# Interactive Verification Program User's Manual

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# 1. Introduction

### 1.1 Overview
The IVP program is tool for verifying hydrologic forecasts. It provides the ability to (1) view pairs of observations and forecasts, (2) compute statistics by category within an interval, and (3) transform the data into normalized space. It is intended as a "back-end" gui for the **Verify** program, and reads output generated by it. This manual describes how to operate the IVP.

### 1.2 Notation
Within this documentation, the following notational conventions are used:

- *Italics* will denote gui components and chart types within the program.
- CAPITAL LETTERS will denote the names of windows within the program.
- "Quotations" will denote file names and Apps-defaults tokens.

All figures mentioned within this documentation will be attached in order at the end.

### 1.3 Data
The IVP uses pairs files generated by the **Verify** program. It expects the files to be located in the directory corresponding to the Apps-defaults token "vsys_output". By default, this is the directory

/awips/hydroapps/rfc/verify/output/<user>

where <user> is the user name for the person running the program. This directory can be changed by overriding the Apps-defaults token "vsys_output".

### 1.4 Starting It Up
To start IVP, open up a term window and type in the following at the prompt:

- cd $(get_apps_defaults vsys_dir)/scripts
- ivp

If you have fun_go installed, you can replace the first command with

- go verify scripts

After typing in the "ivp" command, a window will popup with a title of "Select Data Source". This is a SELECT DATA SOURCE window (described in the next section).

### 1.5 Comment
The IVP program is available on both the Unix and Windows platforms. It is recommended that it be tried on the Unix platform first, and if it proves to be intolerably slow, then try it on the Windows platform. The IVP program will not run correctly through Exceed.

# 2. SELECT DATA SOURCE Window

The SELECT DATA SOURCE window, shown in Figure 1, provides the means for the user to select files from which to read data and then choose specific location ids (lids) to extract from the files. It is used to create a DATA SOURCE DISPLAY window, which is the main analysis window for the verification process. The components of this window are:

- *Title*: The title is always "Select Data Source".
- *Files To Load* list: The top list is marked with the label "Files to Load:", and provides a list of the currently selected files from which data is to be extracted. Each file is listed as a complete path name.
- *Available LIDs* list**:** The *Available LIDs* list a list of the currently available lids paired with a physical element (pe). Each element of this list will have the format,

  <lid> (<pe>)

  To select an (lid, pe) pair, just click on it. Multiple pairs may be selected.
- *Buttons*: There are seven buttons on the SELECT DATA SOURCE window, each of which will be described below.

Step by step instructions for creating a new data source are provided in Summary 1.

**2.1 *Add File* Button**
Clicking on the *Add File* button brings up a file dialog which is used to select files to add to the *Files to Load* list. It works as any other file browser works. Just find the file, click on it, and click the *Okay* button. The only requirement that must be met for a file to be added to the list is that the file name must contain the string ".pairs" at some point. A warning message will be displayed if the file name is invalid and the file will not be added to the list.

**2.2 *Remove File* Button**
Clicking on the *Remove File* button removes the selected file from the *Files to Load* list.

**2.3 *Fill LIDs* Button**
The *Read Data* button compiles a list of (lid,pe) pairs, available within the files in the *Files to Load* list. It then fills up the *Available LIDs* list (described below). The process of compiling the list may take several seconds, depending on the number of files and the sizes of those files.

★ NOTE: The IVP will attempt to read from every file within the *Files To Load* list. The only check for a file format error is performed based on the assumption that a line of valid paired data will consist of exactly 16 fields separated by the character '|'. If a line does not satisfy this assumption, it will not be read.

★ NOTE: Reading the data is the slowest aspect of the IVP.

**2.4 *Select All* Button**
Clicking on the *Select All* button selects all (lid, pe) pairs.

**Summary 1: Instructions for Creating a DATA SOURCE DISPLAY WINDOW**

1. Click on the *Add File* button to choose all the files from which to read the data.
2. Click on the *Fill LIDs* button to fill in the *Available LIDs* list once you have chosen all the files.
3. Select the (lid, pe) pairs for which you want data.
4. Click *Okay*.

### 2.5 *Clear* Button

Clicking on the *Clear* button deselects all (lid, pe) pairs.

### 2.6 *Cancel* Button

Clicking the *Cancel* button closes the SELECT DATA SOURCE window. If there is no DATA SOURCE DISPLAY window currently open, IVP will shutdown.

### 2.7 *Okay* Button

Clicking the *Okay* button reads in the data for the selected (lid, pe) pairs, with the requirement that all the pairs must have the same pe. If this requirement is met, then the data will be read in and a DATA SOURCE DISPLAY window will be opened for the selected data.

## 3. DATA SOURCE DISPLAY Window

The DATA SOURCE DISPLAY window, shown in Figure 2, is the main display of the data. The components of this window are:

- *Title*: The window *Title* is "Data Source #<num>", where <num> is the identification number for this set of data.
- *Menu Bar*: The *Menu Bar* has three menus: *Actions* menu, *Options* menu, and *Charts* menu. Each menu and its menu items are described below.
- *Data Tracker*: The *Data Tracker* is placed on the window's menu bar and has the format "(<x>,<y>)", where <x> is the x-axis value corresponding to the current location of the mouse pointer inside the chart, and <y> is the y-axis value.
- *Data Scatter Plot*: The *Data Scatter Plot* is a scatter plot of all the data read in by the SELECT DATA SOURCE window. It takes up most of the window and the scatter points are broken down by lid. A legend is provided at the right giving the symbol that corresponds to each lid.

Some other features are:

- The window is resizable. However, there may be a delay whenever the window is resized as the chart gets redrawn.
- The chart may be clicked on. For more details, see the *Zoom In/Zoom Out* button and the BOUNDS EDITOR window, described below. If the zoom mode is not on and the BOUNDS EDITOR window is not open, the click will have no effect.

All of the menu items within the menu bar will now be described.

**3.1 *Actions* Menu: *Open New Data* Menu Item**
Clicking on the *Open New Data* menu item will open up a SELECT DATA SOURCE window (see section 2). Once the *Okay* button within this window is clicked, and the select (lid, pe) pairs are valid, a new DATA SOURCE DISPLAY window will be opened with a new data source and identification number.

**3.2 *Actions* Menu: *Change Data Source* Menu Item**
Clicking on the *Change Data Source* will have the same result as clicking on the *Open New Data* menu item, except that the current DATA SOURCE DISPLAY will be changed and no new windows will be opened. Its data source will have the same identification number but will contain the newly select (lid, pe) pairs, and the *Data Scatter Plot* will be cleared and drawn from scratch. The BOUNDS EDITOR window will also be refreshed (i.e. initialized; see below).

★ NOTE: Any charts spawned from this DATA SOURCE DISPLAY will NOT be redrawn automatically for this data change. To redraw a chart, click the *Refresh* menu item on that chart (see below).

**3.3 *Actions* Menu: *Close* Menu Item**
Clicking on the *Close* menu item will close this DATA SOURCE DISPLAY and any chart or windows spawned from this DATA SOURCE DISPLAY. Also, if there are no other DATA SOURCE DISPLAY windows open, IVP will shutdown.

**3.4 *Actions* Menu: *Exit* Menu Item**
Clicking on the *Exit* menu item will shutdown the IVP.

**3.5 *Options* Menu: *Apply NQT...* Menu Item**
Clicking on the *Apply NQT...* menu item applies the Normal Quantile Transform (NQT), described in Summary 2, to both the x and y axis variables, transforming each into standard normal variables. It has two sub-menu items, one of which must be selected for anything to happen:

- *By Segment*: Clicking the *By Segment* sub-menu item will apply the NQT for each lid independently. This is the recommended approach.
- *For All*: Clicking the *For All* sub-menu item will apply the NQT for all the lids lumped together.

Upon selecting one of the two sub-menu items, the following will happen: (1) the *Data Scatter Plot* will change to display the transformed data, (2) the BOUNDS EDITOR window will refresh, and (3) the *Apply NQT...* menu item will be disabled while the *Recover Original Data* menu item will be enabled.

**Summary 2: How the Normal Quantile Transform (NQT) Is Applied**

The NQT is applied by first computing an empirical estimate, F, of the cumulative distribution function for the data set X. Then, for every sample value, x, in the data set X, a new sample value is generated as

$$z = Q^{-1}(F(x)),$$

where Q is the standard normal cumulative distribution function. The data set Z containing all the transformed values from X is then the NQT transformed data set.

### 3.6 *Options* Menu: *Recover Original Data* Menu Item

Clicking on the *Recover Original Data* menu item will undo any changes to the data by clicking on the *Apply NQT...* menu item, described above. Upon clicking the menu item, the following will happen: (1) the *Data Scatter Plot* will change to display the original data, (2) the BOUNDS EDITOR window will refresh, and (3) the *Recover Original Data* menu item will be disabled (i.e. it cannot be clicked) while the *Apply NQT...* menu item will be enabled.

### 3.7 *Options* Menu: *Edit Bounds* Menu Item

Clicking on the *Edit Bounds* menu item will open up the BOUNDS EDITOR window (see Section 4) associated with this DATA SOURCE DISPLAY.

### 3.8 *Options* Menu: *Clear Bounds* Menu Item

Clicking on the *Clear Bounds* menu item will refresh the BOUNDS EDITOR window associated with this DATA SOURCE DISPLAY.

### 3.9 *Options* Menu: *Show Line y = x/Hide Line y = x* Menu Item

Clicking on the *Show Line y = x/Hide Line y = x* menu item either displays the line y = x, which is a green line connecting all points in which the x and y values are identical, or hides the line y = x. Which of these actions it performs is decided according to the current label of the menu item.

### 3.10 *Options* Menu: *Zoom In/Zoom Out* Menu Item

Clicking the *Zoom In/Zoom Out* menu item either turns on zoom mode, which allows the user to zoom in on a region of the *Data Scatter Plot*, or recovers the original plot dimensions. Which of these actions it performs is decided according to the current label of the menu item. Instructions on how to zoom in on a region are given in Summary 3.

### 3.11 *Charts* Menu

By clicking on a menu item within the *Charts* menu, a specific CHART window will be opened up. Each of the chart types is described in Section 6. Details about the different chart types and how to use the chart menu are described below.

**Summary 3: Instructions for Zooming In On A Region**

1. Click on the menu item when its label is "Zoom In".
2. Press the left mouse button (DO NOT RELEASE) inside the *Data Scatter Plot* where you would like the upper left hand corner of the zoom region to be. When this is done, the following will happen: The *Data Tracker* will change its format to "(<x1>,<y1>) - (<x>,<y>)", where <x1> is the coordinate on the x-axis of the point you chose, and <y1> is the coordinate on the y-axis (<x> and <y> are the same as before).
3. Drag the mouse inside the *Data Scatter Plot* where you would like the lower right hand corner of the zoom region to be and release the button. When this is done the following will happen: (1) a box will be drawn showing the region you have select which will disappear when the button is release, (2) the data tracker will return to normal, (3) the limits on both the x and y axes will change to reflect the zoom region, and (4) the label of the menu item will change to "Zoom Out".

## 4. BOUNDS EDITOR Window

The BOUNDS EDITOR window, shown in Figure 3, provides the user with a mechanism to edit selected intervals along the x and y axes. The window consists of two check boxes, two lists, an editable text field, and a menu bar. The components of this window are:

- *Title*: The title will always be the title of the DATA SOURCE DISPLAY window which owns this BOUNDS EDITOR window with the string ": Bounded Regions Manager" concatenated on it. For example, if you opened the BOUNDS EDITOR window from a window titled, "Data Source #1," then the BOUNDS EDITOR window will have the title, "Data Source #1: Bounded Regions Manager."
- *X and Y Axis Selection* Check Boxes: The two check boxes, one for the x-axis and one for the y-axis, determine which interval lists are selected. Either one, both, or neither may be checked and unchecked by simply clicking on the box.
- *X and Y Axis Intervals* Lists: The two lists, one for the x-axis and one for the y-axis, display the intervals currently selected along both axes. Each list line will specify the interval on the left (in typical mathematical notation) and the number of observations in the interval on the right.
- *Value* Text Field: The *Value* text field is a multipurpose text field and may be edited by the user. It will be referred to below as needed.

The initial interval for an axis is the interval [<lb>, <ub>], where <lb> is the smallest value along the axis and <ub> is the largest. Refreshing or initializing the intervals will set the current intervals to be the initial intervals. Instructions for how to create a new interval are given in Summary 4. The menu bar items will now be described.

★ NOTE: Whenever the interval list changes for either axis, the *Data Scatter Plot* of the DATA SOURCE DISPLAY window will be redrawn, with blue lines showing where the current interval boundaries are. The smallest and largest boundaries, or the minimum and maximum value along each axis, will not be displayed.

**Summary 4: Instructions for Creating a New Interval**

A new interval can be created through the BOUNDS EDITOR or by clicking on the DATA SOURCE DISPLAY as follows:

1. Click on the check box for each axis for which you want to create an interval.
2. Either,
   a. click at the point inside the *Data Scatter Plot* of the DATA SOURCE DISPLAYwhere the interval boundary is to be inserted (paying attention only to the current axis, or axes, selected), or
   b. enter a floating point value in the *Value* text field which is the interval boundary to be inserted and click on the *Add Value To Regions* menu item from the *Actions* menu (described below).

When these two steps are completed, the following will happen: (1) the interval list for the axis, or axes, selected will be searched and the interval boundary will be inserted into the appropriate location, thus slicing one of the existing intervals into two pieces about this new boundary, and (2) the *Data Scatter Plot* of the DATA SOURCE DISPLAY window will be updated with the new interval boundaries.

### 4.1 *Actions* Menu: *Create Default Using Value As...* Menu Item

Clicking on the *Create Default Using Value As...* menu item will setup default intervals on the currently selected axis or axes. It has two sub-menu items, one of which must be selected for anything to happen:

- *Minimum Size*: Clicking the *Minimum Size* sub-menu item will read in an integer from the *Value* text field and then create a set of intervals such that no interval has fewer points than that integer.
- *Number Of Regions*: Clicking on the *Number Of Regions* sub-menu item will read in an integer from the *Value* text field and then create a set of intervals such that the number of intervals is that integer and each interval is of equal size.

Once one of the two sub-menu items is clicked, the bounds for the selected axis, or axes, will be removed and the default interval boundaries will be added.

★ NOTE: If an invalid string is in the *Value* text field (i.e. if it expects an integer but reads a float) then an error message dialog will be displayed and nothing will be done.

### 4.2 *Actions* Menu: *Add Value To Regions* Menu Item

Clicking on the *Add Value To Regions* menu item will create a new interval, as described in the instructions in Summary 4.

### 4.3 *Actions* Menu: *Remove Selected Region(s)* Menu Item

Clicking on the *Remove Selected Region(s)* menu item will remove all currently selected regions.

### 4.4 *Actions* Menu: *Merge Selected Regions* Menu Item

Clicking on the *Merge Selected Regions* menu item will merge all of the selected regions into one larger region. The selected regions must be adjacent, or an error message will be displayed.

**4.5 *Actions* Menu: *Clear Regions* Menu Item**
Clicking on the *Clear Regions* menu item will refresh the bounds for the selected axis, or axes, to their initial values.

**4.6 *Actions* Menu: *Close* Menu Item**
Clicking on the *Close* menu item will close the BOUNDS EDITOR window. The interval boundaries cannot be changed by clicking on the *Data Scatter Plot* while the BOUNDS EDITOR window is closed.

## 5. CHART Window

The CHART window is a generic window that displays a chart as selected by the user and provides some limited functions. The components of the window are:

- *Title*: The title will always be the title of the DATA SOURCE DISPLAY window which owns this CHART window with the string ": <chart name>" concatenated on it. The <chart name> is just a name describing the chart.
- *Menu Bar*: The *Menu Bar* has one menu: *Actions* Menu. Its menu items will be described below.
- *Data Tracker*: The *Data Tracker* is the same as the *Data Tracker* in the DATA SOURCE DISPLAY window.
- *Plot Area*: The *Plot Area* is the area of the window devoted to displaying the selected chart. It may or may not have a legend.

As with the DATA SOURCE DISPLAY window, the CHART window is resizable, but it may take it a few seconds to redraw the chart. However, clicking on a CHART WINDOW will have no effect. The two menu items in the *Actions* menu will now be described.

**5.1 *Actions* Menu: *Refresh* Menu Item**
Clicking the *Refresh* menu item will cause the CHART window to redraw itself. It will pickup any changes to the data within the DATA SOURCE DISPLAY window that owns it, and any changes in the interval settings within the BOUNDS EDITOR window that is associated with it.

★ NOTE: Any changes to the DATA SOURCE DISPLAY window or BOUNDS EDITOR window associated with a chart will NOT be picked up until you click that chart's *Refresh* button.

**5.2 *Actions* Menu: *Close* Menu Item**
Clicking the *Close* menu item will dispose of this CHART window.

# 6. The Charts

This section describes each of the charts and how they are constructed. The general instructions for creating a chart are given in Summary 5. A description of how the data sets are prepared will now be provided, followed by a description of every type of available chart.

## 6.1 Data Set Preparation

When a plot is generated, one of three approaches will be used to setup the data set for computation of the chart's statistics. When each of the charts is described, it will be stated which approach is used.

> Approach 1: Interval Subsets Approach
> The data set displayed within the DATA SOURCE DISPLAY window is broken down into subsets based on the selected axis and its intervals, and the chart statistics are computed and displayed for the non-selected axis and for each subset. For example, if the observed axis is selected and one of the intervals is (5.5, 6.5], then one of the subsets created will consist of all of the points for which the observed value is larger than 5.5 and no larger than 6.5. Once the subset is created, the chart statistics will be computed for the forecasted values of all the points within the subset.
>
> Approach 2: Categorical Approach
> The statistics produced by the chart are based on the intervals created for the selected axis. These intervals are used to define categories within the total data set. The categorical statistics currently provided are described below.
>
> Approach 3: LID Subset Approach
> The data set displayed within the DATA SOURCE DISPLAY window is broken down into subsets based on the lid. Then statistics are produced based on these subsets.

Any chart that requires computation of statistics based on intervals or categories will have two sub-menu items associated with its menu item in the *Chart* menu of the *DATA SOURCE DISPLAY.* One submenu item will correspond to the observed data axis and the other to the simulated data axis. So the user can select which set of interval or categories to use.

## 6.2 *Probability Bar Plot* Chart

The *Probability Bar Plot* chart, shown in Figure 4, is constructed using the Interval Subset Approach. The statistics computed are the specific probability quantiles, i.e. for probability p, the probability quantile is x such that $P(X \leq x) = p$, and they are displayed in the form of a bar chart. For example, if the user has selected that the observed regions are used, the statistics are computed based on the forecasted values. So, read the chart as,

"When the observed value is within a specific interval, the forecast has a 25% chance of being in blue region, a 25% chance of being in the yellow region (or 50% chance of being in the yellow or blue regions), a 25% chance of being in the red region (or 75% chance of being in the red, yellow, or blue regions), and a 25% chance of being above the red region."

**Summary 5: Instructions for Creating A Chart**

1. Click on the *Edit Bounds* menu item to open up the BOUNDS EDITOR window.
2. Create intervals, as described in the section on the BOUNDS EDITOR window, for either one or both of the axes.
3. Click on the menu item for the chart you wish to create.
4. Click on the appropriate sub-menu item.

These steps work for all charts that are created over intervals (approaches 1 and 2 in the Data Set Preparation section). If a chart is not created for intervals, then you need only follow step 3, and step 4 where appropriate.

### 6.3 *Error By Region* Chart

The *Error By Region* chart, shown in Figure 5, is constructed using the Interval Subset Approach. The statistics computed are,

- Root Mean Squared Error (RMSE)
- Maximum Error (MaxErr)
- Mean Absolute Error (MAE)
- Mean Error (ME)

The legend will show which symbol corresponds to which error statistic.

### 6.4 *Categorical Stats* Chart

The *Categorical Stats* chart, shown in Figure 6, is constructed using the Categorical Approach. It is the only chart with two y axes. The following table will be used to describe the computation of each categorical statistic:

| | Observed was... | | |
|---|---|---|---|
| Forecast was... | below | within | above |
| above | **A** | **B** | **C** |
| within | **D** | **E** | **F** |
| below | **G** | **H** | **I** |

The table reads as, "B is the number of observed within the interval in which the corresponding forecast was above the interval" or, conversely, "B is the number of forecasts above the interval in which the corresponding observed was within the interval." The statistics computed and plotted against the left hand y-axis are,

- Probability of Detection (POD): The number of times the forecast and observed are both within the interval, divided by the total number of data points, or E/(B + E + H).

- Traditional False Alarm Rate (TFAR): The number of times the forecast is within the interval but the observed is not, divided by the total number of times the forecast is within the interval, or (D + F)/(D + E + F).
- Hydrologic False Alarm Rate (HFAR): The number of times the forecast is within the interval but the observed is too low, divided by the number of times the forecast is within the interval and the observed is within the interval or too low, or D/(D + E).
- Under Forecast Rate (UFR): The number of times the observed is within the interval and the forecast is below the interval, divided by the number of times the observed is within the interval, or H/(B + E + H).
- Over Forecast Rate (OFR): The number of times the observed is within the interval and the forecast is above the interval, divided by the number of times the observed is within the interval, or B/(B + E + H).

The average lead time of detection is provided as a gray bar plotted against the right hand y-axis. This statistic is computed by averaging the lead time (i.e. the difference between the basis time and valid time) for each of the detections, or points in which the forecast and observed are both within the interval.

The usefulness of the HFAR is best described through an example. Suppose for a specific lid, a minor flood stage and a major flood stage are available. Then, the HFAR over the interval from minor to major flood stage will tell the user the rate at which a minor flood is forecasted but no flooding occurs. Similarly, the HFAR over the interval above major flood stage will tell the user the rate at which a major flood is forecasted but either no flooding or minor flooding occurs.

### 6.5 ***Probability Range*** Chart

The *Probability Range* chart, shown in Figure 7, is constructed using the Interval Subset Approach. The statistics displayed are the probability quantiles, as described for the *Probability Range* chart, as well as the minimum and maximum. The legend will show which symbol corresponds to which quantile, minimum, or maximum.

### 6.6 ***Murphy Interval Histogram*** Chart

The *Murphy Interval Histogram* chart, shown in Figure 8, is constructed using the Interval Subset Approach. However, there are no statistics produced. Rather, the density function of the variable for which the statistics are normally produced is displayed within the interval. By displaying the density function, the spread of the statistics variable can be seen. The density is computed by (1) breaking down the range of the statistics variable into 10 equal sized sub-intervals, (2) counting the number of values of the statistics variable within each sub-interval, and (3) dividing it by the total number of points within the user selected interval. This proportion is then plotted against the midpoint of the subinterval. This is the standard method through which histograms are produced.

For example, suppose the user selected the observed regions, and one of the intervals is (5.5, 6.5]. The first step is to create a subset of the pairs data for which the observed value is between (5.5, 6.5]. Next, suppose that the forecasted values for the points in this subset range from 4 to 8.

For this chart, the interval [4, 8] is broken down into 10 sub-intervals of equal size, which means each sub-interval has a width of 0.4, or (8 - 4)/10. Then, for each sub-interval, the number of forecasted values within that interval is counted and divided by the total number of points within the interval [4, 8]. Then, that proportion is plotted against the midpoint of the sub-interval. So, a proportion is generated for [4, 4.4] and plotted against 4.2, for (4.4, 4.8] and plotted against 4.6, for (4.8, 5.2] and plotted against 5.0, and so on.

### 6.7 *Error By LID* Chart

The *Error By LID* chart, shown in Figure 9, is constructed using the LID Subset Approach. The statistics computed are the exact same as the *Error By Region* chart.

### 6.8 *Kolmogorov-Smirnov* Chart

The *Kolmogorov-Smirnov* chart, shown in Figure 10, is constructed using the Interval Subset Approach. The statistics displayed are the Kolmogorov-Statistics indicating the similarity of the conditional distribution in one Subset with the conditional distribution in the other Subsets.

One important characteristic of forecasts is discrimination. When forecasts are skillful the distributions in one interval will be distinct from the distribution for another interval. When the conditional distributions in the intervals are very distinct, the forecasts can be said to be discriminatory. When the forecasts are unskillful, neighboring distributions will overlap and the forecasts do not discriminate. The higher the K-S statistic the greater the difference between distributions. If the distributions are properly centered on the interval from which the sample has been extracted, it is possible to identify one set of forecasts as being more discriminatory and therefore better, than another.

The significance of the Kolmogorov-Smirnov statistic depends upon sample size. The critical values of the Kolmogorov-Smirnov statistic are listed in Table 1. If the Kolmogorov-Smirnov statistic is greater than the critical value the two distributions can be said to be different. [Table 1 is extracted from: Haan, C. T., Statistical Methods in Hydrology, Iowa State University Press, Ames, Iowa, 1977.]

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| Critical Values of the Kolmogorov-Smirnov Statistic | | | |
|---|---|---|---|
| Sample Size (N) | Significance Level | | |
| | 0.1 | 0.05 | 0.01 |
| 10 | 0.368 | 0.409 | 0.486 |
| 15 | 0.304 | 0.338 | 0.404 |
| 20 | 0.264 | 0.294 | 0.352 |

| | | | |
|---|---|---|---|
| 25 | 0.24 | 0.264 | 0.32 |
| 30 | 0.22 | 0.242 | 0.29 |
| 35 | 0.21 | 0.23 | 0.27 |
| 40 | | 0.21 | 0.25 |
| 50 | | 0.19 | 0.23 |
| 50 | | 0.17 | 0.21 |
| 70 | | 0.16 | 0.19 |
| 80 | | 0.15 | 0.18 |
| 90 | | 0.14 | |
| 100 | | 0.14 | |
| | | | |
| Asymptotic Formula | $1.22/\sqrt{N}$ | $1.36/\sqrt{N}$ | $1.63/\sqrt{N}$ |

**6.9 The *Cumulative Distribution* Chart**

The *Cumulative Distribution* (Figure 11) chart shows the conditional distributions derived using the Interval Subset Approach as cumulative distribution functions. They are shown in the *Murphy* plot as density functions.

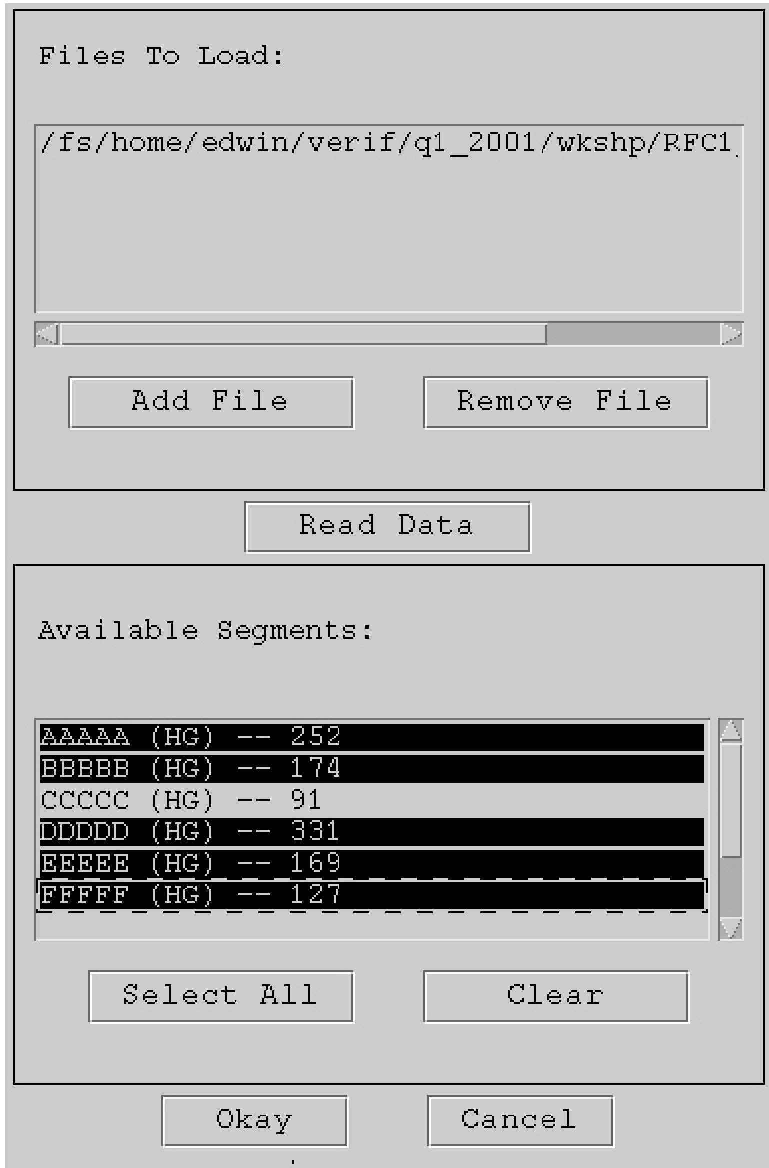


**Figure 1: SELECT DATA SOURCE window.**

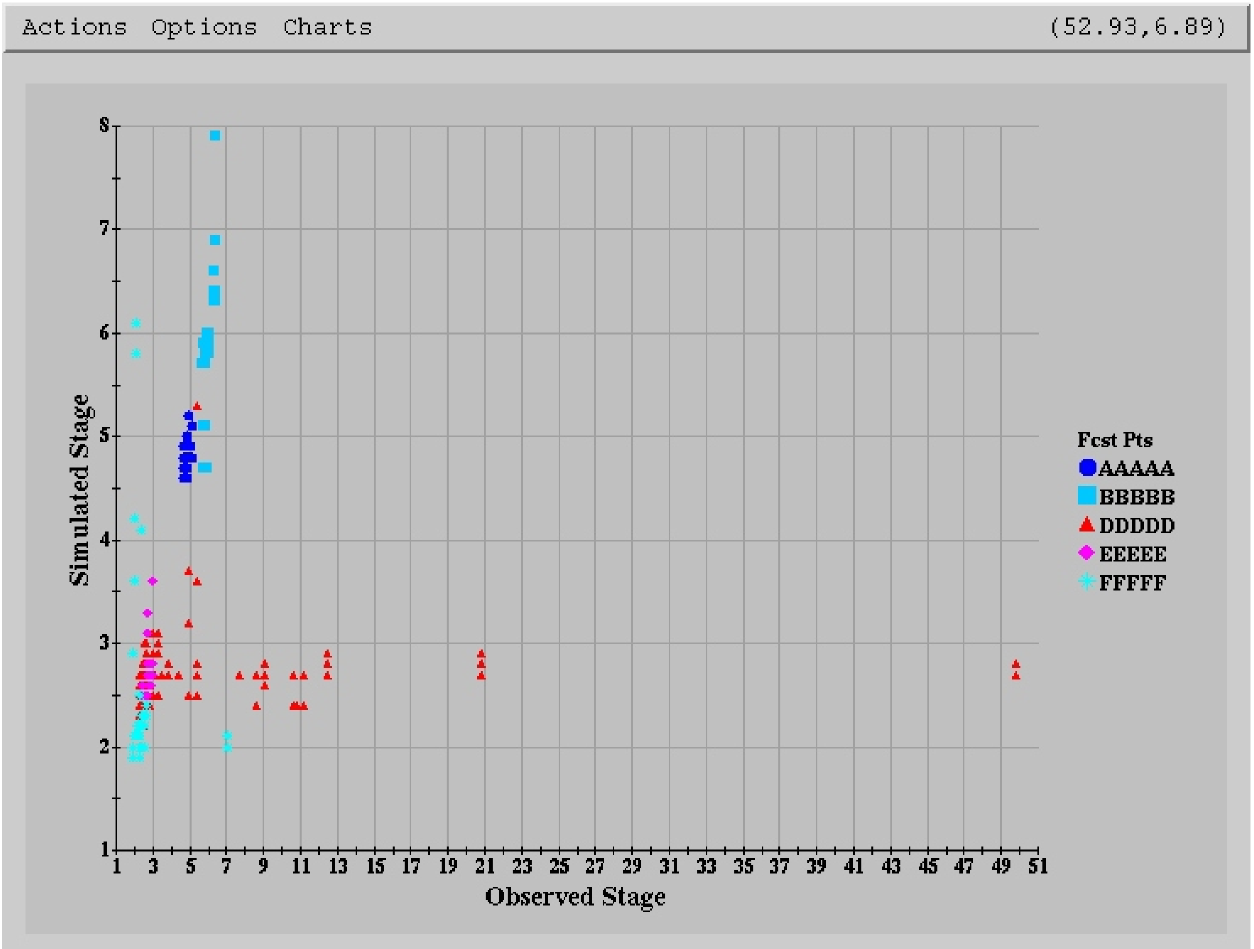


**Figure 2: The DATA SOURCE DISPLAY window.**

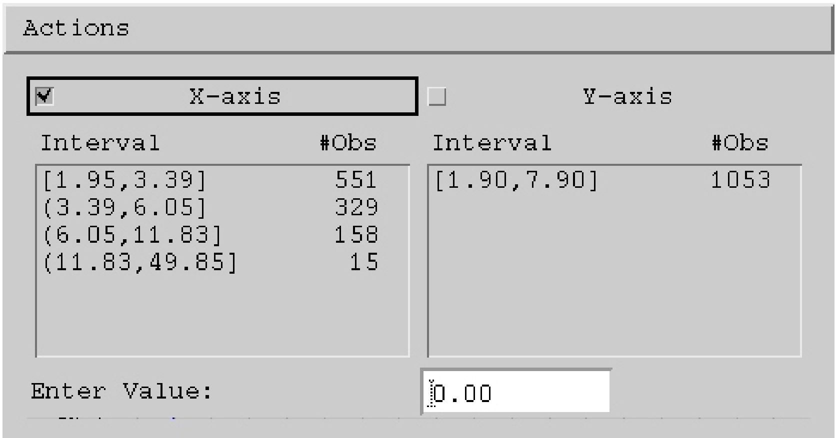


**Figure 3: The BOUNDS EDITOR window.**

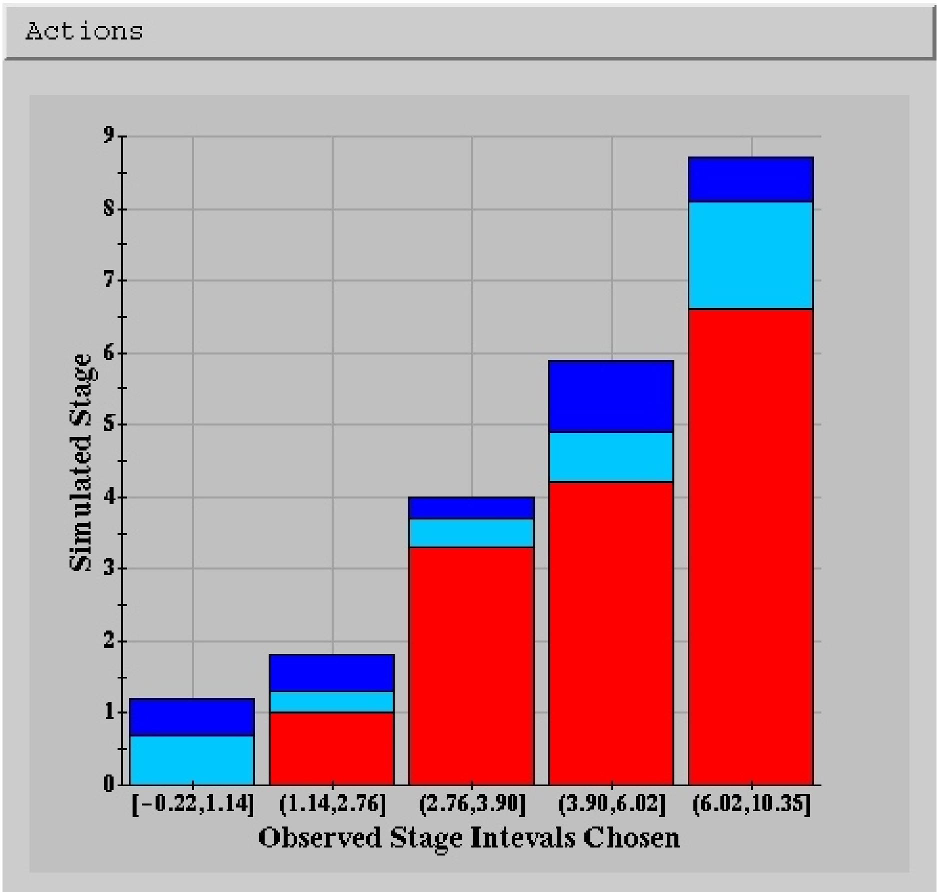


**Figure 4:** ***Probability Bar*** **chart.**

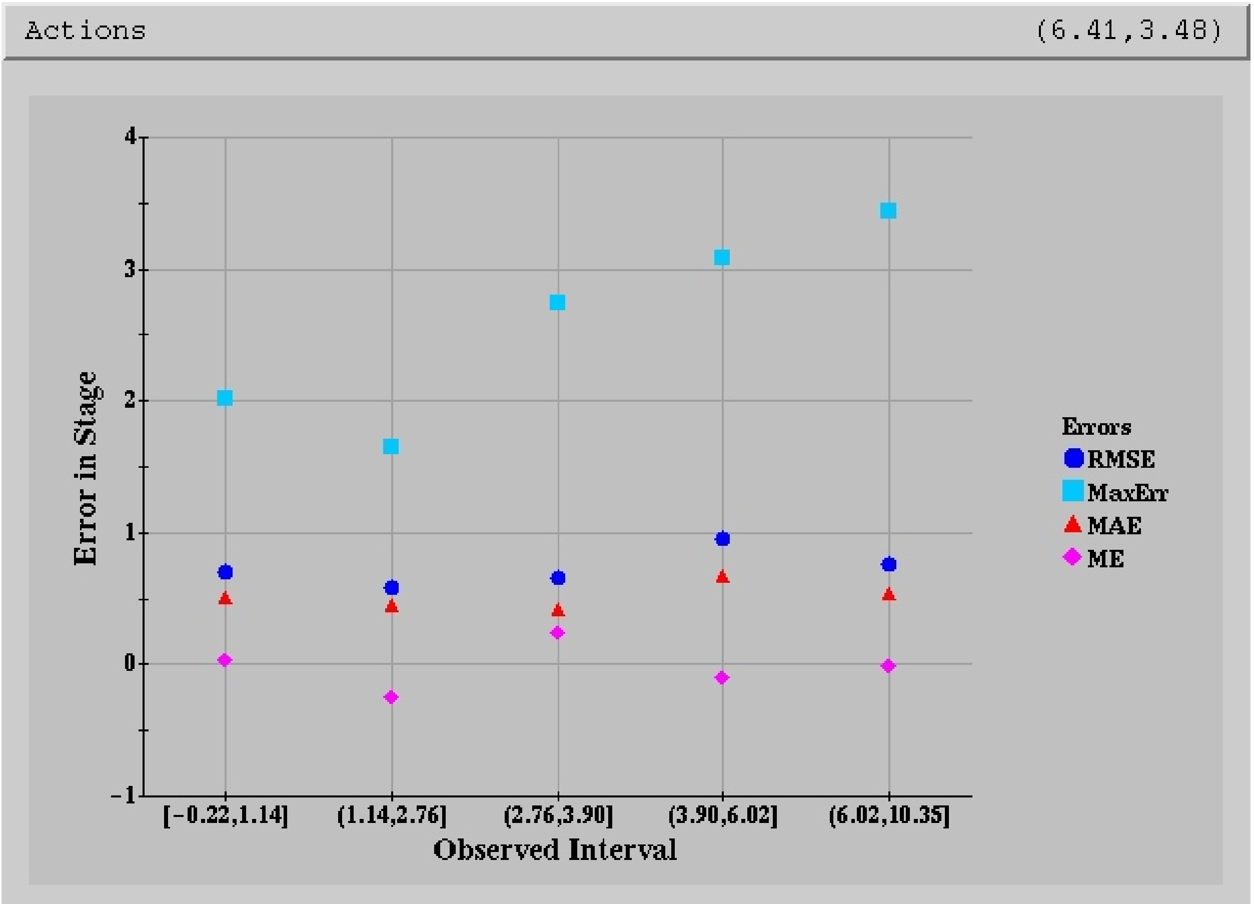


**Figure 5: *Error By Region* chart.**

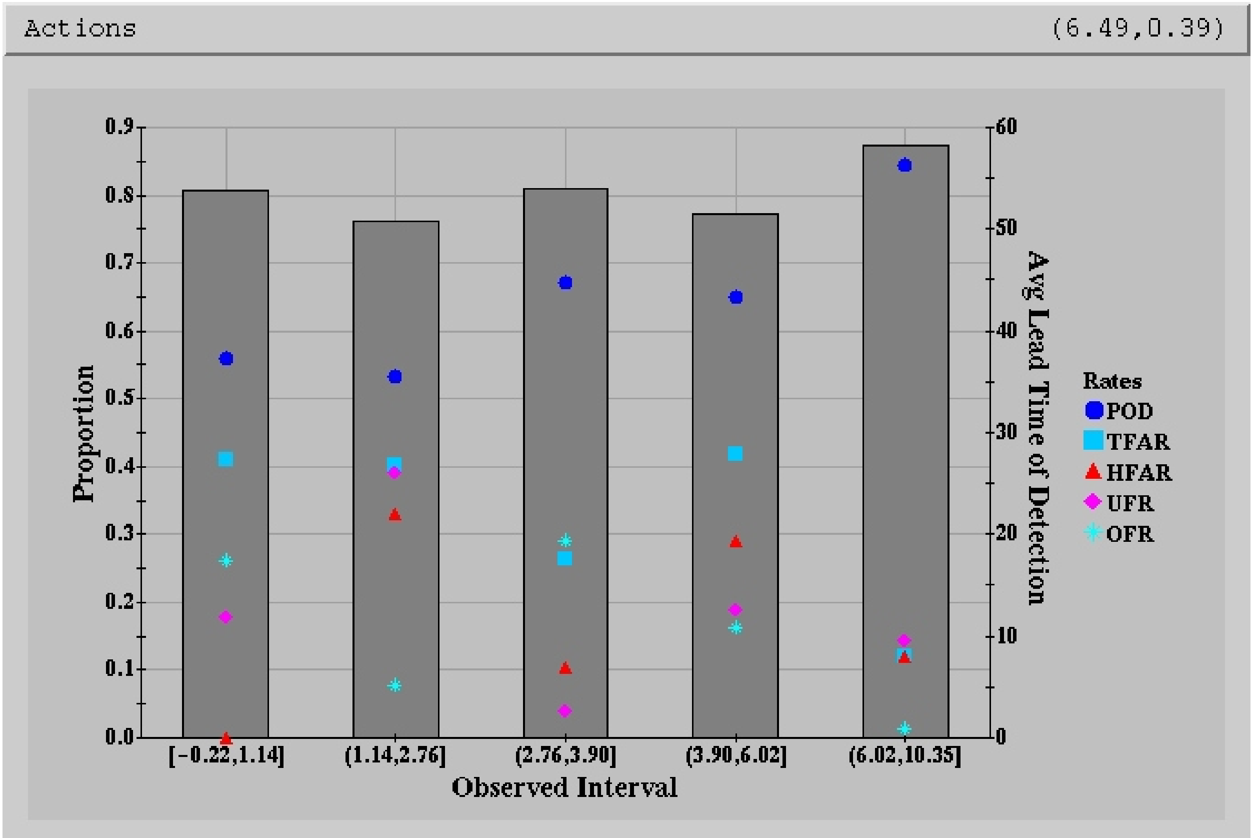


**Figure 6:** ***Categorical Stats*** **chart.**

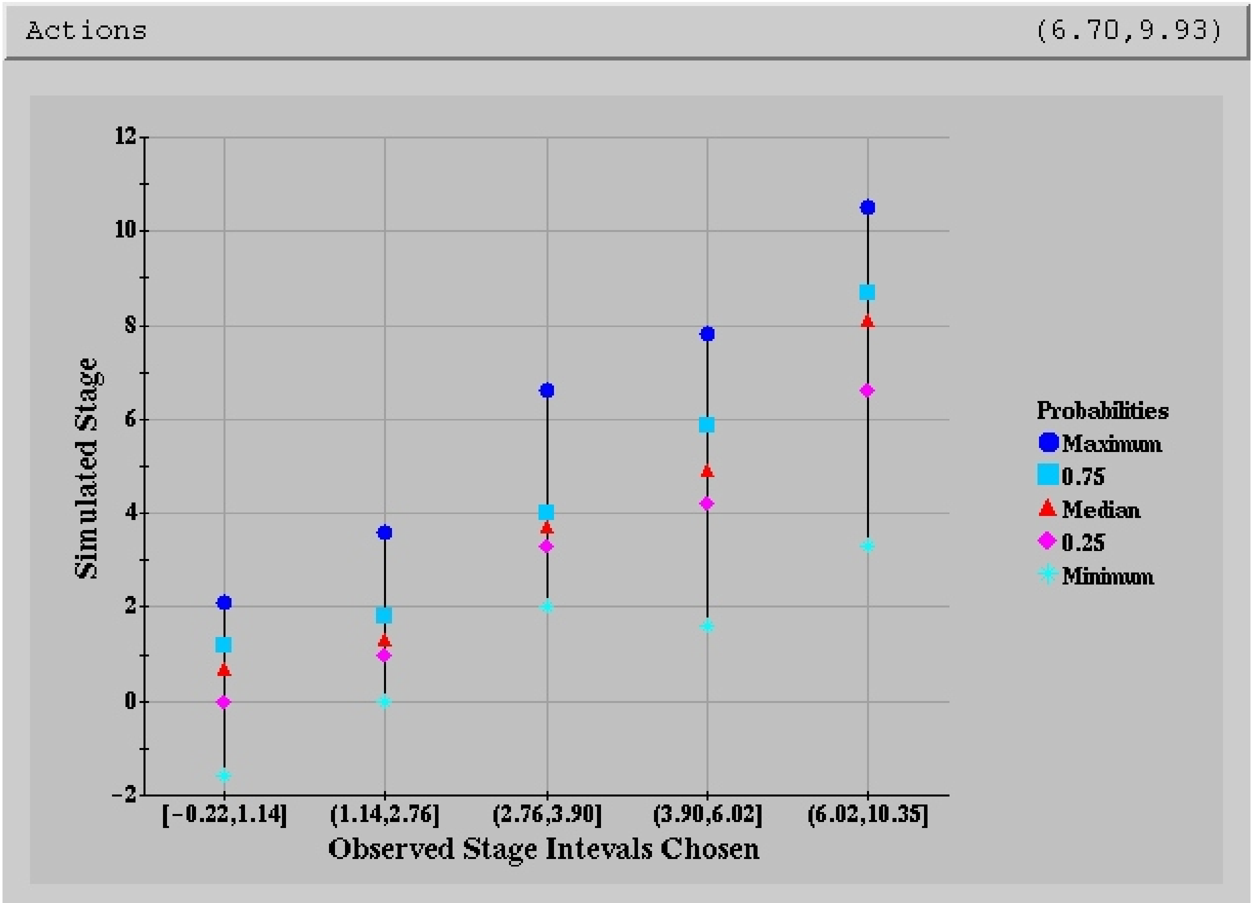


**Figure 7:** ***Probability Range*** **chart.**

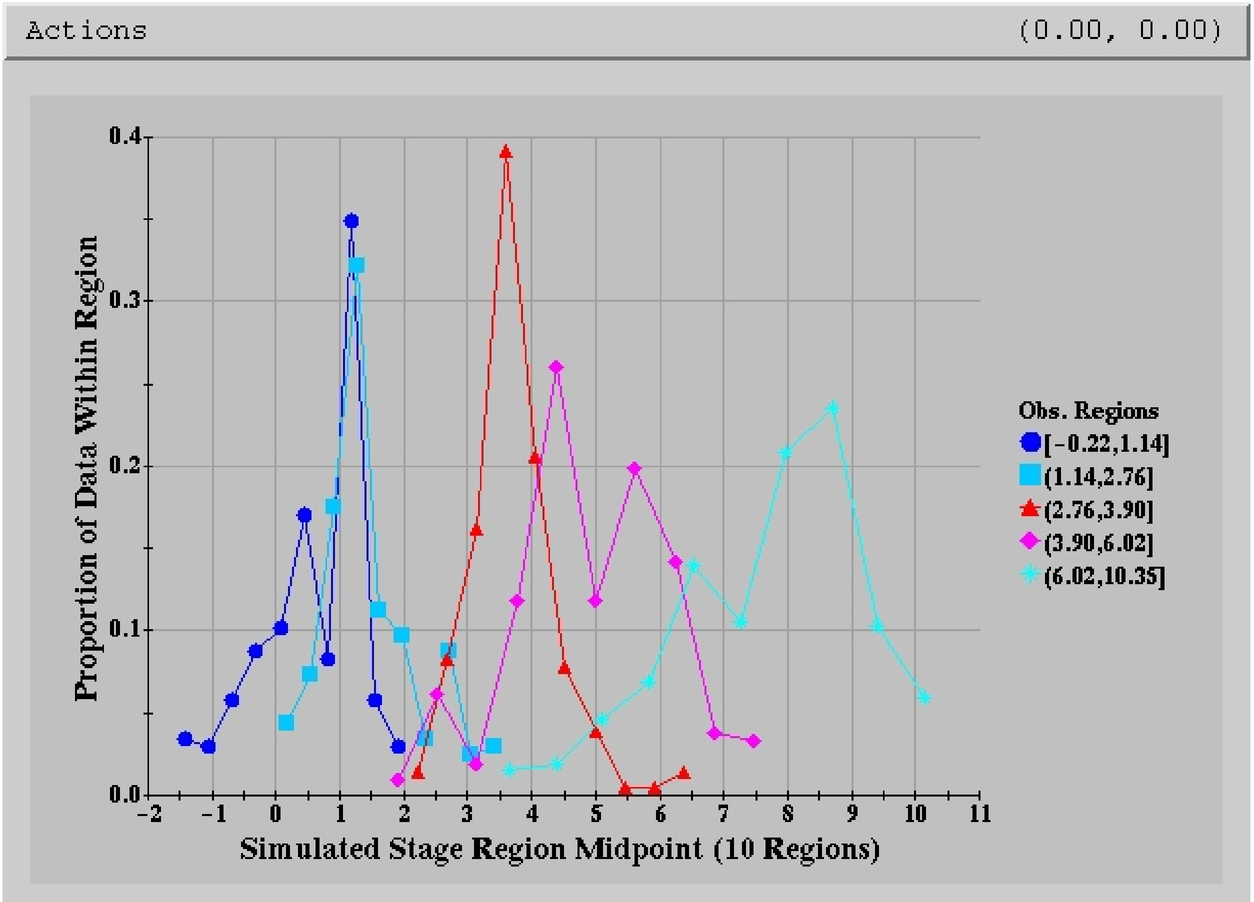


**Figure 8:** ***Murphy Interval Histogram*** **chart.**

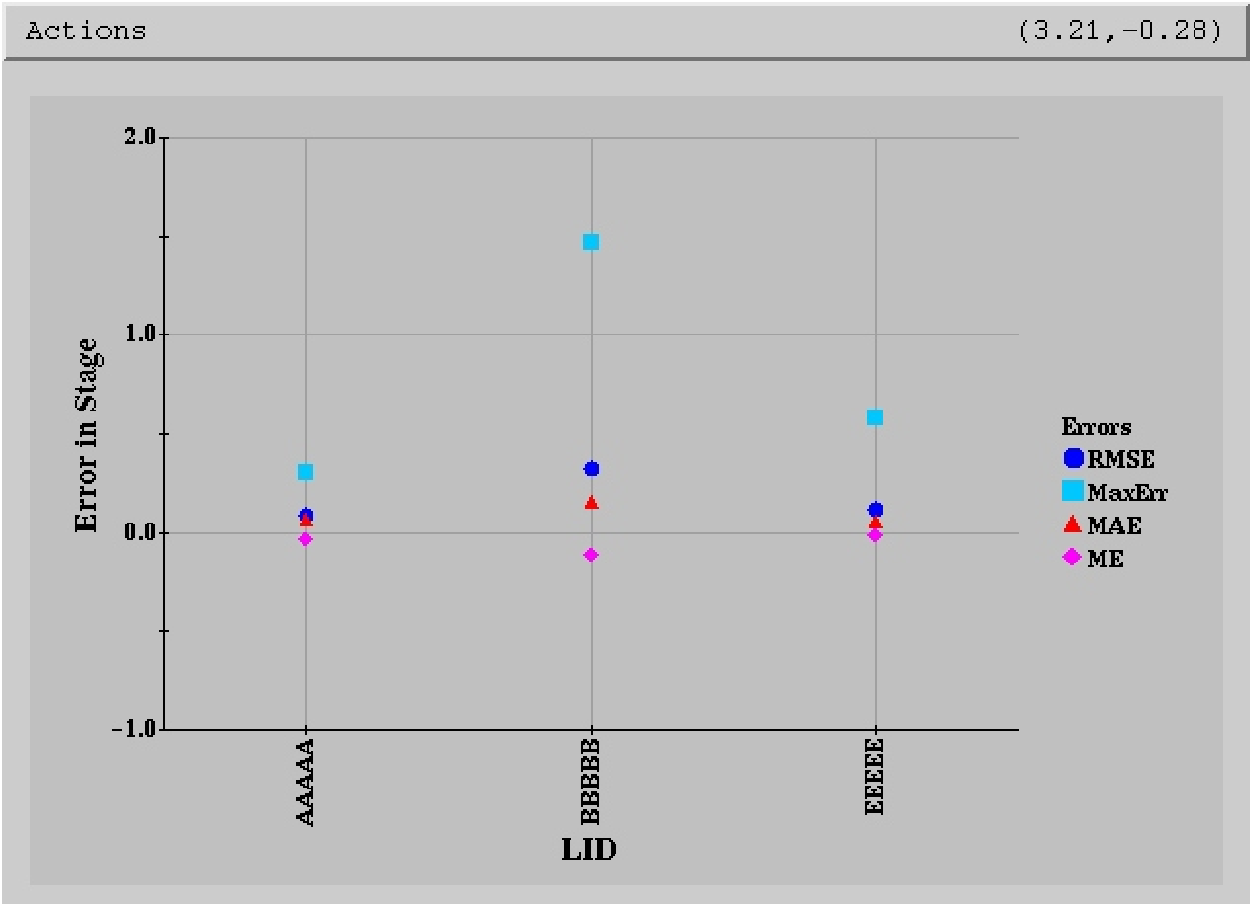


**Figure 9: *Error By LID* chart.**

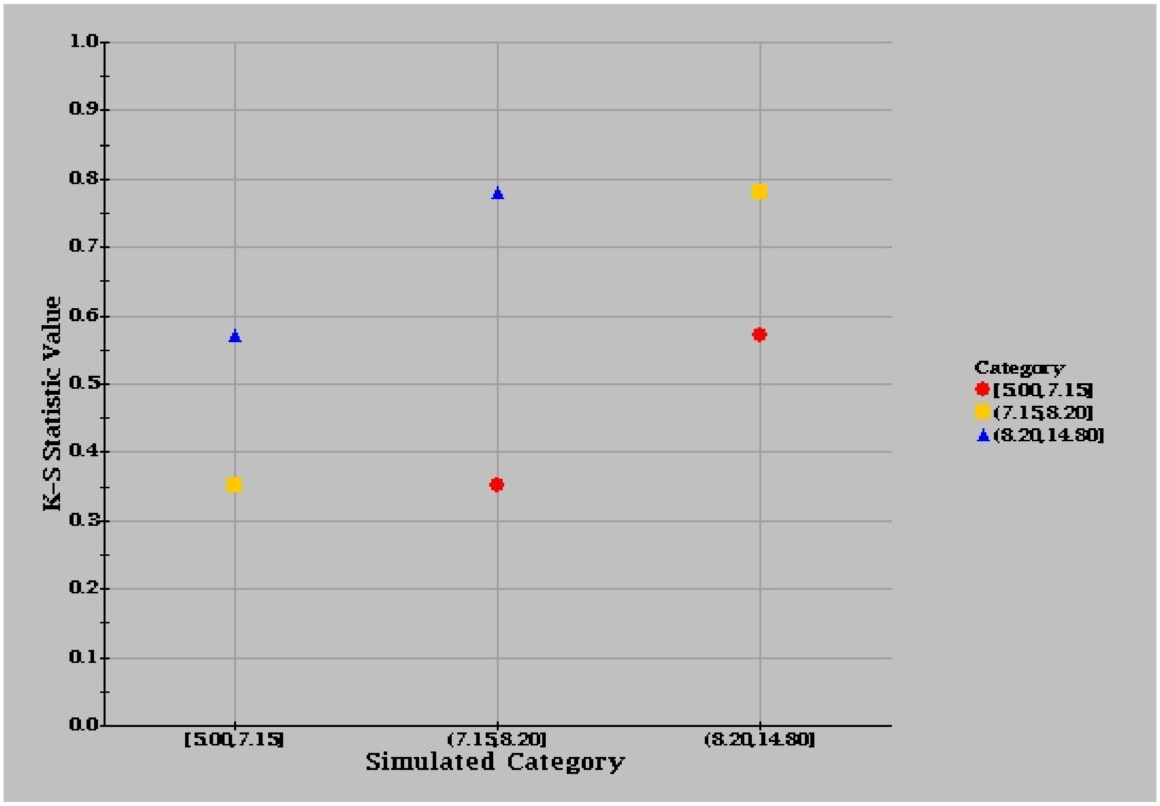


**Figure 10: The *Kolmogorov-Smirnov* Chart**

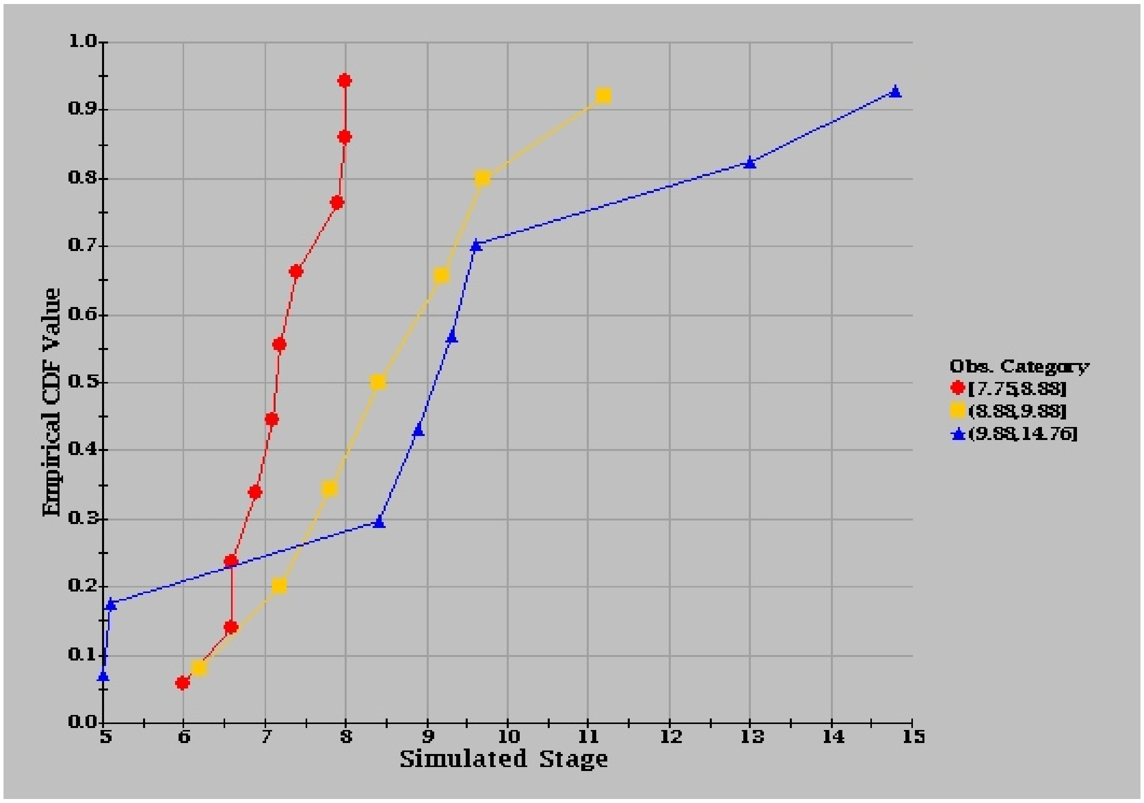


**Figure 11: The *Cumulative Distribution* Chart**