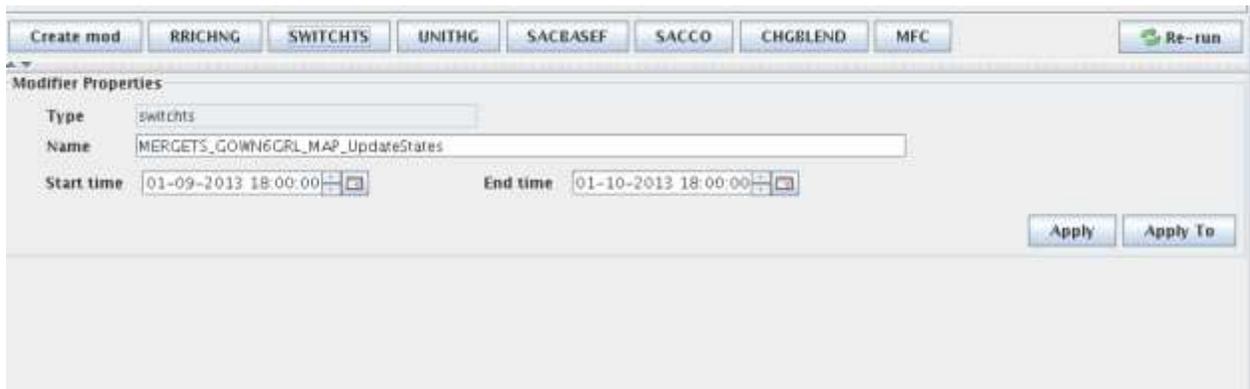
The plot depicts both the unadjusted and adjusted time series. This plot can get confusing when there are upper and lower zone time series alongside unadjusted and adjusted. Pay attention to the legend. You should only be able to modify the time series tagged as "modified".

SWITCHTS

The SWITCHTS mod changes which time series is used for a particular model. Most offices configure this to change the most common precipitation forcing.

Precipitation forcings from hourly MPE (MAPX) incorporate both radar and gage estimates, and the MPE DailyQC (MAP) function uses gage values only.

During the warm and cool seasons, MAPX and DailyQC MAP are the default time series used by CHPS, respectively. The SWITCHTS mod allows the forecaster to override the default and use alternative forcing.

The SWITCHTS uses both the start and end dates to define when the model uses the alternate time series. No graphic display is associated with the SWITCHTS mod.

UNITHG

The UNITHG mod used to adjust the ordinates of the unit hydrograph for a specified period.

Best practice: use a single UNITHG mod for the entire duration of the run period or you may get a discontinuity in the hydrograph plot where the transition between two unit hydrographs occurs.

The unit hydrograph converts a runoff volume to a flow in the river. Unit hydrographs assume an even spatial distribution of rainfall across the basin. However, if the bulk of the rainfall is closer to the gage, it may be necessary to make the unit hydrograph peak earlier and higher. Likewise, if most of the precipitation is in the headwaters, the unit hydrograph will likely be somewhat later and less peaked. Some rivers also experience seasonal differences in their response. Beware of locations with dual peaks.

The easiest way to adjust the unit hydrograph is to click through each of the ordinates you want to change. Focus more on the shape of the unit hydrograph rather than the flow values, because the application recomputes the values so the area under the unit hydrograph represents a unit volume and the same volume as before.
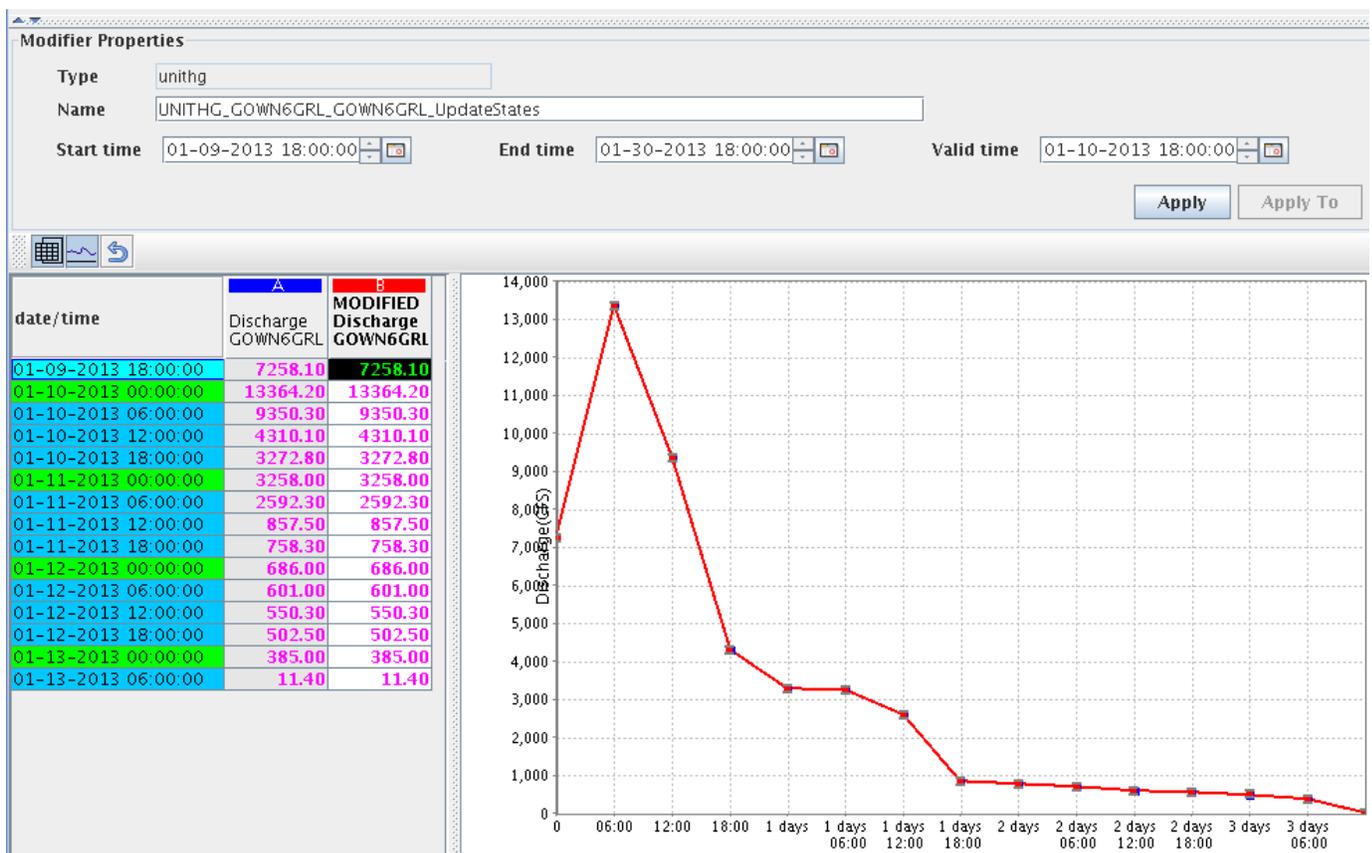
SACBASEF

The SACBASEF mod adjusts the volume of water in the lower zone buckets of the Sacramento model, which adjusts the baseflow amounts.

The SACBASEF mod only requires a single time value, which is the time at which the mod is applied. The value for the mod is the multiplier applied to each of the lower zone buckets. **Note:** if a multiplier fills any of the buckets, it will remain "full", but not exceed capacity.

The effect of this mod should be visible in the Sacramento plot overview display, and you will see an adjustment of the flow conditions in the plot. It can take 12-24 hours for the mod to affect the hydrograph because its effects are routed through the unit hydrographs.

SACCO

The SACCO mod adjusts the contents of one or more of the Sacramento model buckets. Only make this mod with an advanced understanding of the Sacramento model, because it can result in unexpected behavior.

It is generally better to adjust the precipitation input to modify the upper zone buckets and to use the SACBASEF mod to adjust the lower zone states. These methods ensure a more even distribution of moisture among the buckets.

CHGBLEND

The CHGBLEND mod adjusts the number of time steps used to close the gap between the end of the observed time series and the simulated time series.
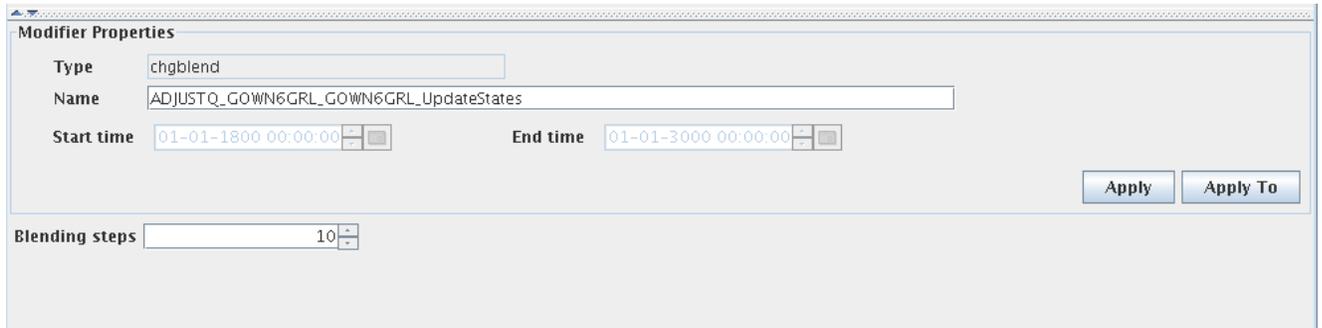
The CHGBLEND mod does not require any time parameters. Its only parameter is the number of blending steps to be used.

MFC

The MFC (Melt Factor Correction) adjusts the rate of snowmelt during non-rain periods.

Use the UADJ mod during periods of rain to adjust the rate of melt.
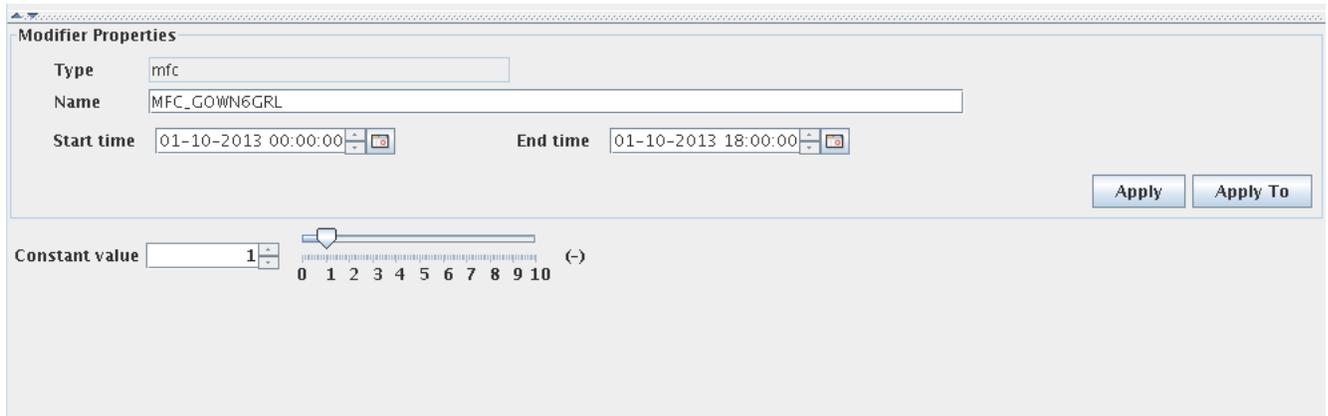
The MFC mod uses both a start and end time parameter. The value of the mod is a multiplier to the melt factor parameters. A mod value greater than one results in more melting (less than one results in less melting).

AESCCHNG

The AESCCHNG mod adjusts the areal extent of snow cover across the basin, which is used to develop the melt rate over the basin.

The value is the percent of the basin with snow cover at the specified time. Input the value using the slider bar, or the text input field.

The mod does not change the areal water equivalent.

IGNORETS

The IGNORETS mod ignores certain observed values of stage (STG) or flow (QIN) and prevents the model from using the values in the ADJUSTQ operation that blends data from observation to simulation.

Suggested use: try this mod for ice-affected rivers where simulated flows are preferable to observed values.

Try ignoring QIN rather than STG. The values still plot, but the adjustment algorithm will not use the data.
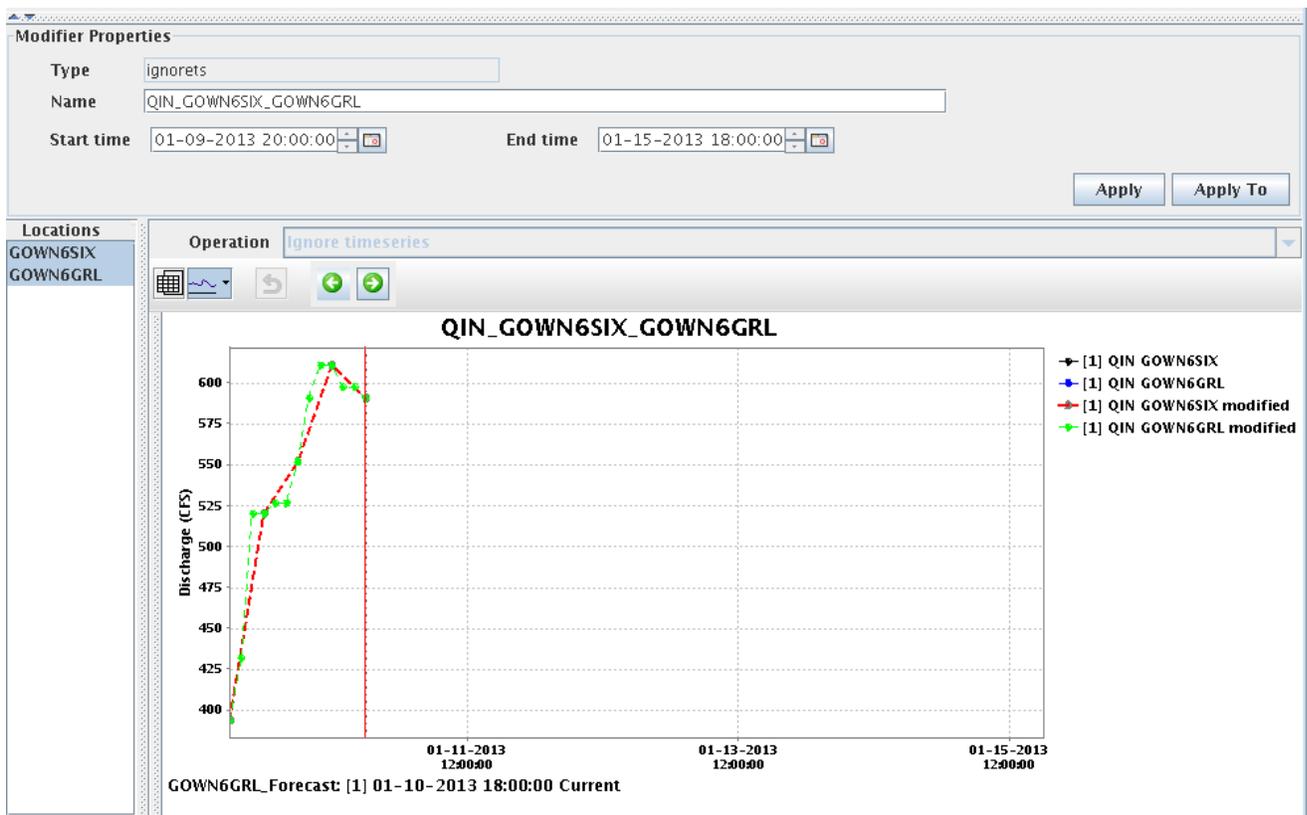
RAINSNOW

The RAINSNOW mod overrides the default model-generated precipitation typing.

The threshold temperature used by some offices is 34 degrees Fahrenheit. However, rain can occur at colder temperatures or snow can occur at warmer temperatures. For these situations, specify the precipitation type using the RAINSNOW mod.
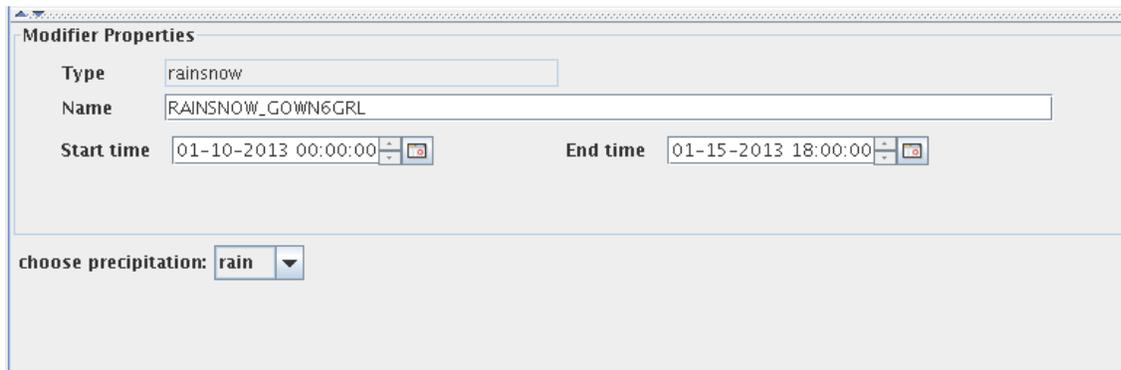
ROCHNG

The ROCHNG mod works similarly to the RRICHNG but works on the runoff output of the Sacramento model, rather than the precipitation input.

Use caution when creating this mod. It is preferable to make adjustments as far upstream in the modeling process as possible rather than adjusting outputs in order to ensure model states are also adjusted.

The ROCHNG mod can result in an abrupt discontinuity in the forecast hydrograph.

ROCHNG works well in situations where rapidly dropping temperatures (below freezing) can shut off runoff following a rain event.
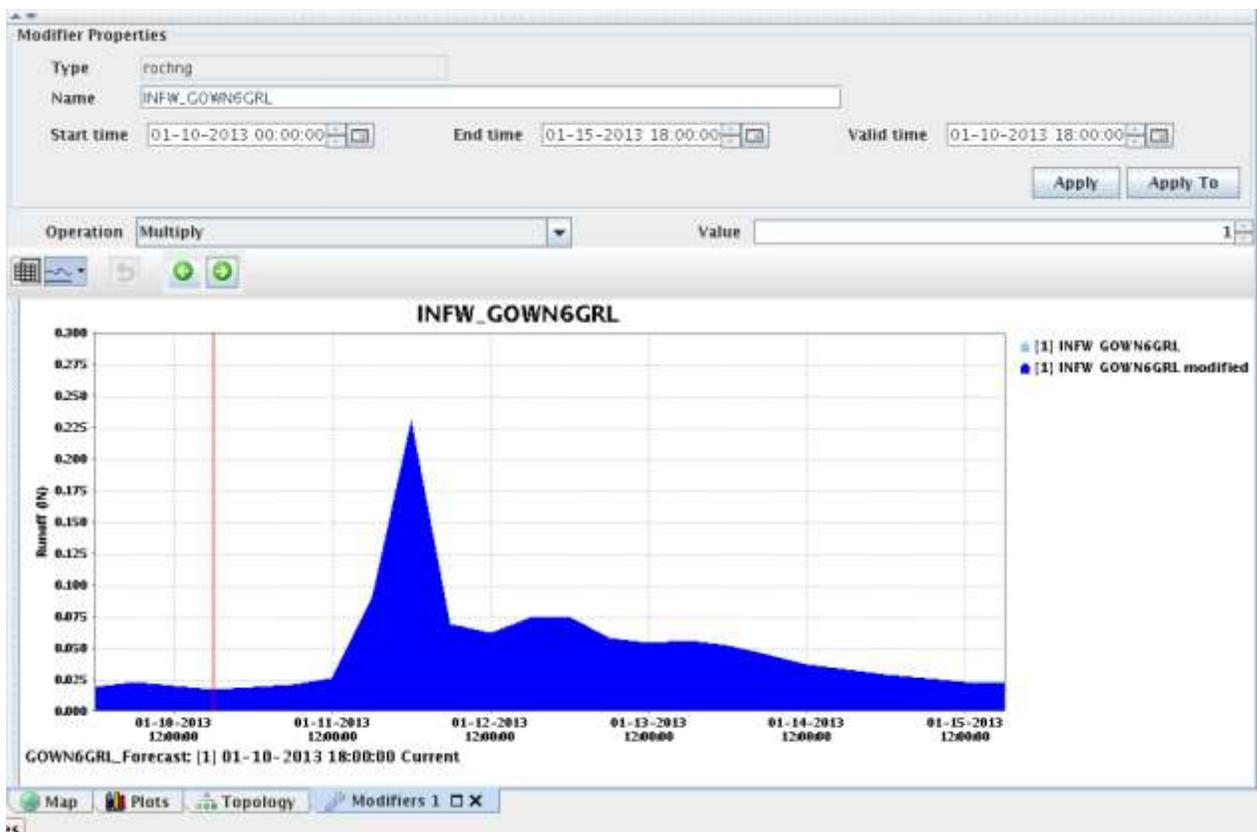
SETMSNG

The SETMSNG mod works similarly to the IGNORETS operation but applies to a broader type of time series rather than just those used for the adjustment algorithm.

Forecasters use the SETMSNG mod to set bad observations to missing.
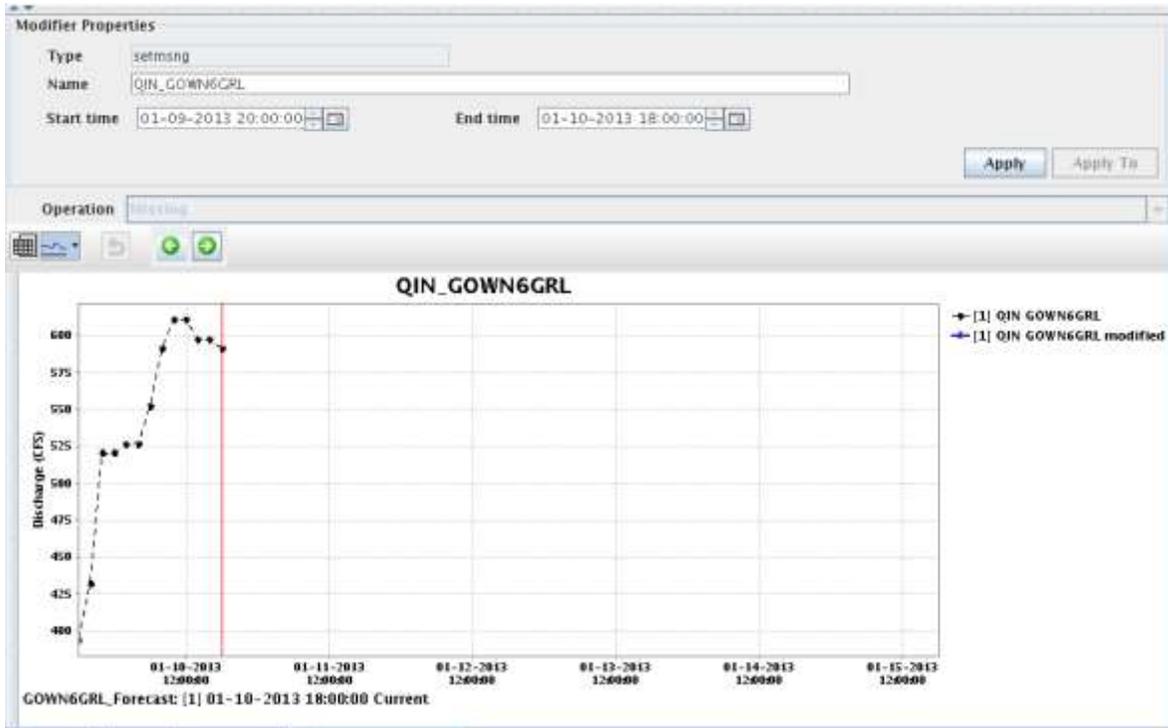
UADJ

The UADJ mod adjusts melt rate to match observed flows by modifying the default wind function used by the snow model.

A mod value greater than or less than one increases and decreases the melt rate, respectively.

WEADD / WCHNG

The WEADD and WECHNG mods are similar ways of adjusting the basin water equivalent of the snow pack.

WEADD – specify a value to add (or subtract) from the modeled water equivalent.

WECHNG – use this to override the modeled value with a forecaster-specified value.