Lag and K Routing (LAG/K) Model

1. Description of Algorithm

http://www.nws.noaa.gov/oh/hrl/nwsrfs/users_manual/part2/_pdf/24lagk.pdf

2. Model Parameters

LAG/K uses an xml representation of model parameters where each parameter is captured within a separate xml tag. The tags are closely related to the NWSRFS definition of LAG/K defined at
http://www.nws.noaa.gov/oh/hrl/nwsrfs/users_manual/part5/_pdf/533lagk.pdf

The table below shows the available parameter tags. For the parameters with type of string, the values are case-insensitive. For example, "YES" and "Yes" are treated by the program as the same value, but "Y" will be treated as error. The sequence of parameters in the table below or in the xml file has no any significance.

Name	Type	Required [Yes/No]	Comment
INFLOW_TS_ID	String	Yes	Identifier of the inflow time series.
INFLOW_TS_DATA_TYPE	String	Yes	Data type of the inflow time series.
INFLOW_TS_INTERVAL	Integer	Yes	Data time interval of the inflow time series (HR).
OUTFLOW_TS_ID	String	No	Identifier of the outflow time series.
OUTFLOW_TS_DATA_TYPE	String	No	Data type of the outflow time series.
OUTFLOW_TS_INTERVAL	Integer	Yes	Data time interval of the outflow time series (HR).
NUMBER_OF_LAGQ_PAIRS	Integer	Yes	If > 0 – number of pairs of Lag and Q values used to define the variable Lag vs. Q curve. If = 0 – constant lag will be used.
NUMBER_OF_KQ_PAIRS	Integer	Yes	If > 0 – number of pairs of K and Q values used to define the variable K vs. Q curve If = 0 – constant K will be used.

Name	Type	Required [Yes/No]	Comment
METR_OR_ENGL_UNITS	String	No	Code specified whether units of parameter and initial carryover values are English or Metric. *Default is metric* ENGL – enter flow in CFS and volume in CSFD. METR – enter flow in CMS and volume in CMSD.
TRANSMISSION_LOSS_COEFFICIENT	Double	No	Transmission loss recession coefficient for the Ft. Worth transmission loss computations. (*Range > 0.0 and < 1.0*)
TRANSMISSION_LOSS_THRESHOLD_FLOW	Double	No	The flow above which the Ft. Worth transmission loss computations are done. (Range >= 0)
LAGQ_PAIRS	Table	Yes	If NUMBER_OF_LAGQ_PAIRS > 0, it contains the Lag and Q values in order Lag(1), Q(1), Lag(2), Q(2), etc. If NUMBER_OF_LAGQ_PAIRS = 0, it contains one value which is the ***constant Lag***. (Note: *A constant Lag of zero will turn off the* ***Lag option.***)
KQ_PAIRS	Table	Yes	If NUMBER_OF_KQ_PAIRS > 0, it contains the K and Q values in order K(1), Q(1), K(2), Q(2), etc. If NUMBER_OF_KQ_PAIRS = 0, it contains one value which is the ***constant K***. (Note: *A constant K of zero will turn off the* ***K option***.)
CONSTANT_LAG_VALUE	Double	Yes	Constant Lag value. If NUMBER_OF_LAGQ_PAIRS = 0 then this tag is used.
CONSTANT_K_VALUE	Double	Yes	Constant K value. If NUMBER_OF_KQ_PAIRS = 0 then this tag is used.

3. Model States

LAG/K model states are defined in a property file format. An example is shown below. The model state property names are:

Property Name	Description
LENGTH_CARRYOVER_ARRAY	The number of carryover/state values
CURRENT_LAGGED_INFLOW	Inflow at the start of the run
CURRENT_OUTFLOW	Outflow at the start of the run
CURRENT_STORAGE	Storage at the start of the run
PAIR_QT_LAG_CARRYOVER	Number of discharge-lag carryover/state pairs
DISCHARGE#0 – DISCHARGE#N	When PAIR_QT_LAG_CARRYOVER > 0; a discharge for each QT pair
LAG#0 – LAG#N	When PAIR_QT_LAG_CARRYOVER > 0; a lag for each QT pair
UNIT	Units for State Variables (always METRIC)

Sample State Definition:

```
UNIT=METRIC
LENGTH_CARRYOVER_ARRAY=21
CURRENT_LAGGED_INFLOW=113.2660
CURRENT_OUTFLOW=113.2660
CURRENT_STORAGE=226.5320
PAIR_QT_LAG_CARRYOVER=8
DISCHARGE#0=113.2660
LAG#0=1.000000
DISCHARGE#1=113.2660
LAG#1=2.000000
DISCHARGE#2=113.2660
LAG#2=3.000000
DISCHARGE#3=113.2660
LAG#3=4.000000
DISCHARGE#4=113.2660
LAG#4=5.000000
DISCHARGE#5=113.2660
LAG#5=6.000000
DISCHARGE#6=113.2660
LAG#6=7.000000
DISCHARGE#7=0.000000
LAG#7=0.000000
```

4. Model Time Series

LAG/K requires 1 input time series and 1 output time series.

Time Series Type	Internal Model Units	Time Step	Input or Output	Missing Values Allowed	Required [Yes or No]
Input/Output Discharge	CMS	any	Input and Output	No	1/
Input Discharge	CMSD	any	Input	No	2/
Output Discharge	CMS	4/		Yes	3/

```
1/ IF no Output TS specified; this TS has input and
output
2/ IF input specified as a volume TS (CMSD) input
discharge not needed
3/ Not required; input TS will have output TS results
4/ must be >= input TS time step
```

5. Modifications (Mods)

- There are two types of modifier to make change Lag/K parameter mods for

1) Forecast runs uses **moduleParameterModifier** type
2) Forecast and Calibration runs use **multipleModuleParameterModifier** type

Note:

- **multipleModuleParameterModifier** type only works on a standalone (SA) system.
- The instructions for configuring a GUI for Lag/K changes below that assume the new LagK parameter names (see section 2 above); therefore, the user should first update the LagK parameters using the cleanup script as follows:

1. cd $REGIONHOME/Config directory
2. Copy "cleanUpParDefinitions" script from the OHD-CORE-CHPS-4.2.a or later release package (under ohd/scripts directory) into $REGIONHOME/Config directory

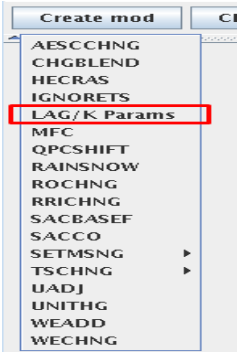
   $ cp /OHD-CORE-CHPS-4.2.a /ohd/scripts/cleanUpParDefinitions .
3. Run a script

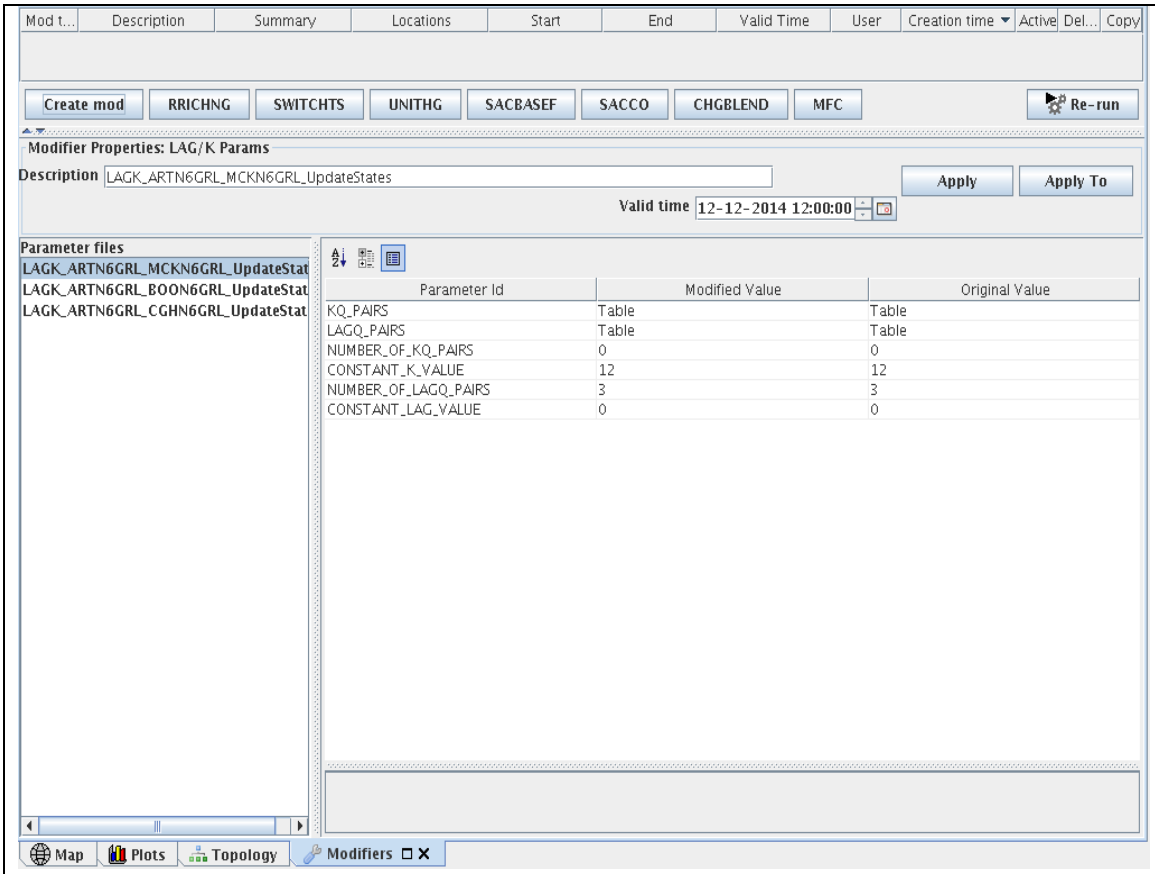
   $ **./cleanUpParDefinitions**
4. After that is done, you can delete a script and cleanUpParLogFile.txt file.

RegionConfigFiles/ModifierTypes.xml
1) moduleParameterModifier: - Add lines below to before the <***unitHydrographModifiers***> tag.

```
<moduleParameterModifier id="lagk" name="LAG/K Params">
  <expiryTimeDeletedModifiers unit="week" multiplier="1"/>
  <filter>
    <moduleParameter id="LAGQ_PAIRS">
      <stringValue>LAGQ_PAIRS</stringValue>
    </moduleParameter>
    <moduleParameter id="CONSTANT_LAG_VALUE">
      <stringValue>CONSTANT_LAG_VALUE</stringValue>
    </moduleParameter>
    <moduleParameter id="CONSTANT_K_VALUE">
      <stringValue>CONSTANT_K_VALUE</stringValue>
    </moduleParameter>
    <moduleParameter id="NUMBER_OF_LAGQ_PAIRS">
      <stringValue>NUMBER_OF_LAGQ_PAIRS</stringValue>
    </moduleParameter>
    <moduleParameter id="KQ_PAIRS">
      <stringValue>LAGQ_PAIRS</stringValue>
    </moduleParameter>
    <moduleParameter id="NUMBER_OF_KQ_PAIRS">
      <stringValue>NUMBER_OF_KQ_PAIRS</stringValue>
    </moduleParameter>
  </filter>
  <defaultValidTime/>
  <overwriteParameterValues>true</overwriteParameterValues>
 </moduleParameterModifier>
```

- GUI to make changes LAG/K parameters mod.





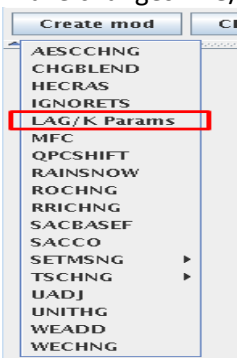
2) multipleModuleParameterModifier:

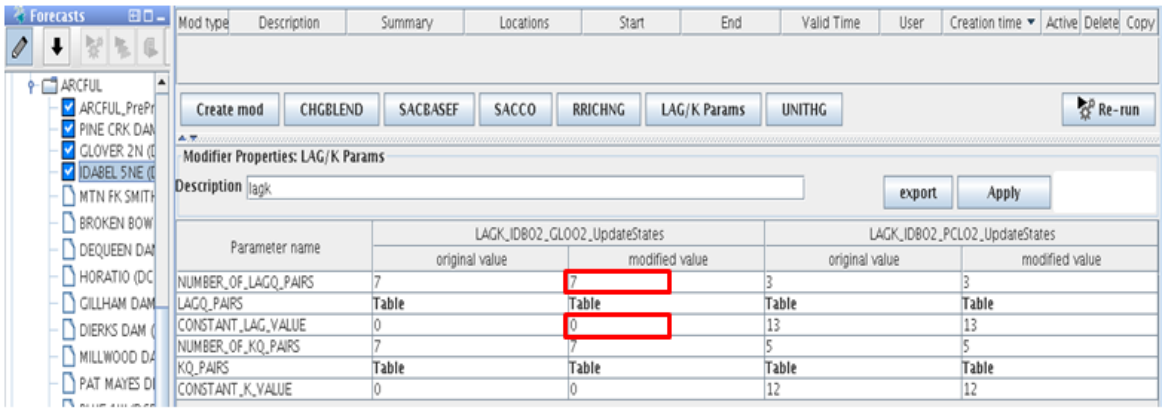
- Add lines below to after the **</moduleParameterModifier>** tag.

```
<multipleModuleParameterModifier id="lagk" name="LAG/K Params">
    <expiryTimeDeletedModifiers unit="week" multiplier="1"/>

    <numberParameter id="NUMBER_OF_LAGQ_PAIRS">
      <minimumValue>0</minimumValue>
    </numberParameter>
    <numberParameter id="LAGQ_PAIRS">
      <minimumValue>0.0</minimumValue>
    </numberParameter>
    <numberParameter id="CONSTANT_LAG_VALUE">
      <minimumValue>0.0</minimumValue>
    </numberParameter>

    <numberParameter id="NUMBER_OF_KQ_PAIRS">
      <minimumValue>0</minimumValue>
    </numberParameter>
    <numberParameter id="KQ_PAIRS">
      <minimumValue>0.0</minimumValue>
```

```
    </numberParameter>
    <numberParameter id="CONSTANT_K_VALUE">
      <minimumValue>0.0</minimumValue>
    </numberParameter>

    <hideParameters>
      <parameterId>INFLOW_TS_DATA_TYPE</parameterId>
      <parameterId>INFLOW_TS_ID</parameterId>
      <parameterId>METR_OR_ENGL_UNITS</parameterId>
      <parameterId>OUTFLOW_TS_INTERVAL</parameterId>
      <parameterId>INFLOW_TS_INTERVAL</parameterId>
      <parameterId>TRANSMISSION_LOSS_THRESHOLD_FLOW</parameterId>
      <parameterId>TRANSMISSION_LOSS_COEFFICIENT</parameterId>
    </hideParameters>
  </multipleModuleParameterModifier>
```

- GUI to make changes LAG/K parameters mod.

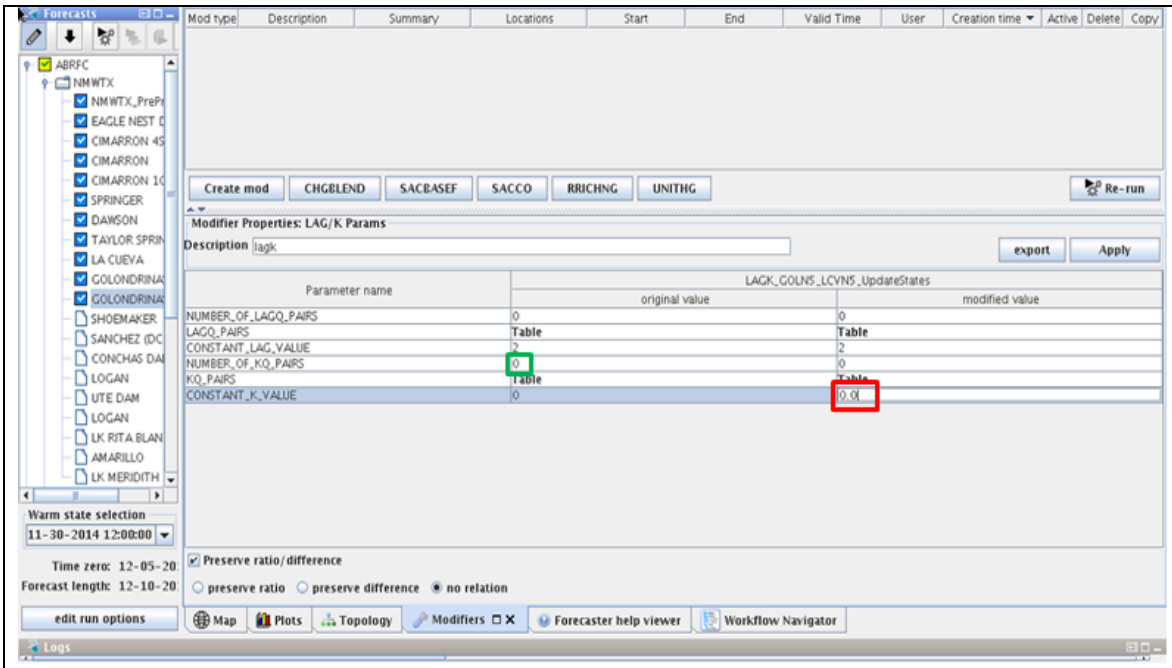




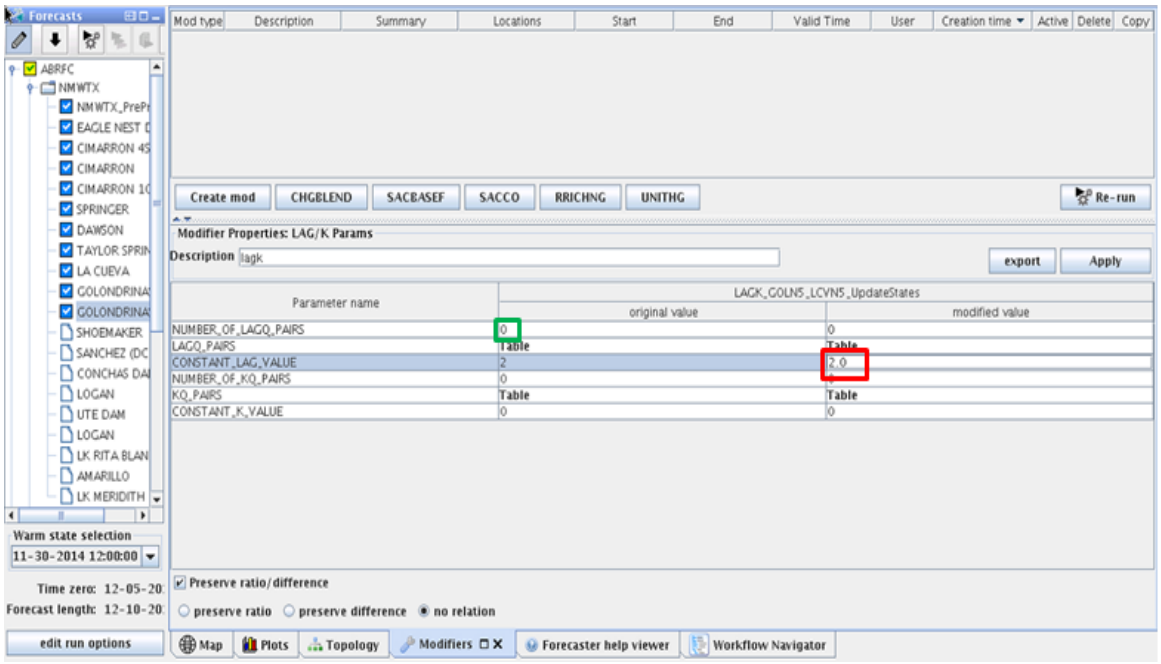
- There are some scenarios for modifying LAG/K parameters

A) If an existing location is already configured to use constant LAG and/or K then modify the parameterId values as follows:

1- Modify CONSTANT_K_VALUE, (NUMBER_OF_KQ_PAIRS should =0)

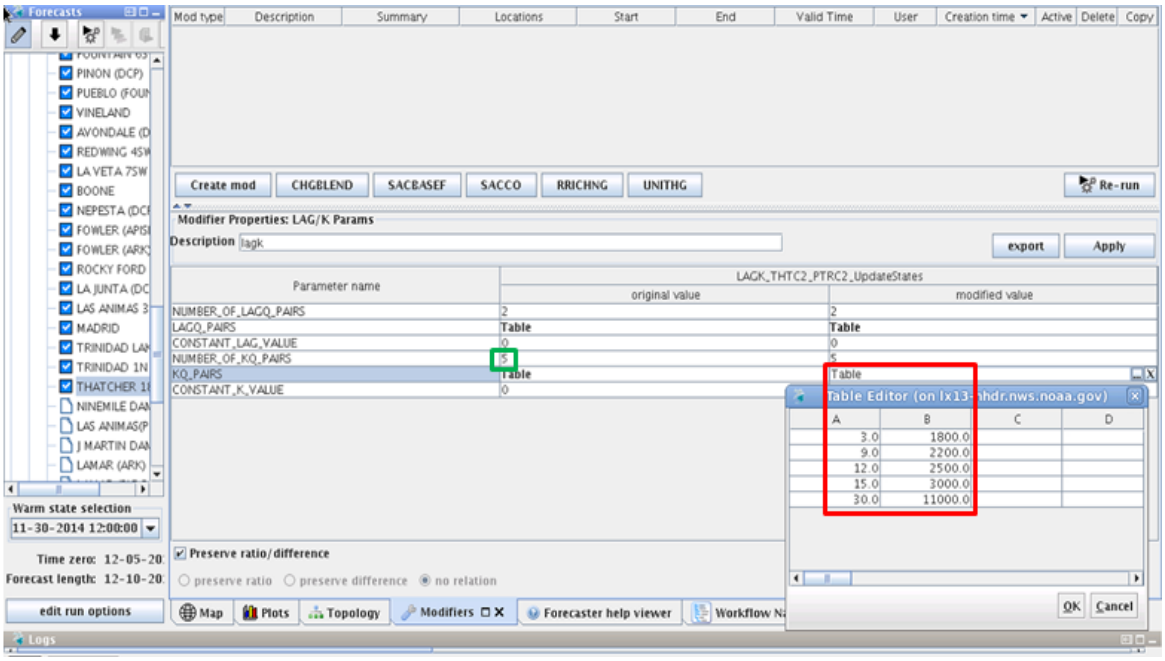


2- Modify CONSTANT_LAG_VALUE (NUMBER_OF_LAGQ_PAIRS should =0)

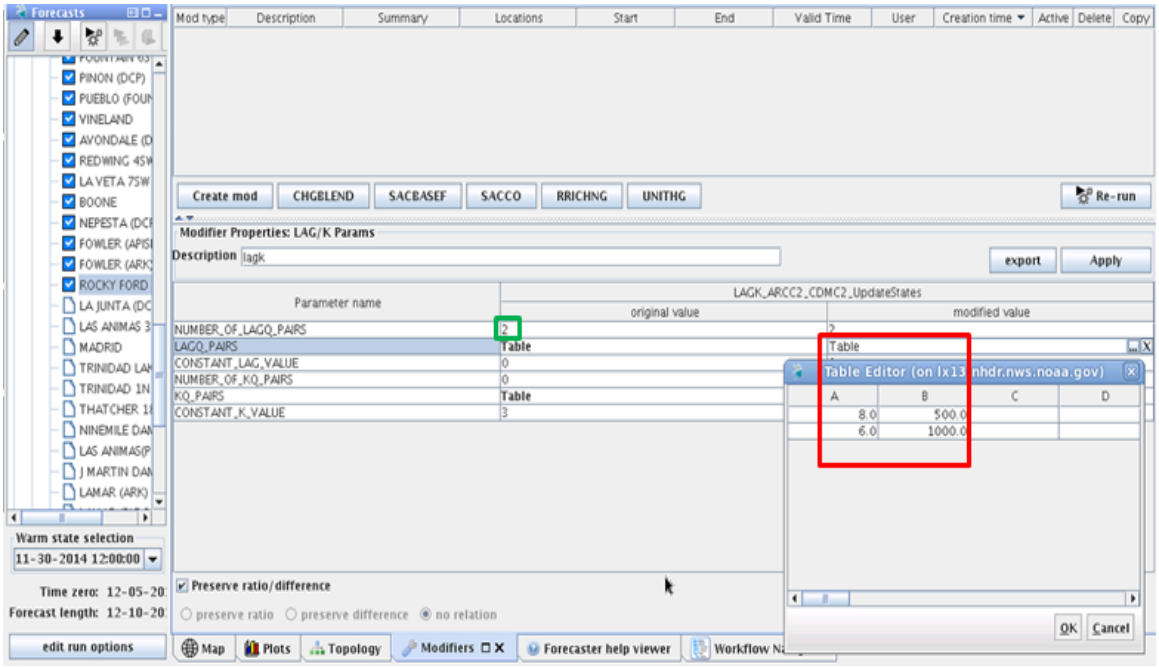


B) If an existing location is already configured to use variable LAG and/or K then modify the parameterId values as follows:

1- Modify variable K values (KQ_PAIRS table) (the NUMBER_OF_KQ_PAIRS should be > 0 and represents the number of rows in the KQ_PAIRS table).
Note: Discharges in the K vs Q table must be in ascending order.



2- Modify variable LAG values (LAGQ_PAIRS table) (the NUMBER_OF_LAGQ_PAIRS should be > 0 and represents the number of rows in the LAGQ_PAIRS table).
Note: Discharges in the LAG vs Q table must be in ascending order.



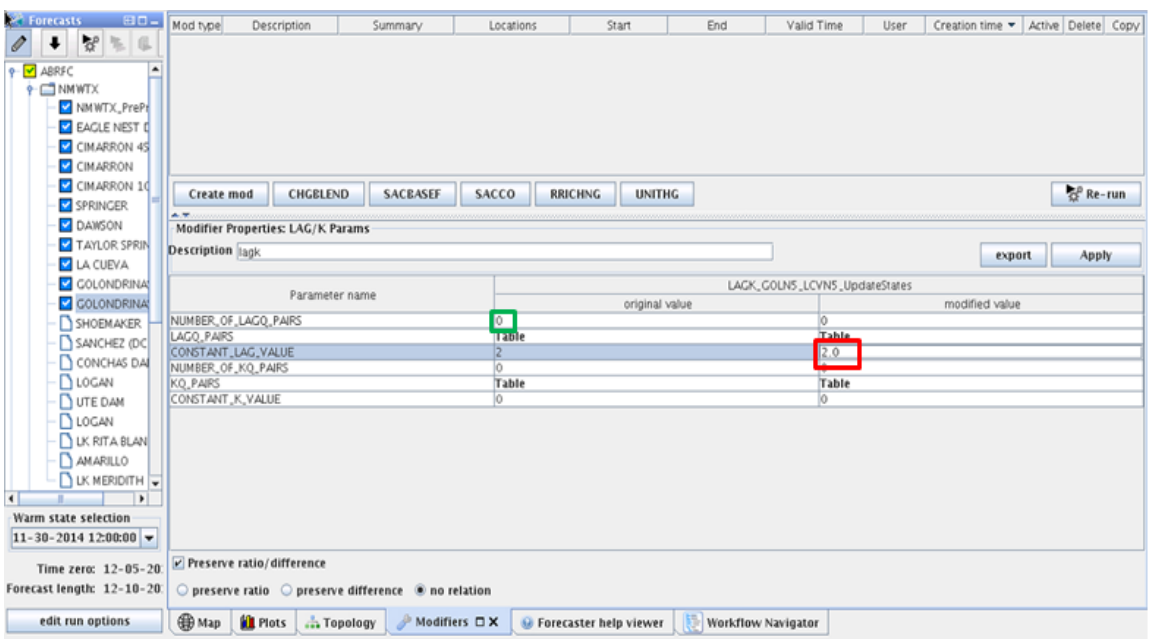
C) If you want to define an existing/new location to use variable LAG and/or K for the first time, then you have to manually edit the module parameter xml file (ModuleParFiles) instead of using the GUI.

Note: If you want to change the variable LAG/K parameter and not change the initial states, you will need to unzip the coldStates file (coldStateFiles), change the variable LAG/K parameter and then freshen existing file.

Example: how to modify constant LAG to variable LAG (refer B2).

<u>Old:</u>

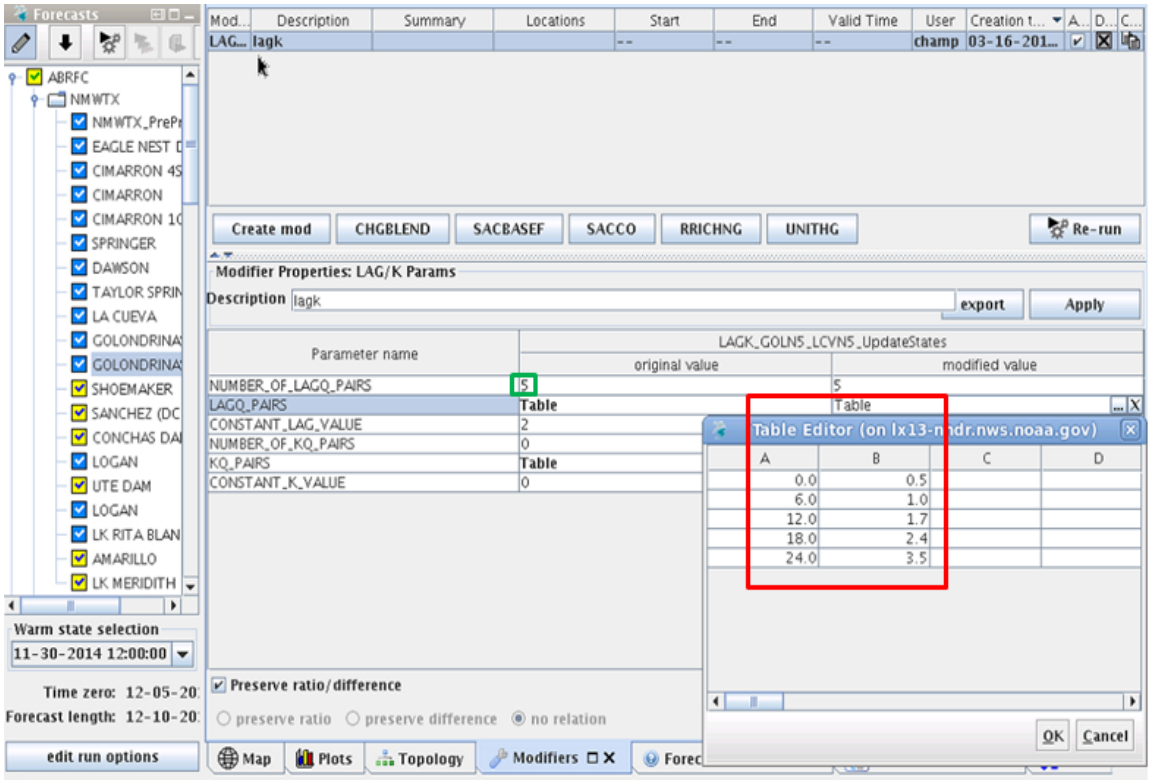
```
<parameter id="LAGQ_PAIRS">
    <table>
      <columnTypes A="double"/>
      <row A="2.0"/>
    </table>
</parameter>
<parameter id="NUMBER_OF_LAGQ_PAIRS">
    <intValue>0</intValue>
</parameter>
```



New:

```
<parameter id="LAGQ_PAIRS">
    <table>
      <columnTypes A="double" B="double"/>
      <row A="0.000" B="0.5"/>
      <row A="6.000" B="1.0"/>
      <row A="12.000" B="1.7"/>
```

```
        <row A="18.000" B="2.4"/>
        <row A="24.000" B="3.5"/>
      </table>
    </parameter>
  <parameter id="NUMBER_OF_LAGQ_PAIRS">
      <intValue>5</intValue>
  </parameter>
```



6. Notes about configuring Model in FEWS workflow

Examples:
Module Configuration File:
ModuleConfigFiles\LAGK_PNTT2_GNVT2_Forecast.xml
Module Parameter File:
ModuleParFiles\LAGK_PNTT2_GNVT2_UpdateStates.xml

7. FEWS Adapter Used

The Lag/K model uses the OHDFewsadapter to communicate. Information about this adapter can be found at OHDFewsadapter.