5.0 ESPVS Verification Statistics

The ESPVS system contains two primary components: trace ensemble generation and verification statistics generation.

Trace ensemble generation is discussed in Section 4.0; verification statistic generation is discussed in this section. The ESPVS GUI is comprised of several pulldown, including *File*, *Data*, *Preferences* (not currently active) and *Help*. *File* options allow the user either to load trace ensembles for statistical analysis or to close ESPVS.

5.1 File...Load

Figure 5-1 demonstrates the *File...Load* option. Selecting *Load* activates the Load trace GUI (Figure 5-2). User specified controls will determine the set of data files loaded into active analysis space within ESPVS. Available pulldown menus are created dynamically from all valid files (previously generated) in the *$(espts_dir)/verification* directory.
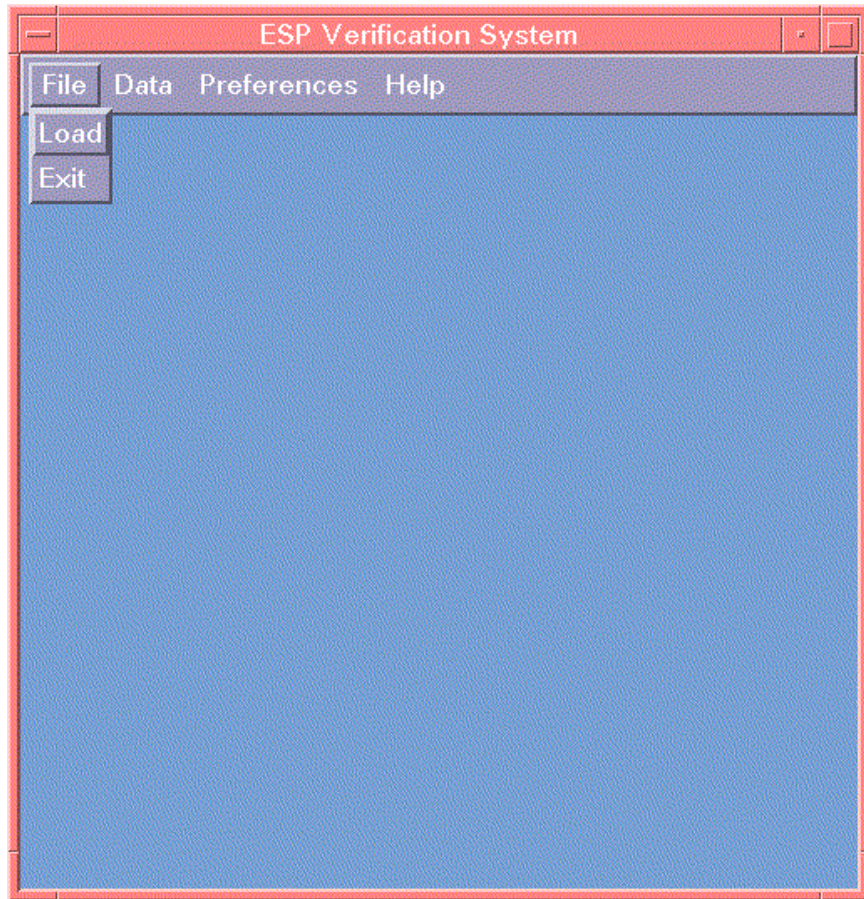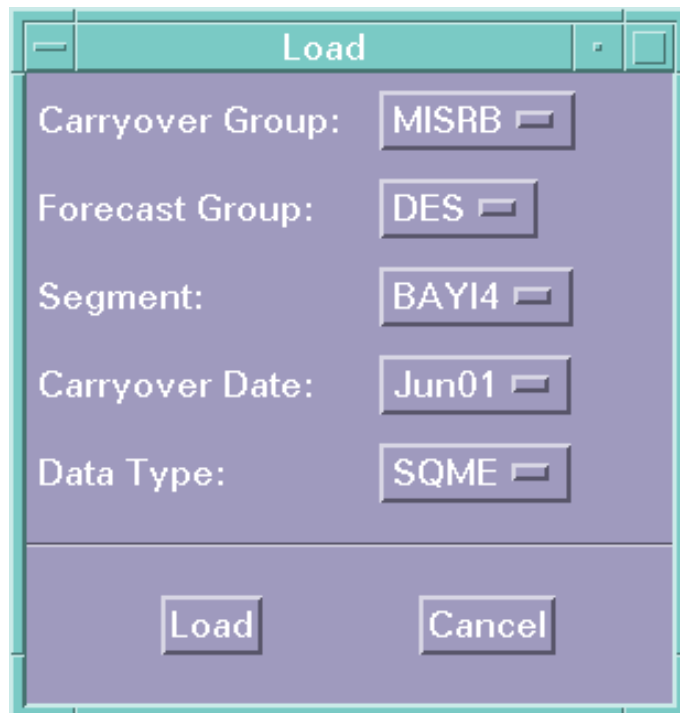
Figure 5-1

Figure 5-2

Load options include *Carryover Group*, *Forecast Group*, *Segment*, *Carryover Date* (month and day) and *Data Type*. All options are created dynamically from the existing verification trace ensemble data files.

Conditional verification, historical simulation and observed data will be required for each *Carryover Date* and *Data Type* designated during the *Load* process in order to calculate all the necessary statistics within the *Data...Verify* option of the ESPVS GUI. The following is an example of all files required during the *Load* process for Segment NEWI4SAC, for SQME data, generated with carryover on Nov 07, over historical water years 1960 - 1965:

```
NEWI4SAC.NEWI4.SQME.24.VS.1960Nov07
NEWI4SAC.NEWI4.SQME.24.VS.1961Nov07
NEWI4SAC.NEWI4.SQME.24.VS.1962Nov07
NEWI4SAC.NEWI4.SQME.24.VS.1963Nov07
NEWI4SAC.NEWI4.SQME.24.VS.1964Nov07
NEWI4SAC.NEWI4.SQME.24.VS.1965Nov07
NEWI4SAC.NEWI4.SQME.24.HS.Nov07
NEWI4SAC.NEWI4.SQME.24.OBS
```

Note that the historical simulation also is tagged with the carryover date and is generated for each simulation of verification trace files.

5.2 Data...Verify

The *Data...Verify* pulldown menu (Figure 5-3) operates on any data sets loaded into active space (the *File...Load* option is described in Section 5.1). Verification generates an interactive GUI. Currently, two displays are available: a tabular summary of verification statistics and a verification exceedance plot. The exceedance plot is the default display. Tabular statistics displayed combine a summary of trace ensemble statistics and statistical significance testing.
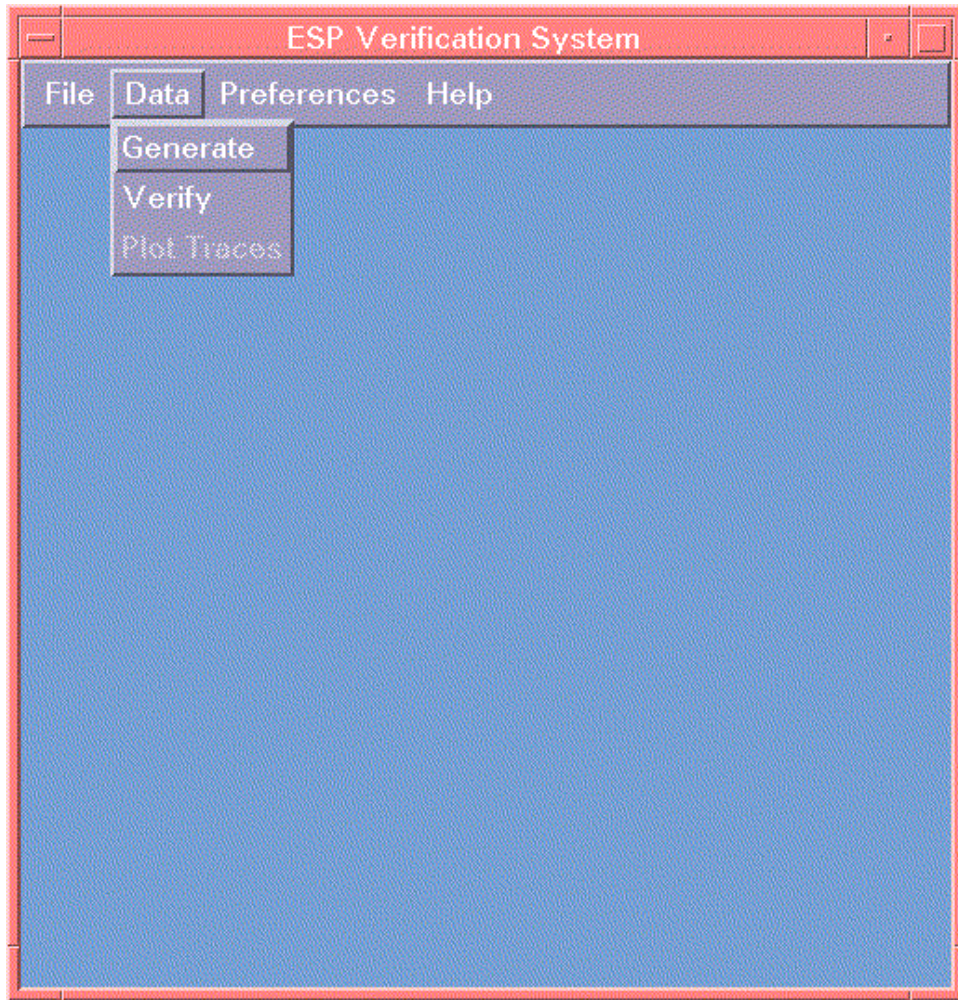
Figure 5-3

5.2.1 Exceedance Plot

Figure 5-4 shows an example of the exceedance plot generated by the verification program. This plot compares the forecast frequency over all historical years in which forecasts were made to the observed frequency over the same period. If there is no bias in the forecasts, the plot of points would follow the 45 degree line on the plot. One way to make a verification statement from this plot is to compare the X-axis value of the generally forecast exceedance probability to the Y-axis plot of the observed exceedance probability.

Figure 5-4

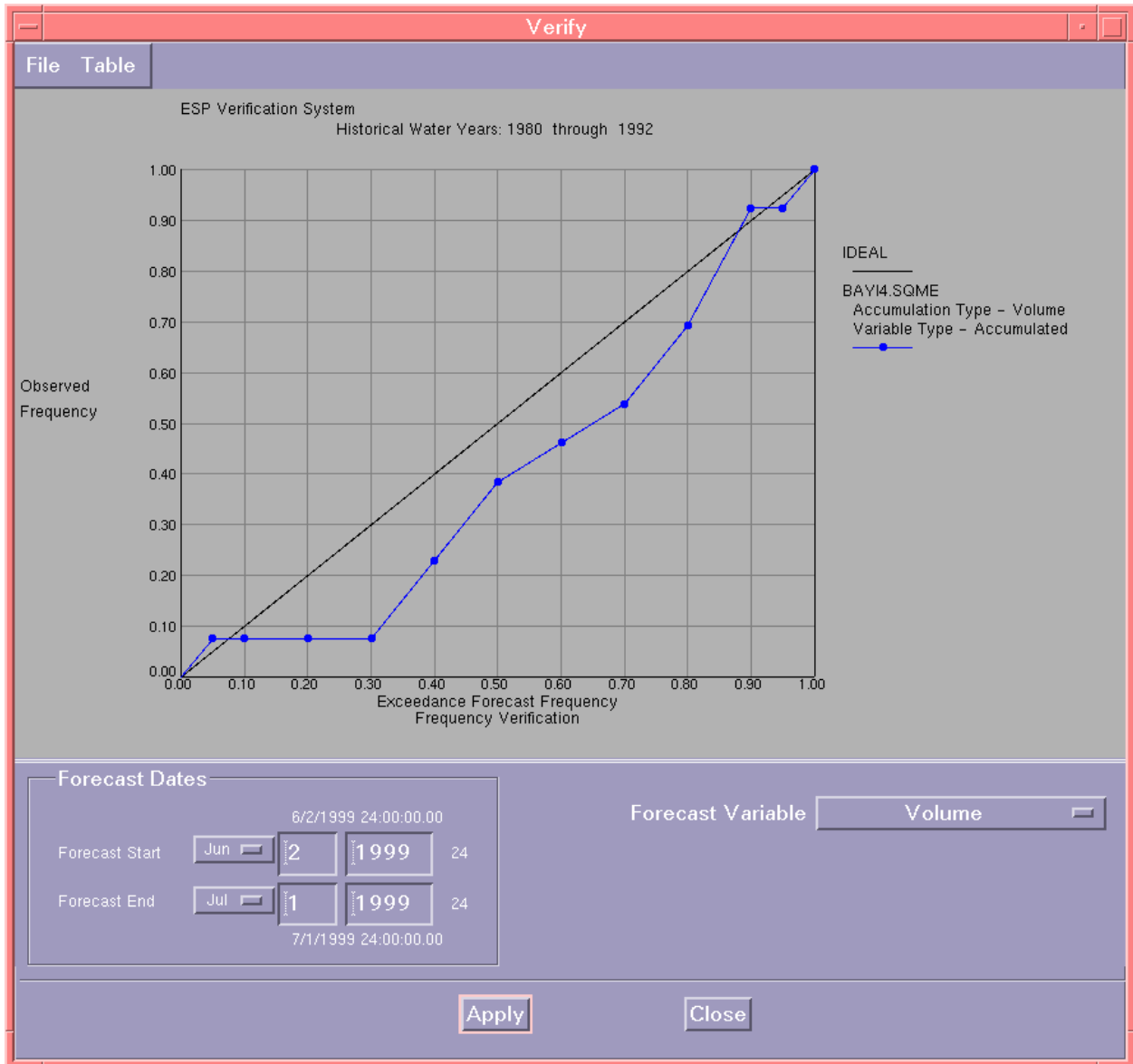## 5.2.2 Tabular Statistics

Statistics either can be viewed in a separate window or written to an ASCII file. From the *Verify GUI...Table* menu option, the user can select either *Export* or *View*. The *Export* option displays a file manager interface for selecting the output file. The *View* option displays statistics in a new display shell. The following is an example output of tabular statistics.

```
Segment - BAYI4  Data Type - SQME  Units - CMSD
Variable Type - Accumulated
Accumulation Type - Volume
Trace Years 1980 to 1992
Carryover Date is 6/1
Statistical Window is 6/2/1999 to 7/1/1999
Number of Years = 13

Years              Obs       Mean Forecast   (0.50)% Exceed Forecast
--------------------------------------------------------------------------
1980              105.20     670.76          677.78
1981               89.51     103.42           61.49
1982              339.21     509.50          500.11
1983              500.31     323.32          212.51
1984              821.93     577.27          470.54
1985              108.31     303.94          258.02
1986              661.21     369.08          261.86
1987              153.08     373.61          354.98
1988              139.38     110.65           45.01
1989              199.47     250.03          146.95
1990             1403.68     302.95          261.74
1991              611.71     426.46          326.57
1992              109.56     238.35          161.96
--------------------------------------------------------------------------

Mean              403.27     350.72          287.66
STD               390.93     166.42          180.35
Error             -----      -52.56         -115.62
Error STD         -----      391.84          409.21
RMSE              -----      380.12          409.81
% Reduction RMSE  -----        0.03           -0.05
Avg Abs Error     -----      259.52          290.62
Avg Abs Error     -----        0.34            0.26

Calibration RMSE = 115.13
Calibration Avg Abs Error = -58.25

Historical Adjustment Function (all years):
Observed = ( 1.51)Historical + ( 1.04 )

Kolmogorov-Smirnoff Test
Test for Uniform Distribution - Quantile interval is 10
Null Hypothesis: Distribution of observed quantiles across 13 years
                         of ESP forecasts is Uniform Distribution

                          Confidence Interval
                          .05             .01

                          --------        --------
Test Statistic            0.22            0.22
Critical Value            0.36            0.43
Null Hypothesis           Accept          Accept

Forecast Comparison With Probability

          0.05   0.10   0.20   0.30   0.40   0.50   0.60   0.70   0.80   0.90   0.95   >0.95
      ---------------------------------------------------------------------------------------
    PDF    1      0      0      0      2      2      1      1      2      3      0      1
    CDF    1      1      1      1      3      5      6      7      9     12     12     13
  Exc %  0.077  0.077  0.077  0.077  0.231  0.385  0.462  0.538  0.692  0.923  0.923  1.000
```

Header Information

The header at the top of the statistics table contains information specific to the verification files selected by the user. This information includes the name of the Segment, the Data Type being analyzed and the Units of those data. The Variable Type can be *Accumulated*, *Instantaneous* or *Mean*, depending on the data type. The Accumulation Type can be *Volume*, *Max*, *Min* or *Mean* and can be selected by the user. The Trace Years are listed along with the Carryover Date used each year to develop the verification traces. The Statistical Window shows the dates over which the verification analysis was performed and must be less than or equal to the ESP run period.

Annual Statistics

The table of annual statistics lists the observations (Obs) for each historical year for the data type, variable type and accumulation type that have been selected. These are compared with the mean (Mean Forecast) and 50 percent exceedance (0.50% Exceed Forecast) probability values of the ESP traces for each year. Standard statistical values also are listed for each of the three values above. These statistics include the Mean, standard deviation (STD) and error of estimate (Error).

Historical Adjustment Function
The Historical Adjustment Function is a measure of the model's ability to simulate historical observations. It is computed by comparing the historical simulation to the observed data and developing a regression equation between the two. A perfect historical simulation would result in a coefficient value of 1.0 and a constant value of 0.0.

Kolmogorov-Smirnoff Test
The Kolmogorov-Smirnoff test is a statistical test that a certain data set fits a given distribution. The Null Hypothesis is stated that the ESP forecasts fit a uniform distribution. If the critical value is greater than the Kolmogorov-Smirnoff test statistic, the null hypothesis cannot be rejected. The Test Statistic is the maximum absolute difference between the cumulative function of the ESP traces and the cumulative function (in this case) of the uniform distribution.

Forecast Comparison
The Forecast Comparison table contains the comparison between the forecast distribution and the observed distribution. The 50 percent exceedance probability of each year's distribution is plotted against the observed frequency to determine the PDF value. The plot of these values is the frequency plot described in Section 5.2.1.