CARRYOVER ANALYSIS—REVISED JANUARY 25, 2009

The regression and prediction analyses were conducted with efficiency index replaced by annual diversion. DIVERSION was an explanatory variable in the best-fit (lowest adjusted R^2) linear regression models for Minidoka, Burley, A&B, American Falls, and North Side. Replacement of efficiency with DIVERSION generally had little to a slightly beneficial effect on adjusted R^2 values (Table 1). Among the independent variables, DIVERSION was negatively correlated with ETR, but in the two cases (A&B and American Falls) in which both ETR and DIVERSION were included in the best-fit regression model, variance inflation factors were low. Diagnostics indicated that model assumptions were met for all seven irrigation companies. Mean DIVERSION was about 20% lower over the prediction period than over the calibration period for Minidoka and Burley, about 10% lower over the prediction period for American Falls and North Side, and about 10% higher over the prediction period for A&B (Table 1). Differences in DIVERSION between the two time periods were much smaller than differences in the efficiency index between the two time periods. There was more overlap in independent variable combinations involving DIVERSION between calibration and prediction periods than those involving efficiency. Single-variable dependence of carryover on DIVERSION was weakly to moderately negative over both periods for Minidoka, Burley, and A&B. For American Falls and North Side, this dependence was weakly negative during the calibration period and weakly positive during the prediction period (Table 1). Using DIVERSION instead of efficiency resulted in systematically smaller confidence intervals and smaller differences between observed and predicted values for Minidoka, Burley, and A&B. Using DIVERSION instead of efficiency had little effect on confidence intervals and differences between observed and predicted values for American Falls and North Side.

Based on these observations and on the observation that DIVERSION does not contain the explicit information contained in ETR, DIVERSION is a better choice of explanatory variable than efficiency index. Although differences remain in variable ranges between calibration and prediction periods, these differences are small enough to render the predictive models useful if confidence intervals around the predictions are considered.

Table 1. Properties of regression models incorporating the explanatory variable DIVERSION.

	Adjusted R^2		Mean of DIVERSION		CRY-DIV. correlation	
Canal	w/ EFFINDEX	w/ DIVERSION	calibration	prediction	calibration	prediction
Minidoka	79.8%	81.0%	4.18×10^5	3.29×10^5	-0.362	-0.488
Burley	87.6%	88.6%	3.42×10^5	2.81×10^5	-0.244	-0.189
A&B	88.3%	88.3%	5.13×10^4	5.61×10^4	-0.660	-0.153
AFRD2	85.3%	85.2%	4.74×10^5	4.31×10^4	-0.154	0.272
North Side	93.0%	93.1%	1.15×10^6	1.03×10^6	-0.224	0.274

MINIDOKA IRRIGATION DISTRICT

Best-model Regression Analysis: CRY versus ALLOC, HEISE100AF, PDSI, DIVERSION

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The regression equation is
CRY = 60650 + 0.640 ALLOC + 51.9 HEISE100AF + 8297 PDSI - 0.661 DIVERSION

Predictor       Coef  SE Coef      T      P    VIF
Constant       60650   120500   0.50  0.621
ALLOC         0.6402   0.3022   2.12  0.048  1.182
HEISE100AF     51.87    12.28   4.22  0.001  2.012
PDSI            8297     3953   2.10  0.050  2.219
DIVERSION    -0.6610   0.2128  -3.11  0.006  1.240

S = 41650.7   R-Sq = 84.4%   R-Sq(adj) = 81.0%

Analysis of Variance

Source          DF           SS           MS      F      P
Regression       4  1.69450E+11  42362394246  24.42  0.000
Residual Error  18  31226082641   1734782369
Total           22  2.00676E+11

Source      DF  Seq SS
ALLOC        1  1.03E+10
HEISE100AF   1  1.24E+11
PDSI         1  1.83E+10
DIVERSION    1  1.67E+10
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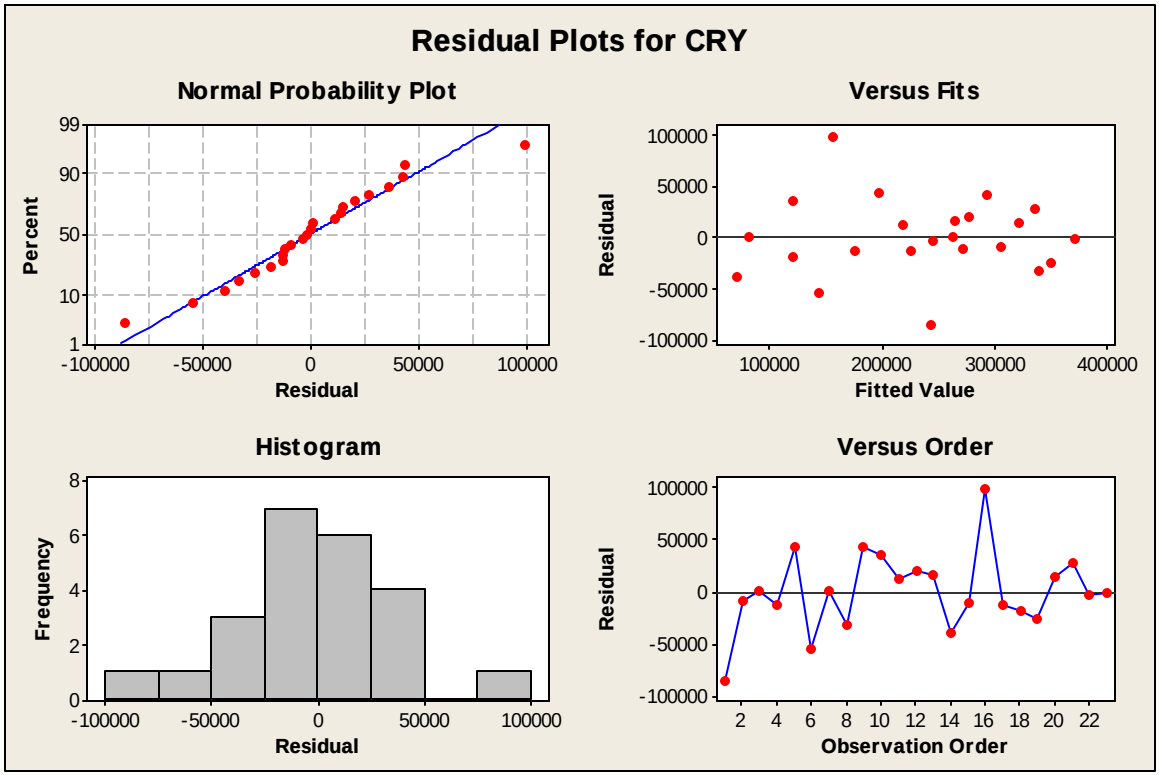
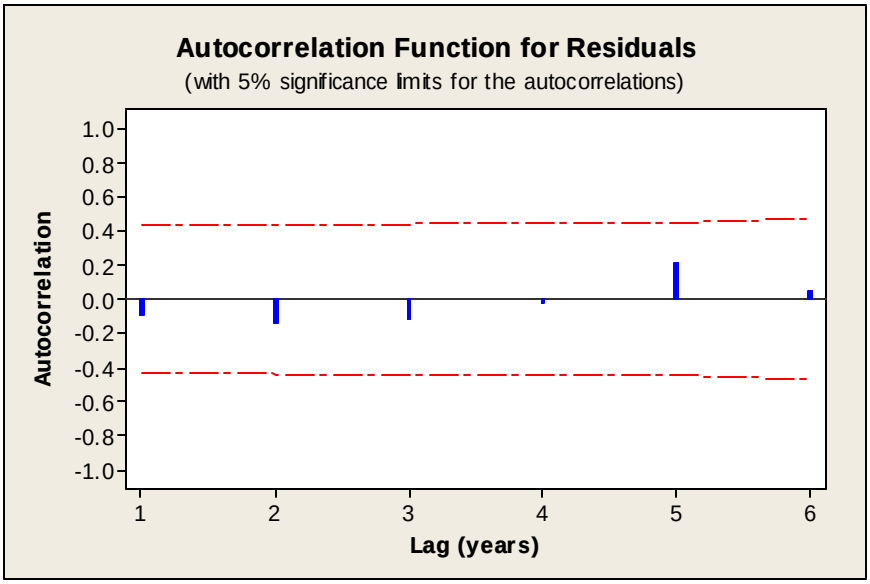
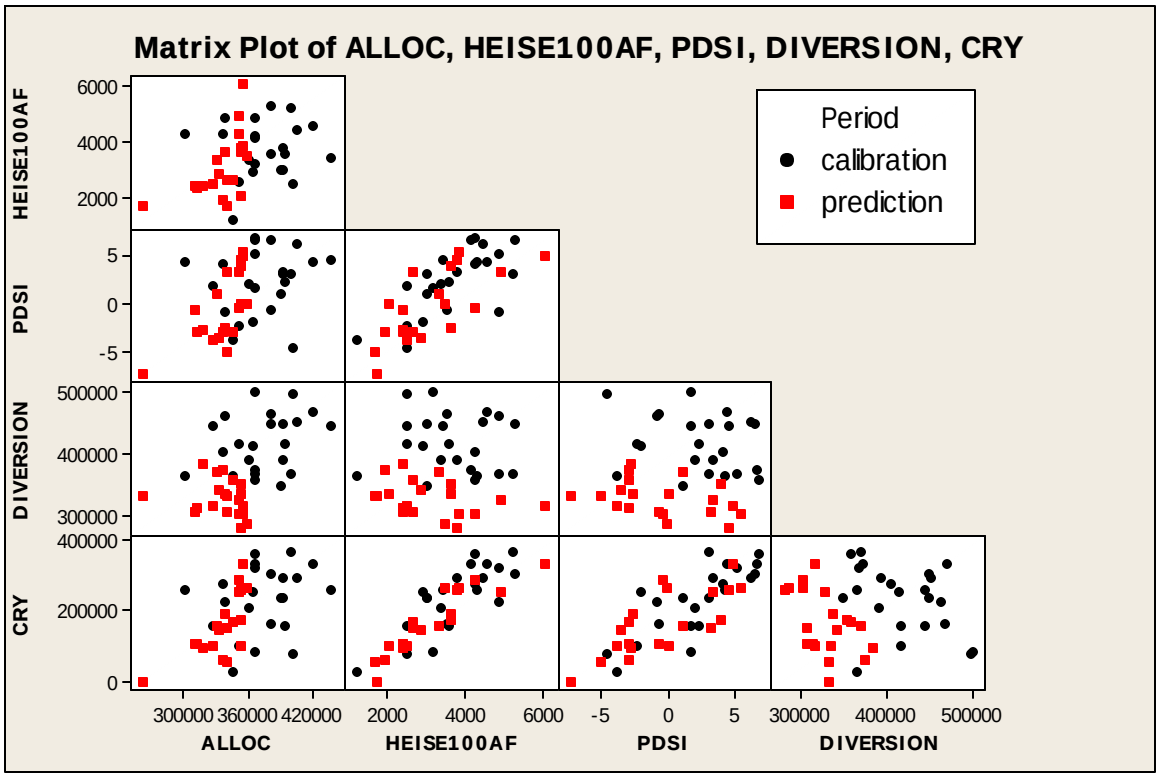


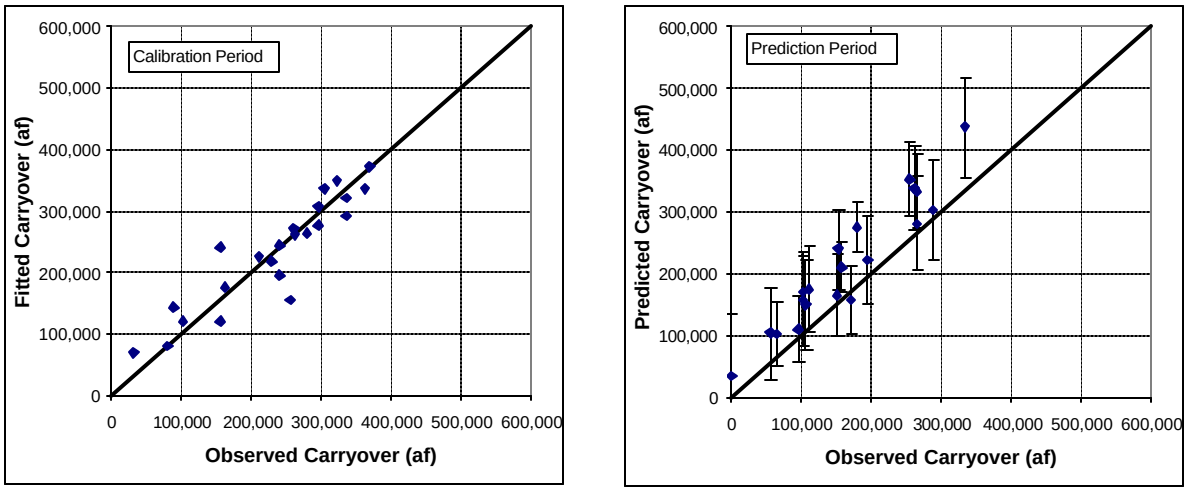
Residual analysis for best model.



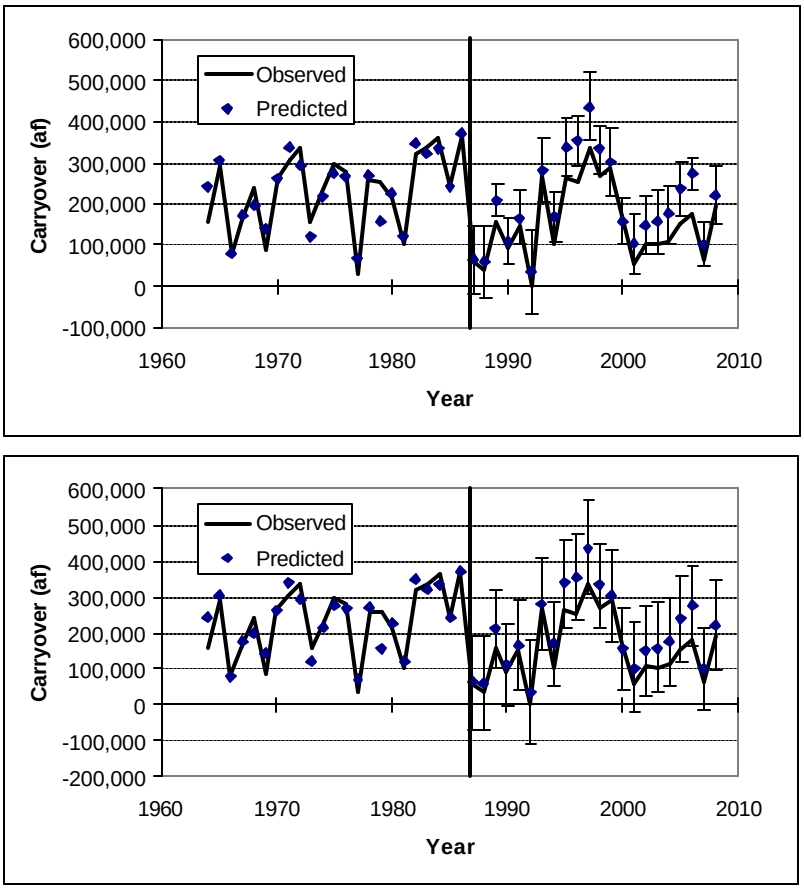
Autocorrelation in best-model residuals.



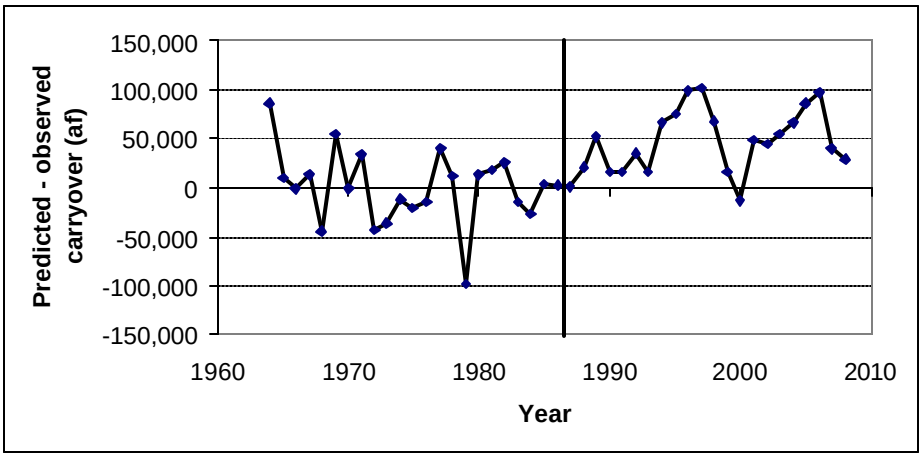
Scatter plots among all independent variables and between carryover and each independent variable. Calibration period is 1964-1986; prediction period is 1989-2008.



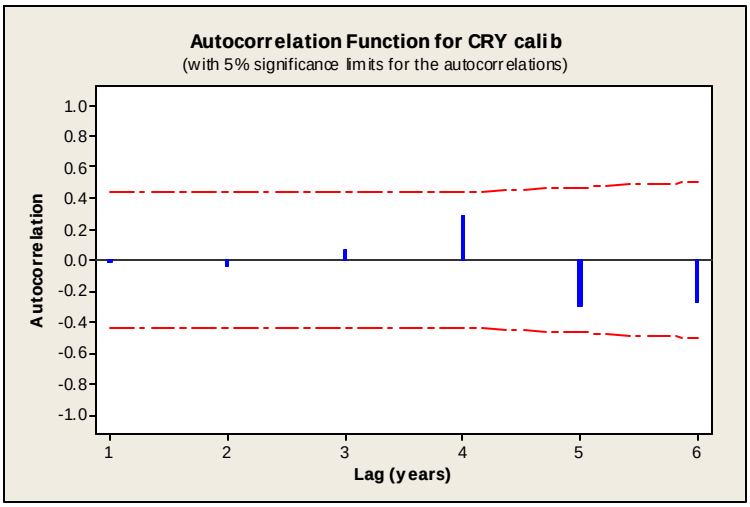
Fitted versus observed carryover (left) for calibration period, and predicted versus observed carryover (right) for prediction period. Error bars show 95% confidence intervals for predicted mean carryover.



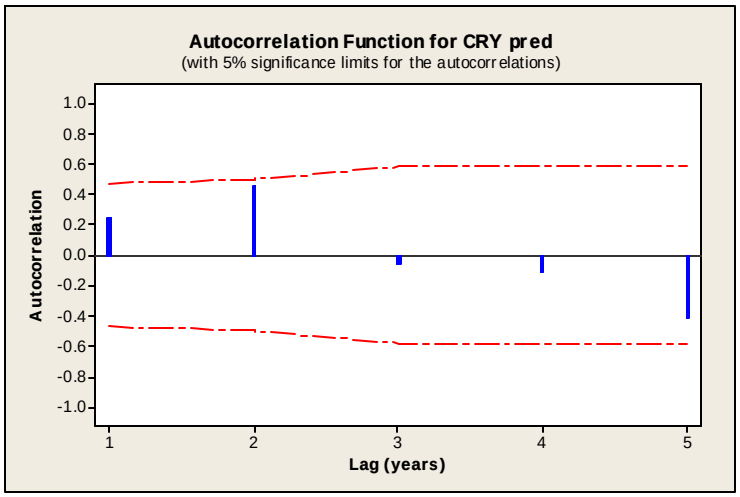
Predicted and observed carryover versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model. Error bars for 1987-2008 values show 95% confidence intervals for predicted mean carryover in top panel and 95% confidence intervals for prediction of new observation in bottom panel.



Prediction residuals (predicted carryover minus observed carryover) versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model.



Temporal autocorrelation in observed carryover, 1964-1986.



Temporal autocorrelation in observed carryover, 1989-2008.

BURLEY IRRIGATION DISTRICT

Best-model Regression Analysis: CRY versus ALLOC, HEISE100AF, PDSI, DIVERSION

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The regression equation is
CRY = 38752 + 0.610 ALLOC + 32.2 HEISE100AF + 6860 PDSI - 0.530 DIVERSION

Predictor       Coef  SE Coef      T      P    VIF
Constant       38752    55211   0.70  0.492
ALLOC         0.6098   0.1749   3.49  0.003  1.378
HEISE100AF    32.228    6.267   5.14  0.000  2.147
PDSI            6860     2057   3.34  0.004  2.459
DIVERSION    -0.5303   0.1820  -2.91  0.009  1.519

S = 20583.3   R-Sq = 90.7%   R-Sq(adj) = 88.6%

Analysis of Variance

Source          DF           SS           MS      F      P
Regression       4  74141066860  18535266715  43.75  0.000
Residual Error  18   7626080286    423671127
Total           22  81767147146

Source      DF  Seq SS
ALLOC        1  5.00E+09
HEISE100AF   1  5.46E+10
PDSI         1  1.10E+10
DIVERSION    1  3.60E+09
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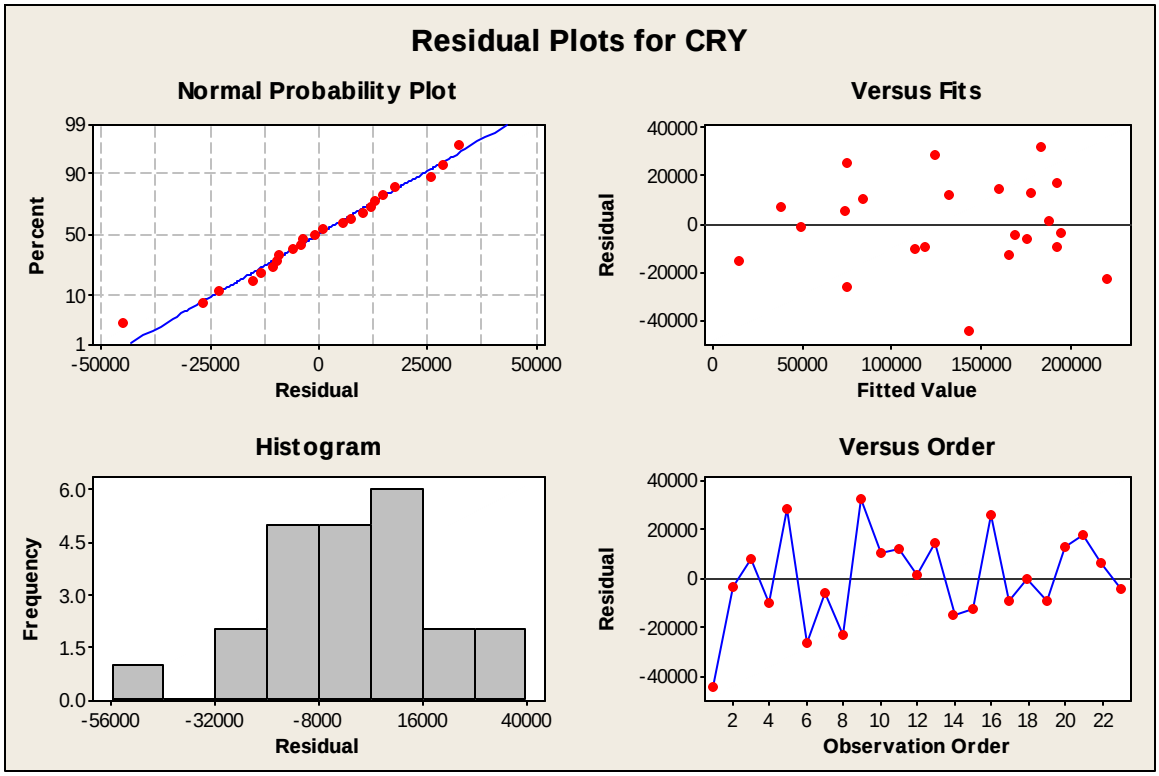
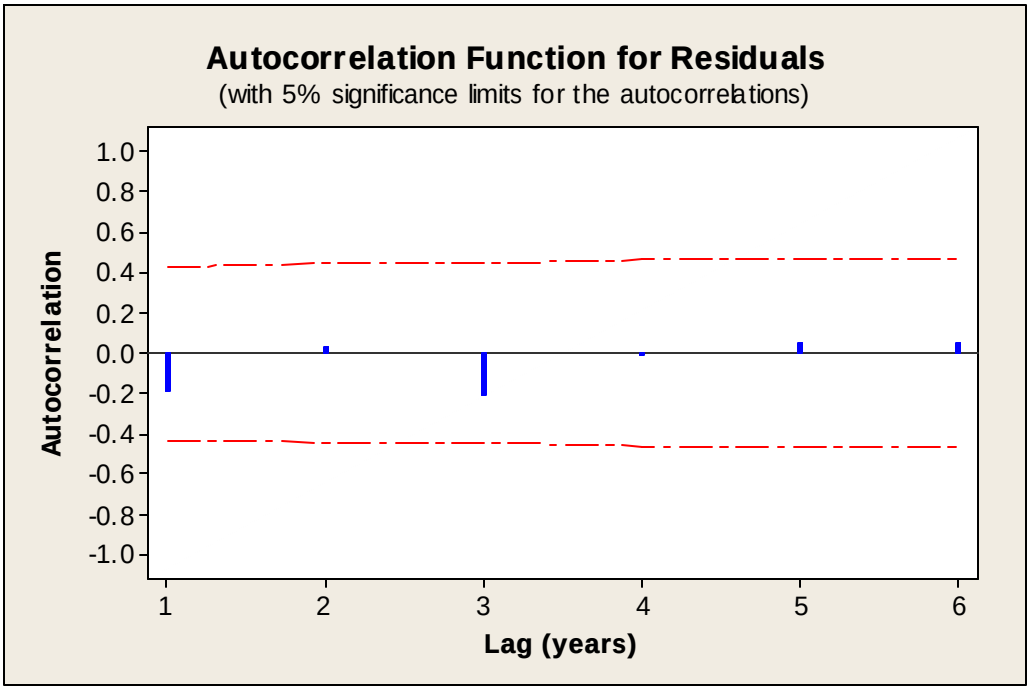
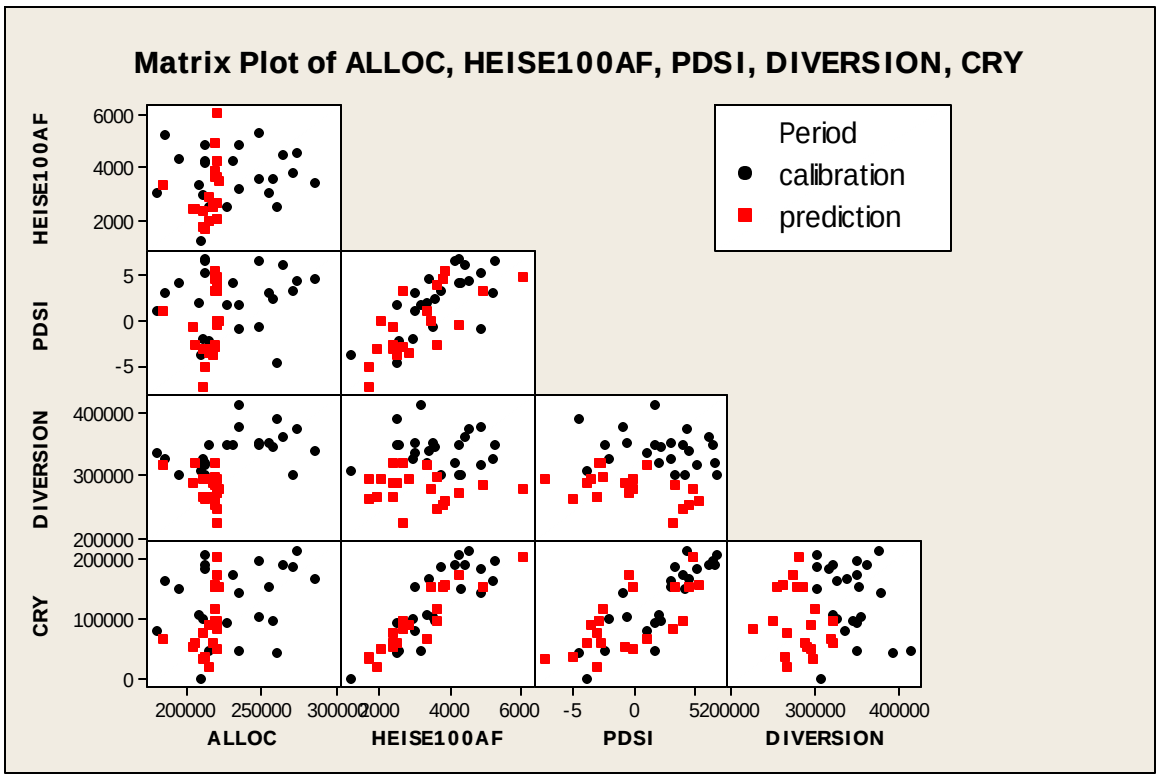


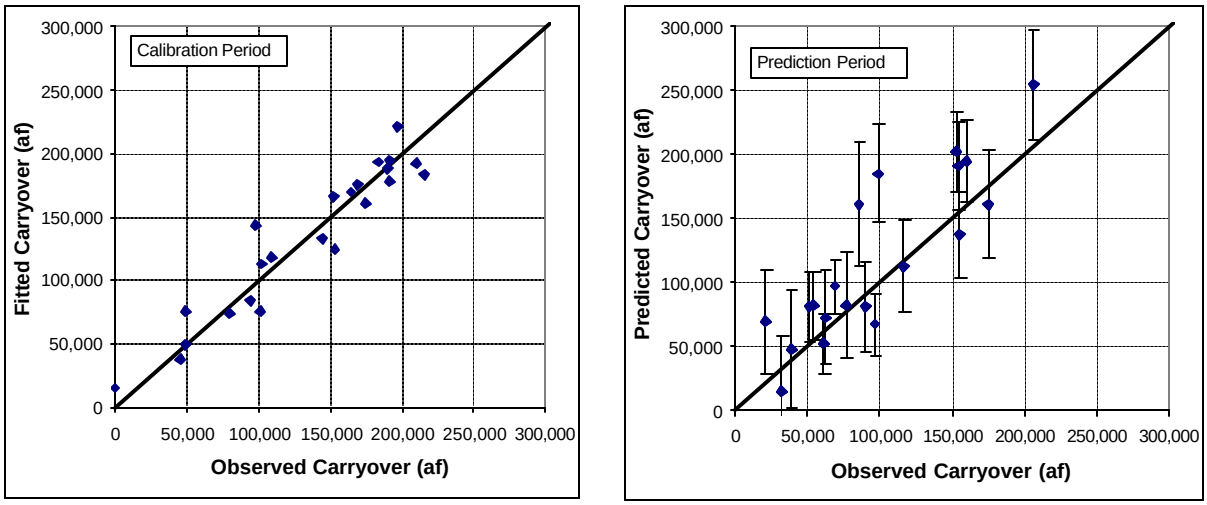
Residual analysis for best model.



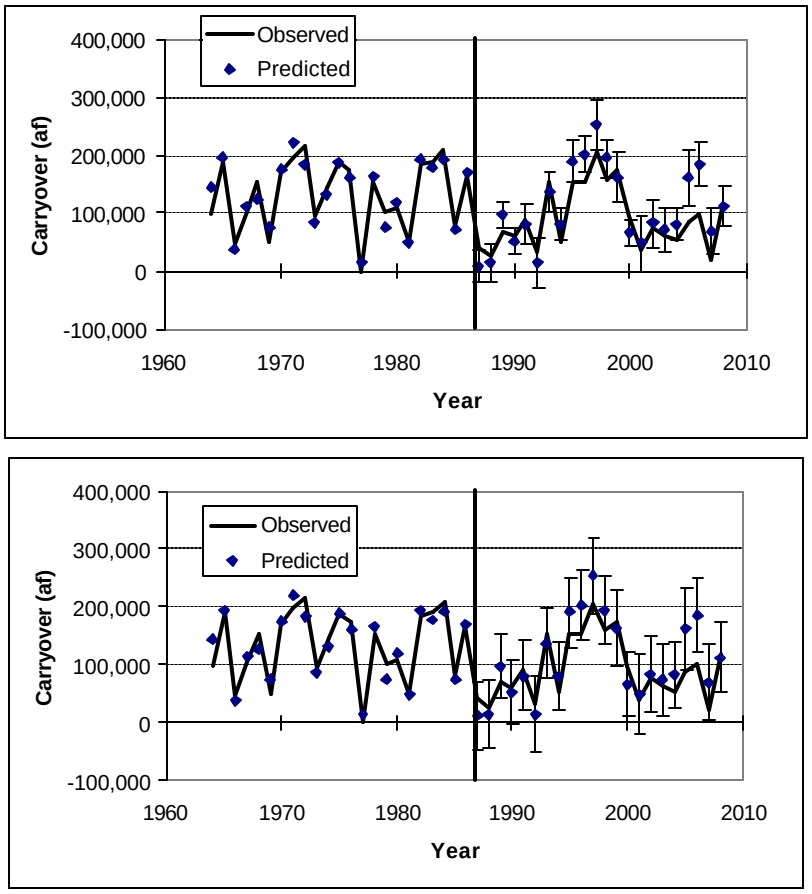
Autocorrelation in best-model residuals.



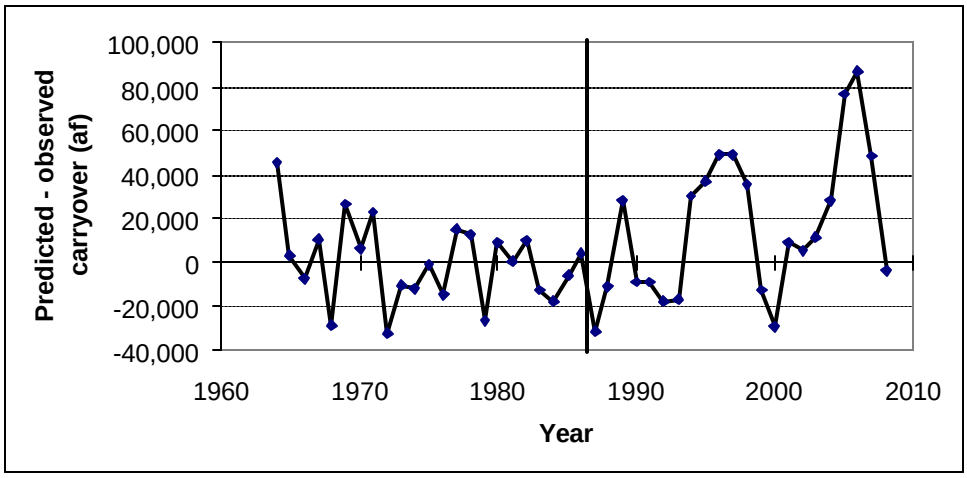
Scatter plots among all independent variables and between carryover and each independent variable. Calibration period is 1964-1986; prediction period is 1989-2008.



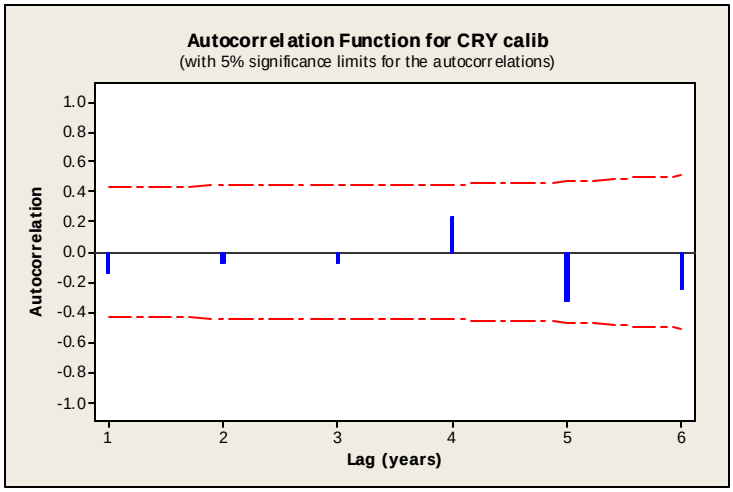
Fitted versus observed carryover (left) for calibration period, and predicted versus observed carryover (right) for prediction period. Error bars show 95% confidence intervals for predicted mean carryover.



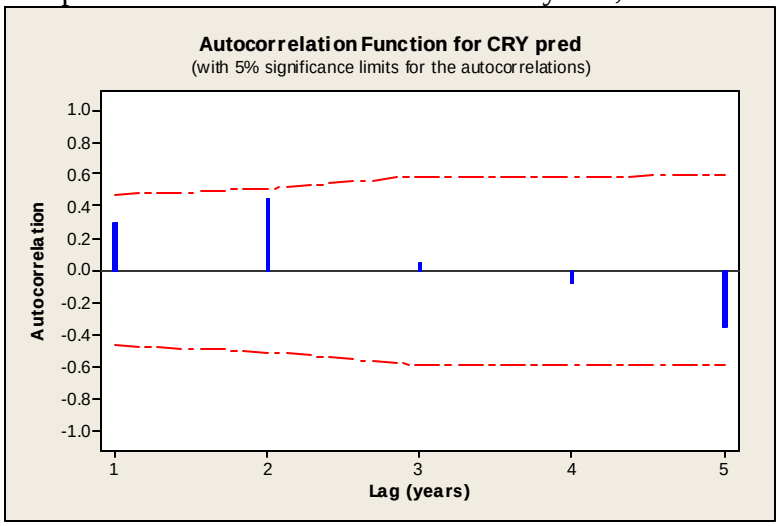
Predicted and observed carryover versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model. Error bars for 1987-2008 values show 95% confidence intervals for predicted mean carryover in top panel and 95% confidence intervals for prediction of new observation in bottom panel.



Prediction residuals (predicted carryover minus observed carryover) versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model.



Temporal autocorrelation in observed carryover, 1964-1986.



Temporal autocorrelation in observed carryover, 1989-2008.

A&B IRRIGATION DISTRICT

Best-model Regression Analysis: CRY versus ALLOC, HEISE100AF, ETR, DIVERSION

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The regression equation is
CRY = 74654 + 0.929 ALLOC + 7.23 HEISE100AF - 2835 ETR - 0.648 DIVERSION

Predictor       Coef  SE Coef      T      P    VIF
Constant       74654    46317   1.61  0.124
ALLOC         0.9294   0.2043   4.55  0.000  1.288
HEISE100AF     7.232    1.287   5.62  0.000  1.408
ETR            -2835     1462  -1.94  0.068  2.492
DIVERSION    -0.6481   0.4843  -1.34  0.197  2.626

S = 5217.76   R-Sq = 90.5%   R-Sq(adj) = 88.3%

Analysis of Variance

Source          DF          SS          MS      F      P
Regression       4  4647514903  1161878726  42.68  0.000
Residual Error  18   490049604    27224978
Total           22  5137564507

Source      DF  Seq SS
ALLOC        1  2.60E+09
HEISE100AF   1  1.52E+09
ETR          1  4.78E+08
DIVERSION    1  4.88E+08
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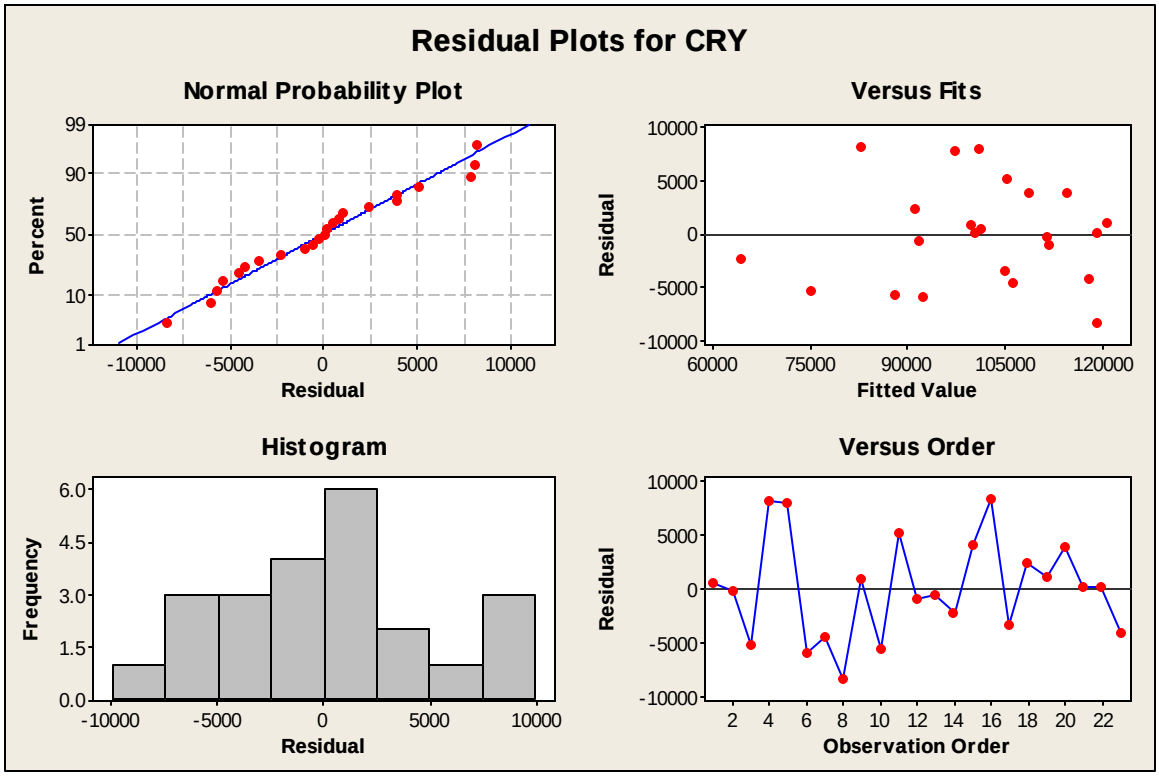
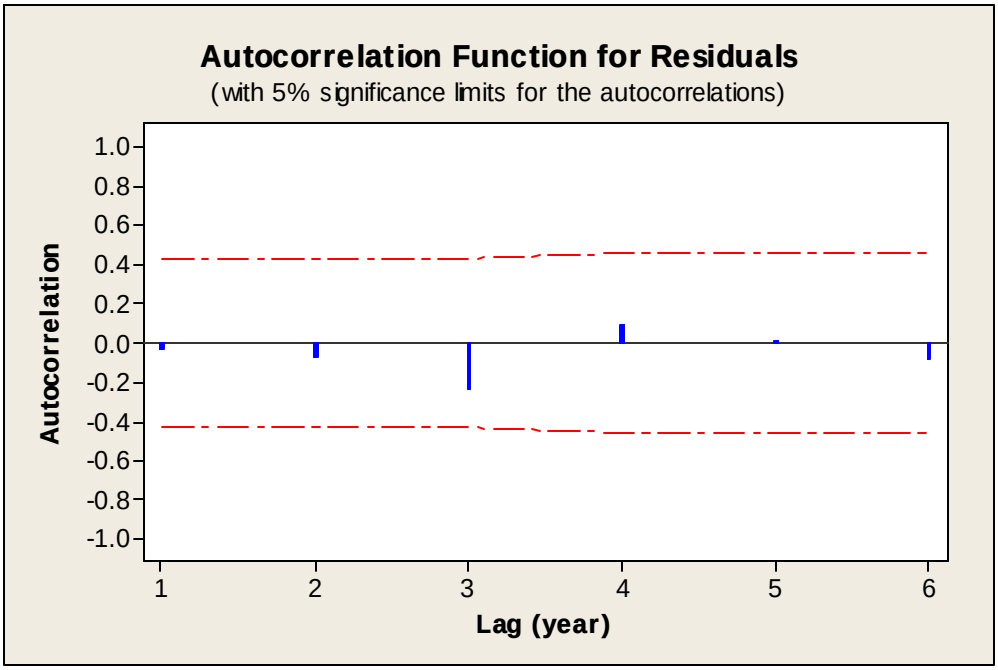
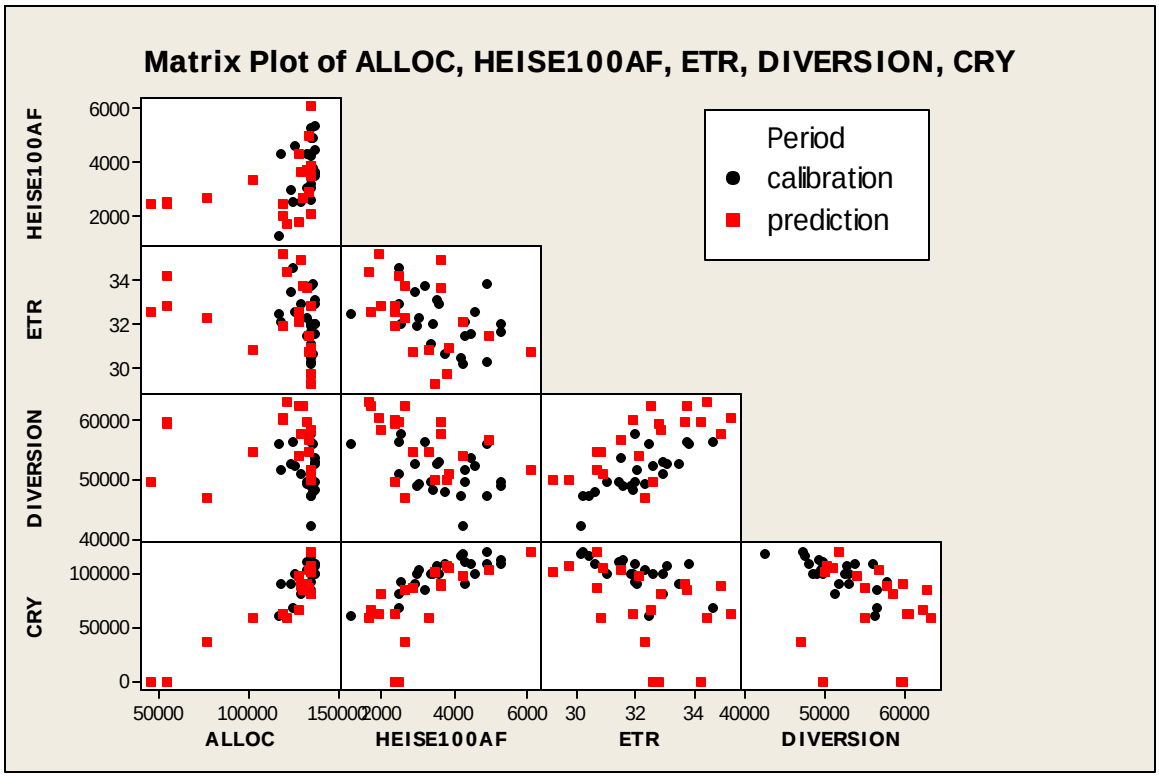


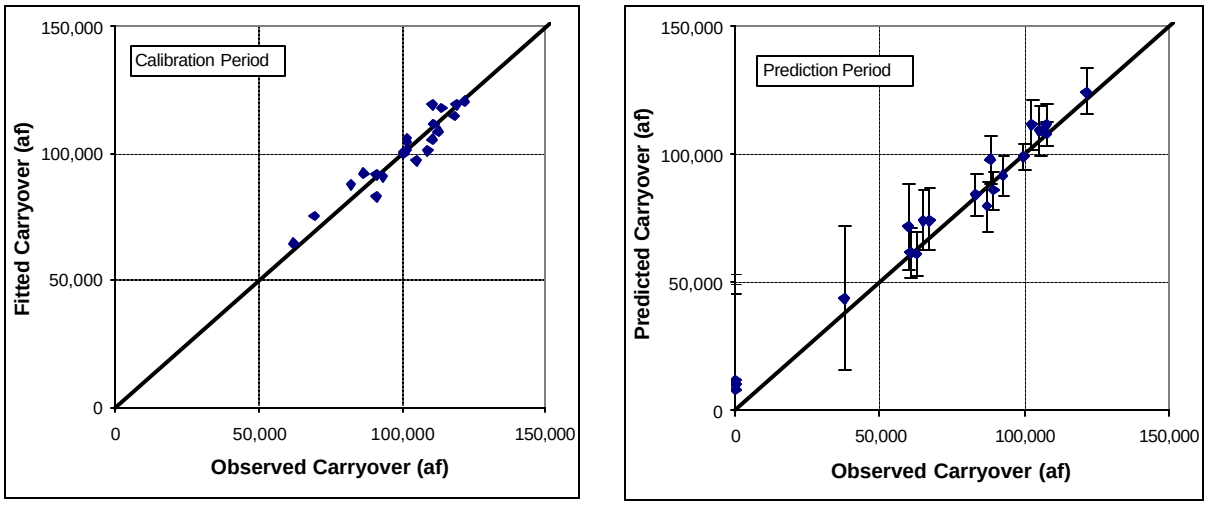
Residual analysis for best model.



Autocorrelation in best-model residuals.



Scatter plots among all independent variables and between carryover and each independent variable. Calibration period is 1964-1986; prediction period is 1989-2008.



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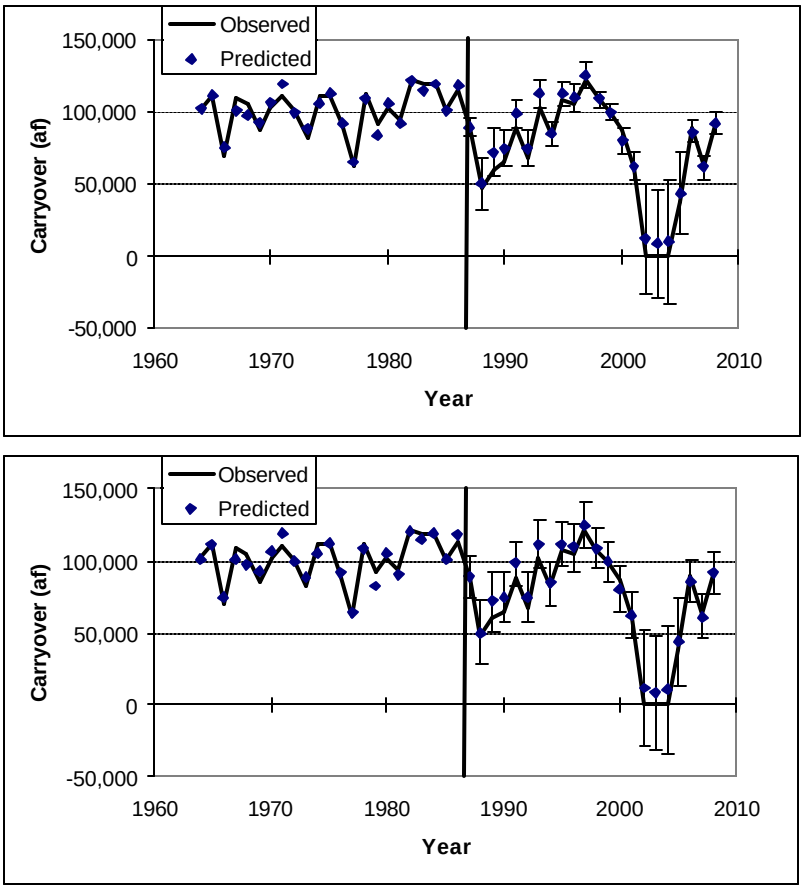
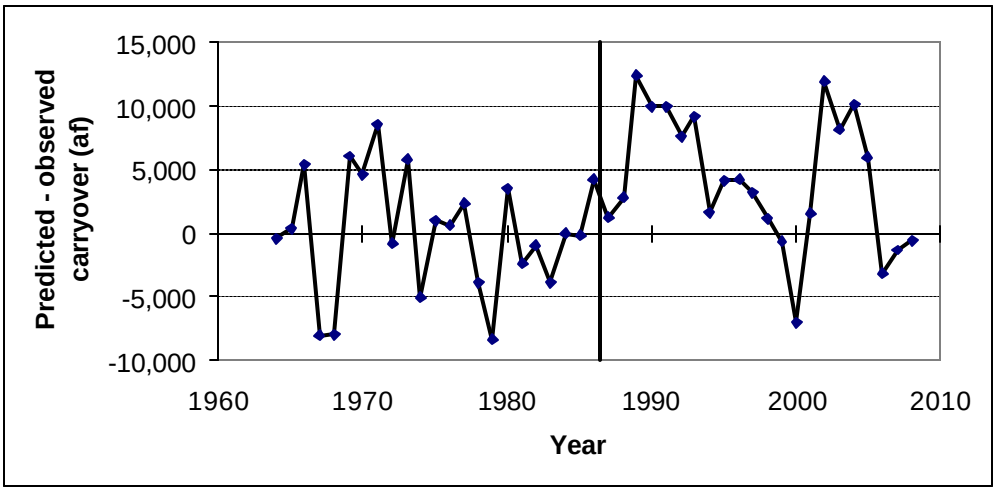
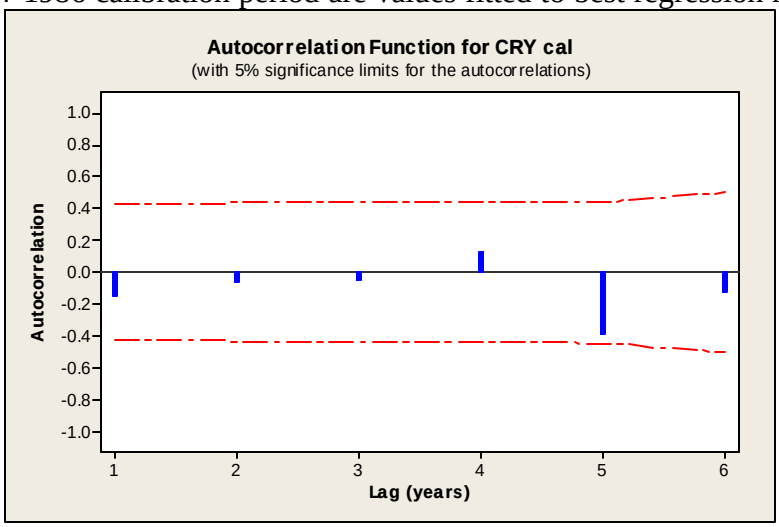


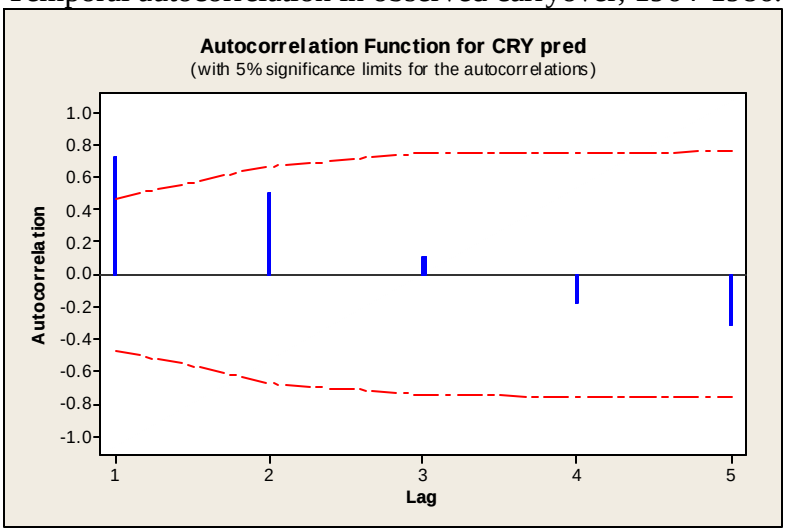
Predicted and observed carryover versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model. Error bars for 1987-2008 values show 95% confidence intervals for predicted mean carryover in top panel and 95% confidence intervals for prediction of new observation in bottom panel.



Prediction residuals (predicted carryover minus observed carryover) versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model.



Temporal autocorrelation in observed carryover, 1964-1986.



Temporal autocorrelation in observed carryover, 1989-2008.

MILNER IRRIGATION DISTRICT

Best-model Regression Analysis: CRY versus ALLOC, HEISE100AF, ETR

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The regression equation is
CRY = 129838 + 1.12 ALLOC + 6.97 HEISE100AF - 6238 ETR

Predictor       Coef  SE Coef      T      P    VIF
Constant      129838    31677   4.10  0.001
ALLOC         1.1189   0.1876   5.96  0.000  1.231
HEISE100AF     6.975    1.059   6.59  0.000  1.394
ETR          -6238.3    825.9  -7.55  0.000  1.162

S = 4314.55   R-Sq = 93.6%   R-Sq(adj) = 92.6%

Analysis of Variance

Source          DF          SS          MS      F      P
Regression       3  5209172364  1736390788  93.28  0.000
Residual Error  19   353690716    18615301
Total           22  5562863080

Source      DF  Seq SS
ALLOC        1  2.38E+09
HEISE100AF   1  1.77E+09
ETR          1  1.06E+09
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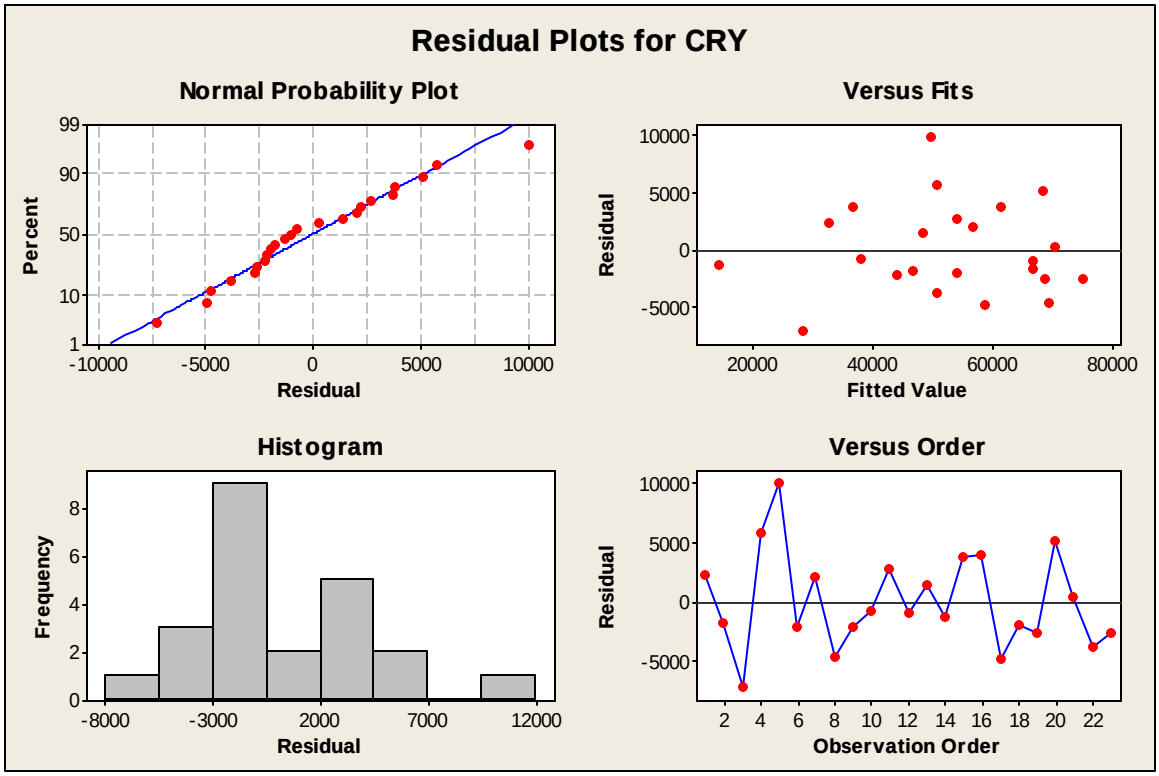
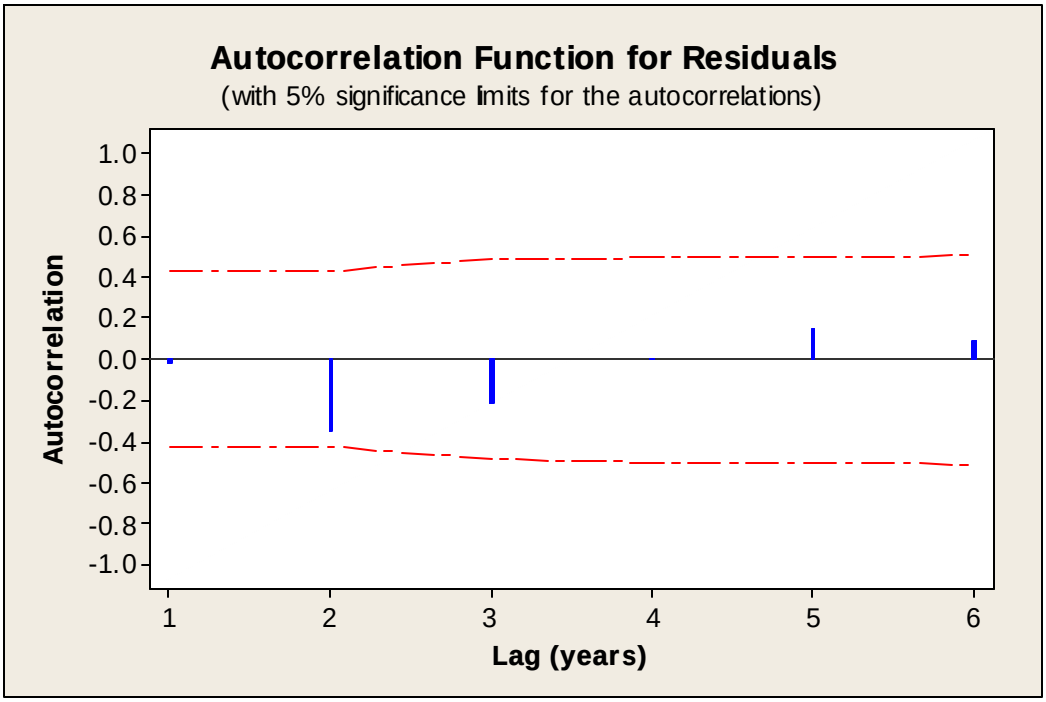
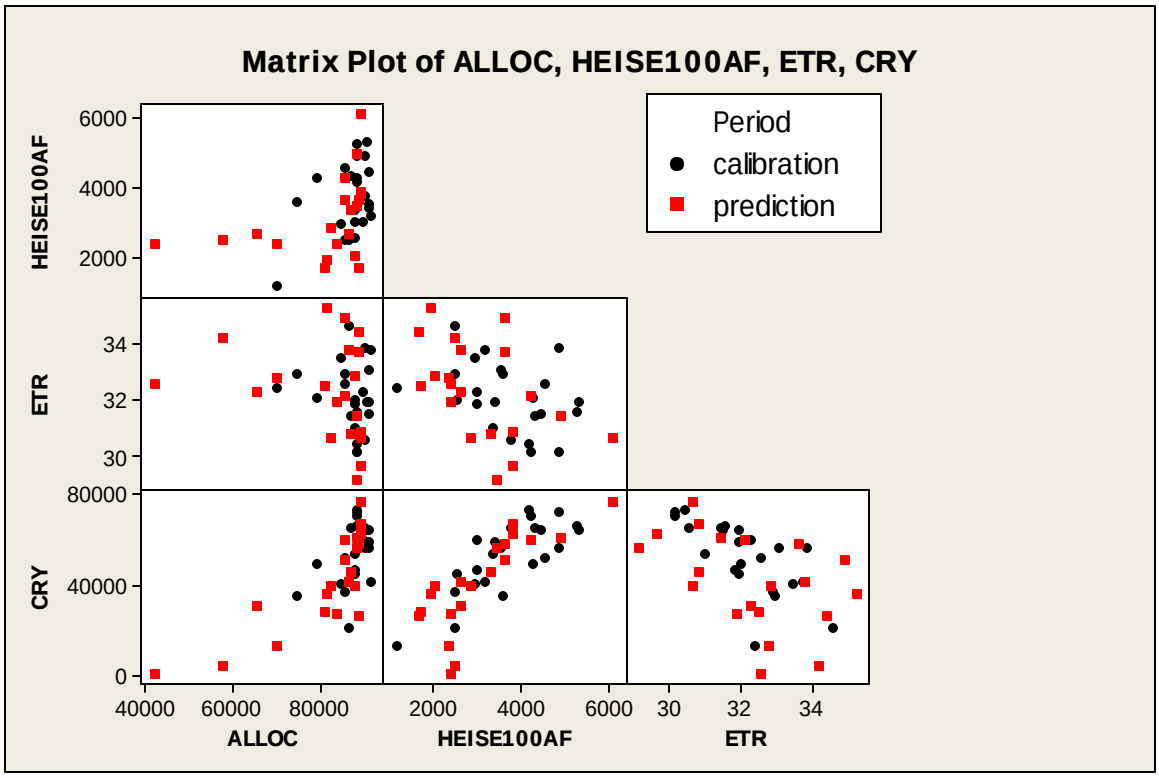


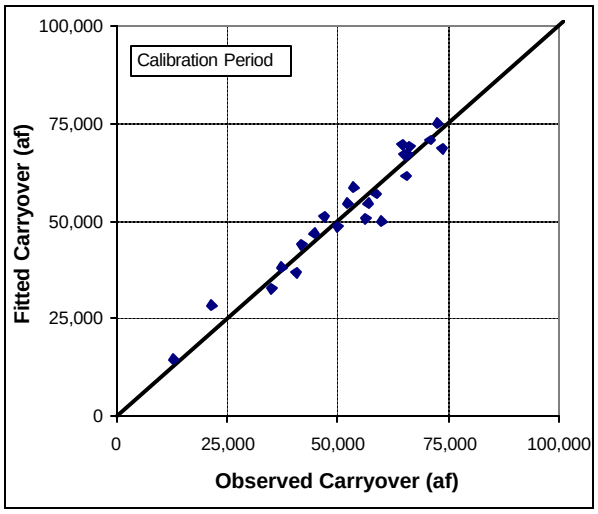
Residual analysis for best model.

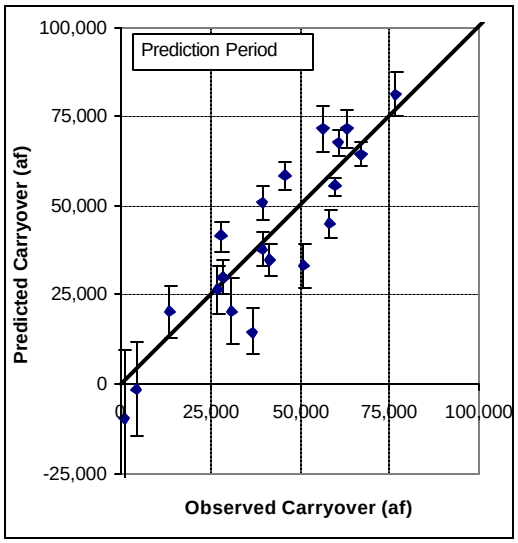


Autocorrelation in best-model residuals.

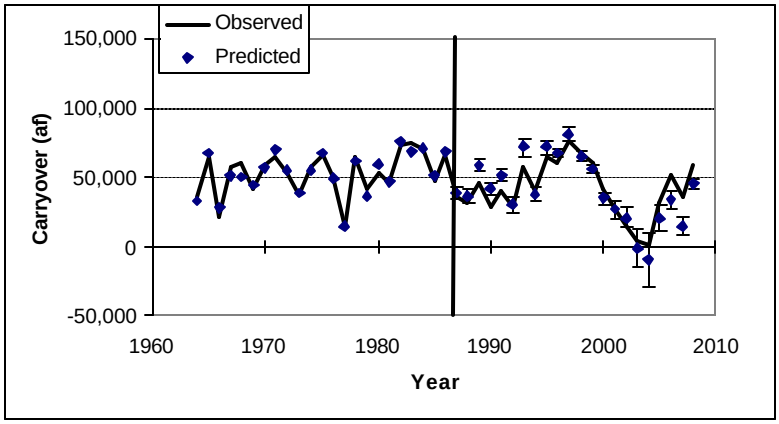


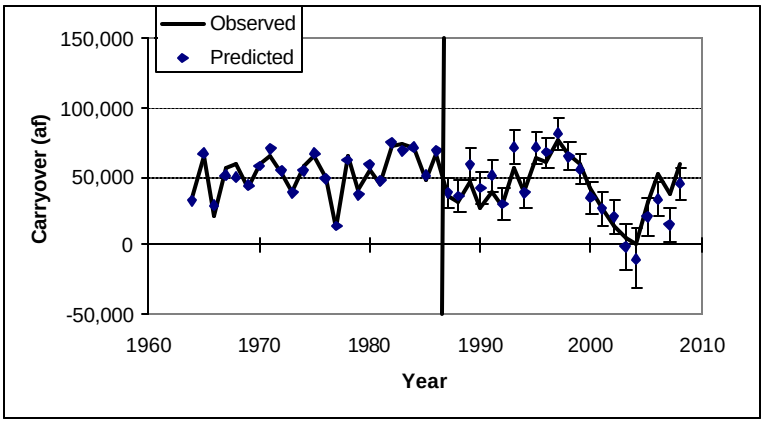
Scatter plots among all independent variables and between carryover and each independent variable. Calibration period is 1964-1986; prediction period is 1989-2008.



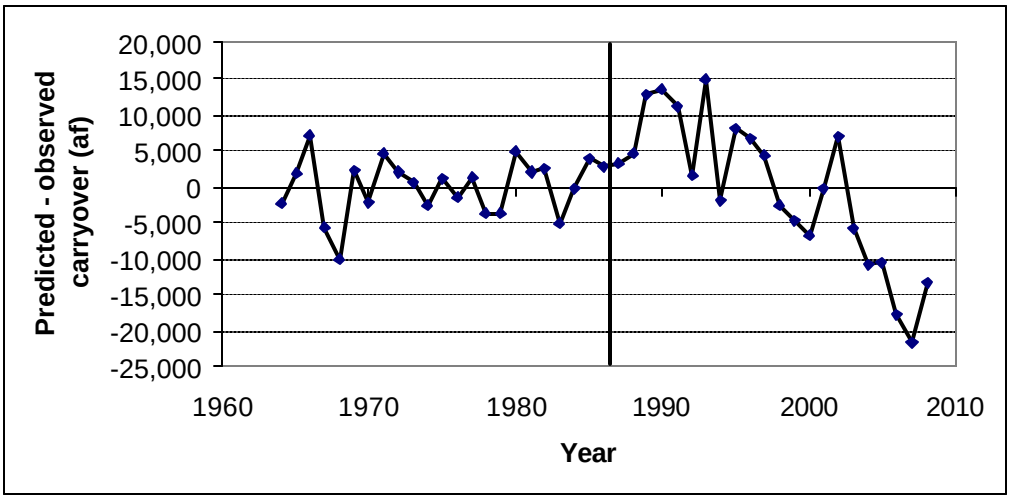


Fitted versus observed carryover (left) for calibration period, and predicted versus observed carryover (right) for prediction period. Error bars show 95% confidence intervals for predicted mean carryover.

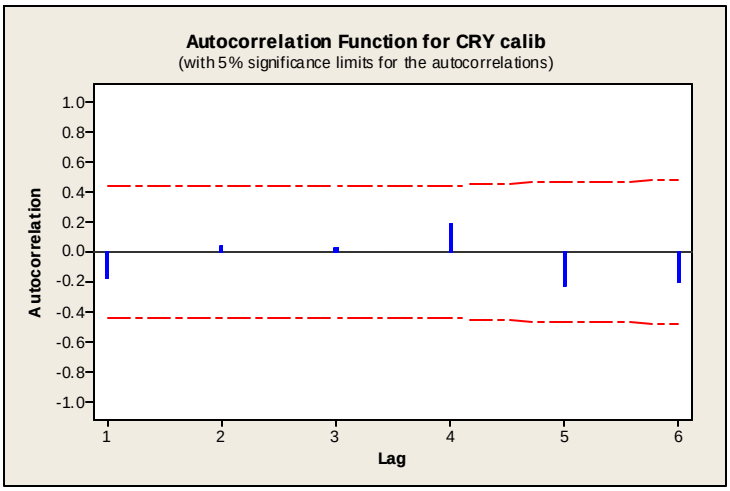




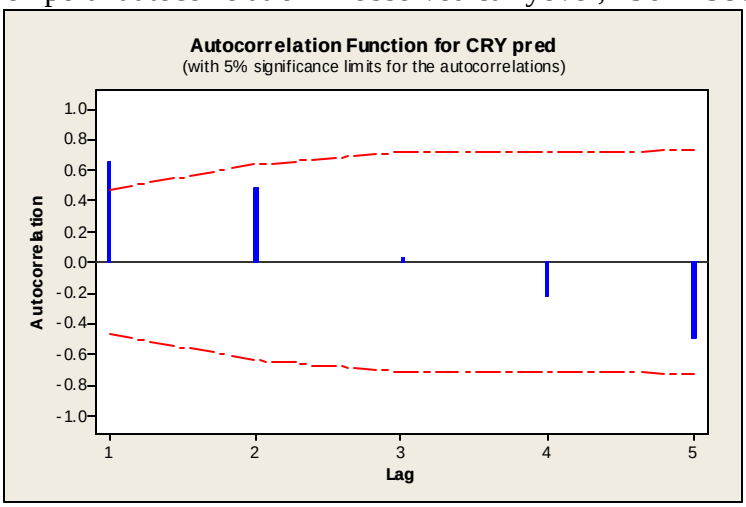
Predicted and observed carryover versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model. Error bars for 1987-2008 values show 95% confidence intervals for predicted mean carryover in top panel and 95% confidence intervals for prediction of new observation in bottom panel.



Prediction residuals (predicted carryover minus observed carryover) versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model.



Temporal autocorrelation in observed carryover, 1964-1986.



Temporal autocorrelation in observed carryover, 1989-2008.

AMERICAN FALLS RESERVOIR DISTRCT 2

Best-model Regression Analysis: CRY versus ALLOC, HEISE100AF, ETR, DIVERSION

```
The regression equation is
CRY = 728797 + 0.976 ALLOC + 35.2 HEISE100AF - 29645 ETR - 0.300 DIVERSION

Predictor       Coef  SE Coef      T      P    VIF
Constant      728797   200439   3.64  0.002
ALLOC         0.9755   0.4223   2.31  0.033  1.809
HEISE100AF    35.217    7.369   4.78  0.000  1.648
ETR           -29645     6025  -4.92  0.000  1.509
DIVERSION    -0.2998   0.2250  -1.33  0.199  1.656

S = 27617.9   R-Sq = 87.9%   R-Sq(adj) = 85.2%

Analysis of Variance

Source          DF           SS           MS      F      P
Regression       4  99324300268  24831075067  32.55  0.000
Residual Error  18  13729518087    762751005
Total           22  1.13054E+11

Source      DF  Seq SS
ALLOC        1  1.66E+10
HEISE100AF   1  5.49E+10
ETR          1  2.64E+10
DIVERSION    1  1.35E+09
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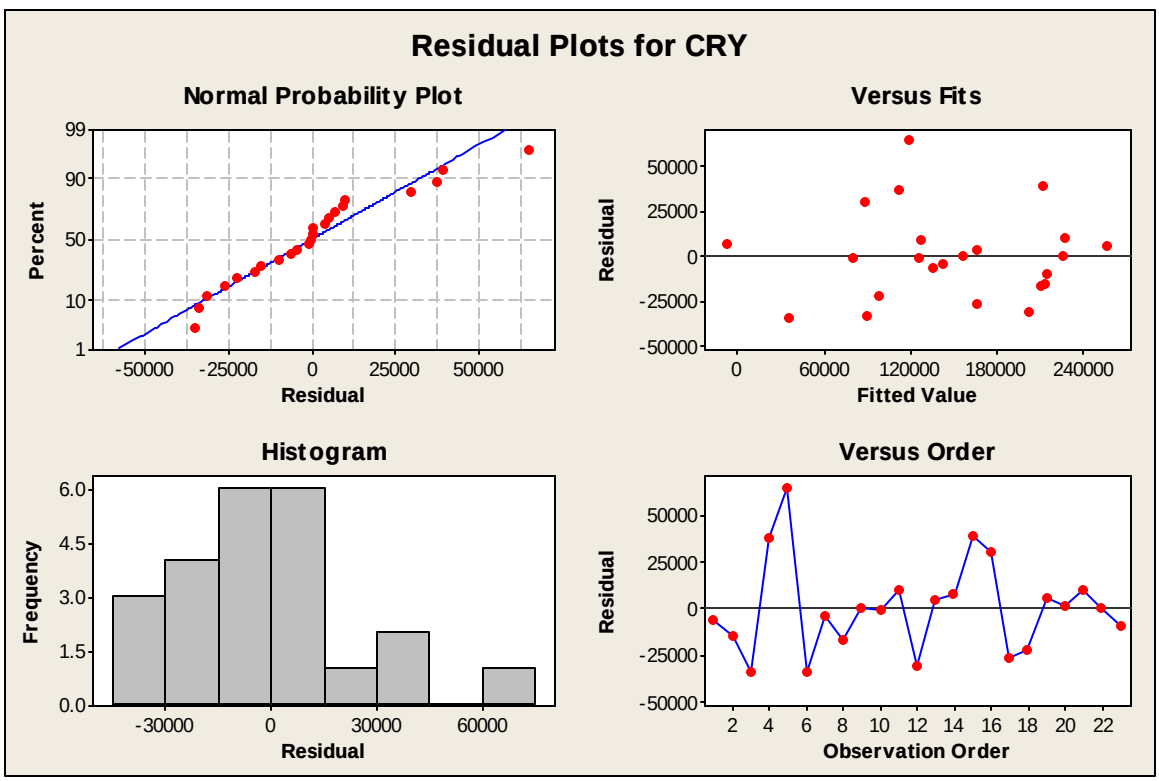
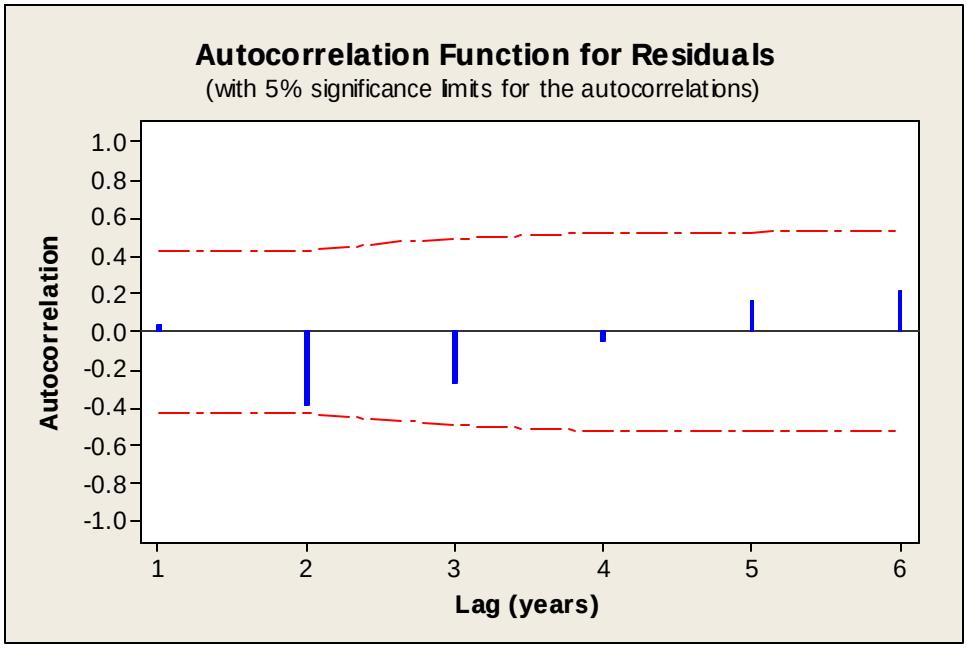
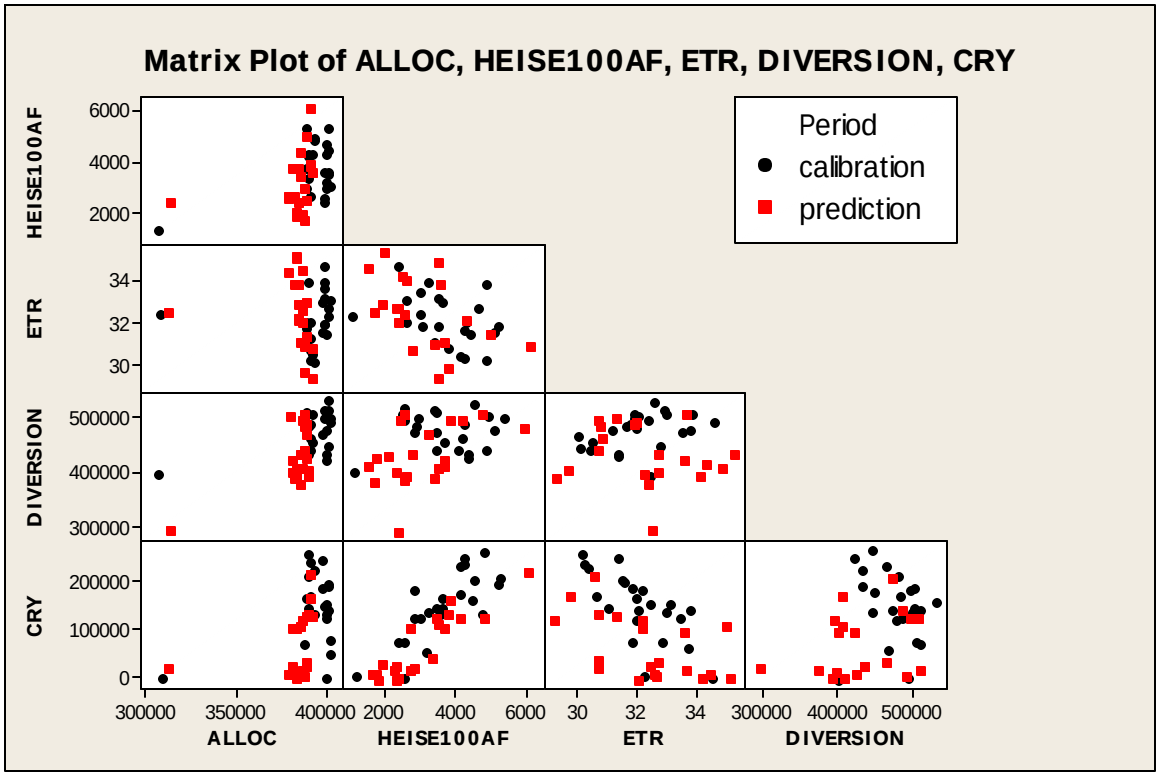


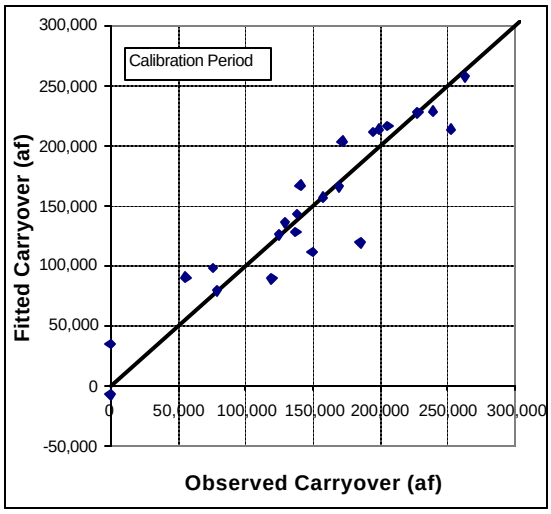
Residual analysis for best model.

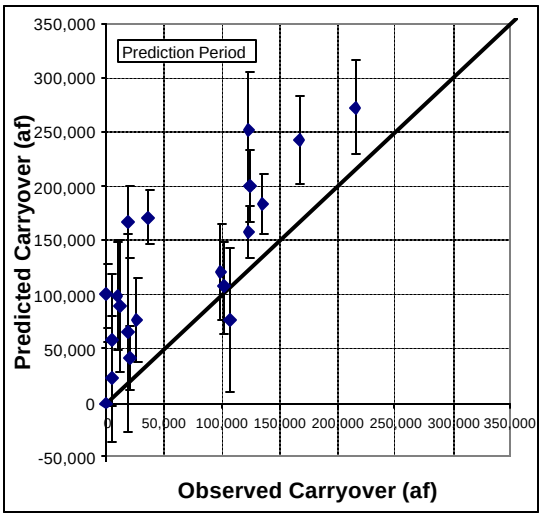


Autocorrelation in best-model residuals.

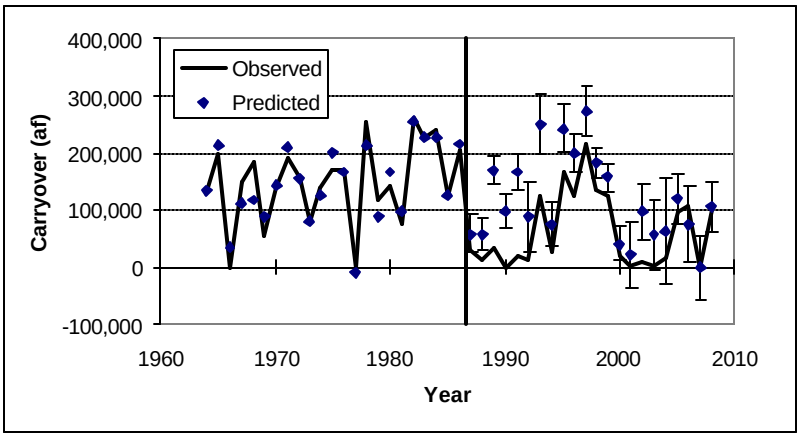


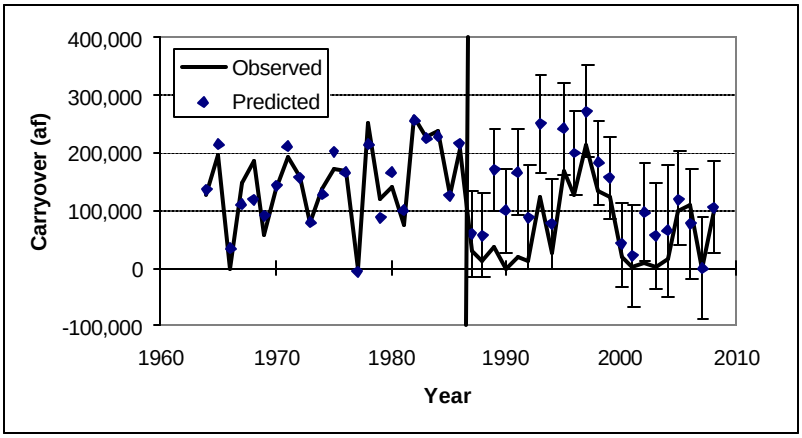
Scatter plots among all independent variables and between carryover and each independent variable. Calibration period is 1964-1986; prediction period is 1989-2008.



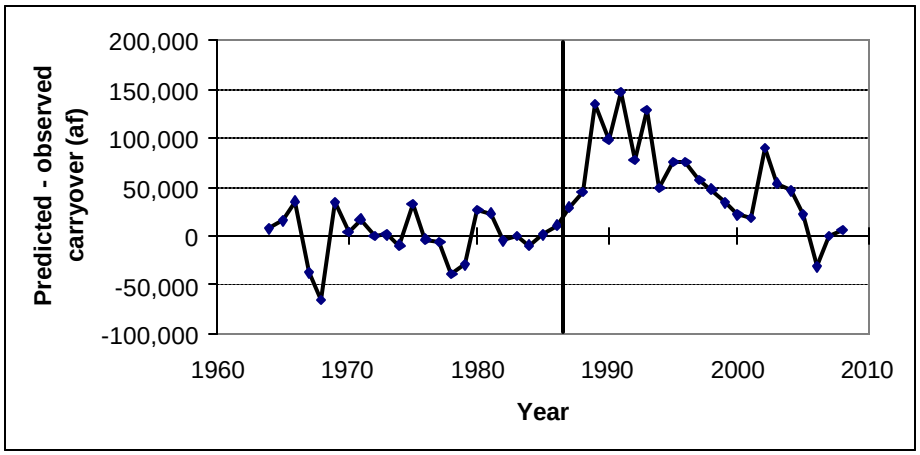


Fitted versus observed carryover (left) for calibration period, and predicted versus observed carryover (right) for prediction period. Error bars show 95% confidence intervals for predicted mean carryover.

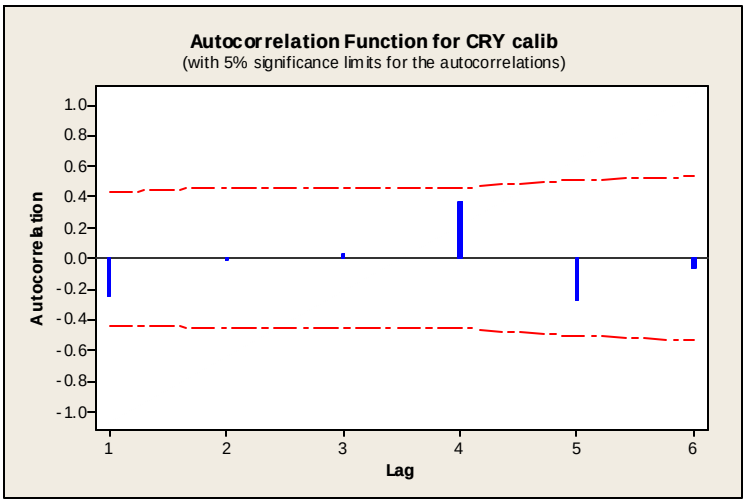




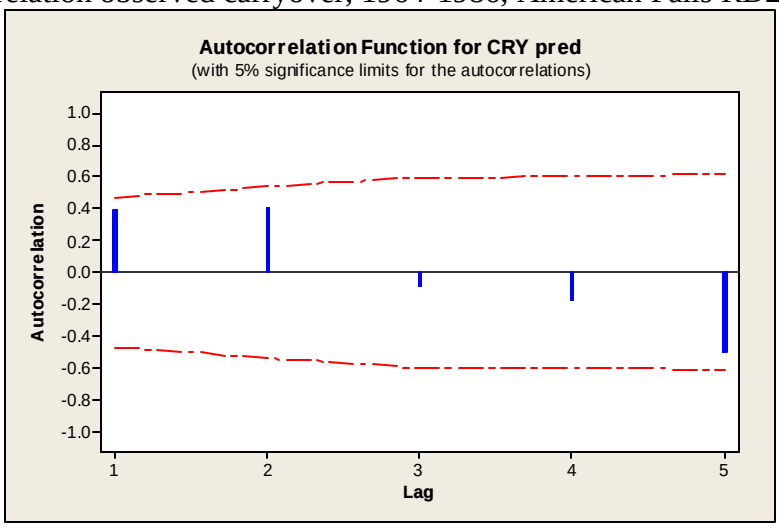
Predicted and observed carryover versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model. Error bars for 1987-2008 values show 95% confidence intervals for predicted mean carryover in top panel and 95% confidence intervals for prediction of new observation in bottom panel.



Prediction residuals (predicted carryover minus observed carryover) versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model.



Temporal autocorrelation observed carryover, 1964-1986, American Falls RD2.



Temporal autocorrelation in observed carryover, 1989-2008, American Falls RD2.

NORTH SIDE CANAL COMPANY

Best-model Regression Analysis: CRY versus ALLOC, HEISE100AF, PDSI, DIVERSION

```
The regression equation is
CRY = - 120451 + 0.950 ALLOC + 64.1 HEISE100AF + 27434 PDSI - 0.472 DIVERSION

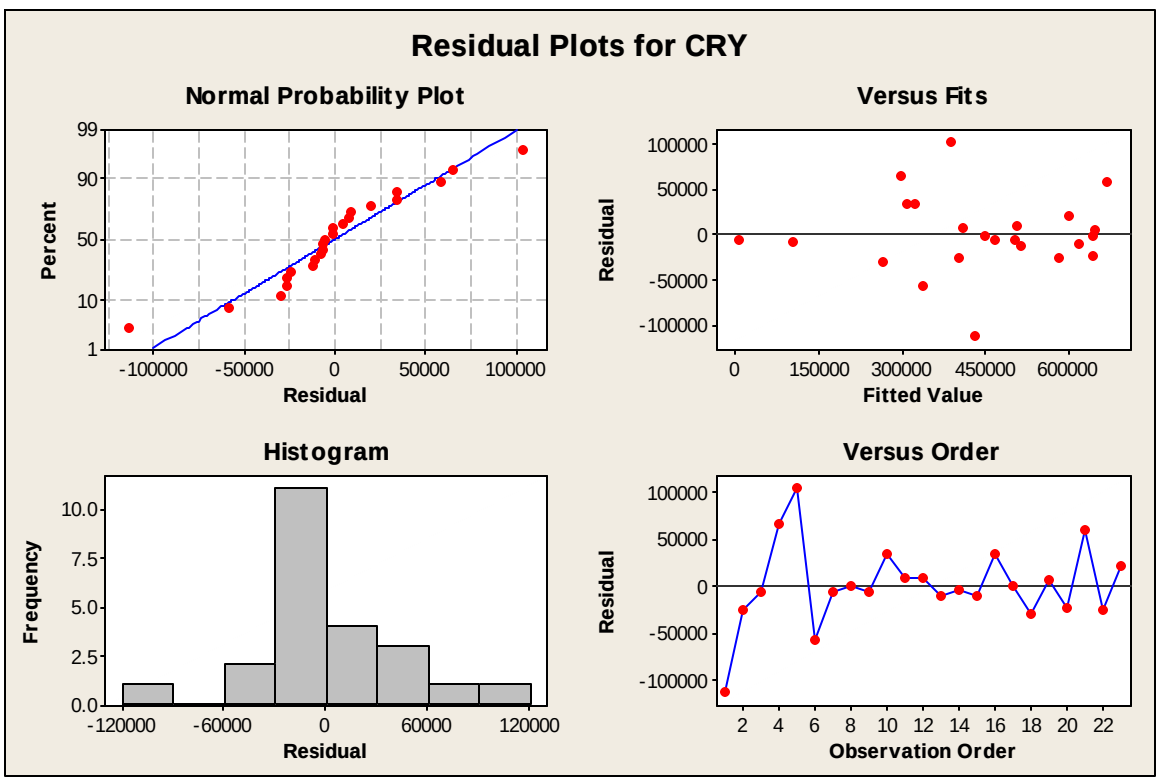
Predictor       Coef  SE Coef      T      P    VIF
Constant     -120451   210952  -0.57  0.575
ALLOC         0.9499   0.3166   3.00  0.008  1.949
HEISE100AF     64.05    14.87   4.31  0.000  2.251
PDSI           27434     4420   6.21  0.000  2.114
DIVERSION    -0.4721   0.1158  -4.08  0.001  1.448

S = 47703.2   R-Sq = 94.3%   R-Sq(adj) = 93.0%

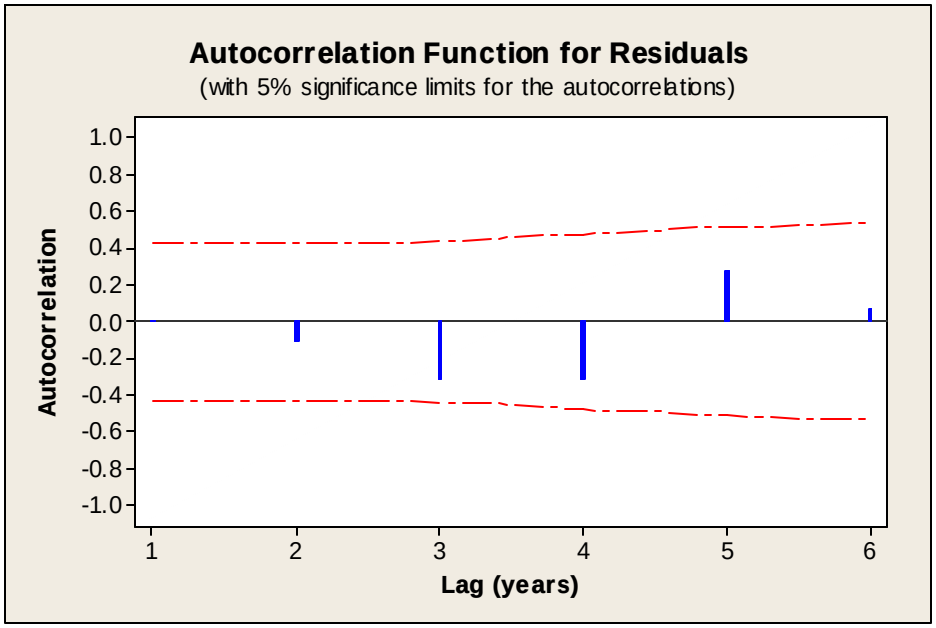
Analysis of Variance

Source          DF           SS           MS      F      P
Regression       4  6.77295E+11  1.69324E+11  74.41  0.000
Residual Error  18  40960750129   2275597229
Total           22  7.18256E+11

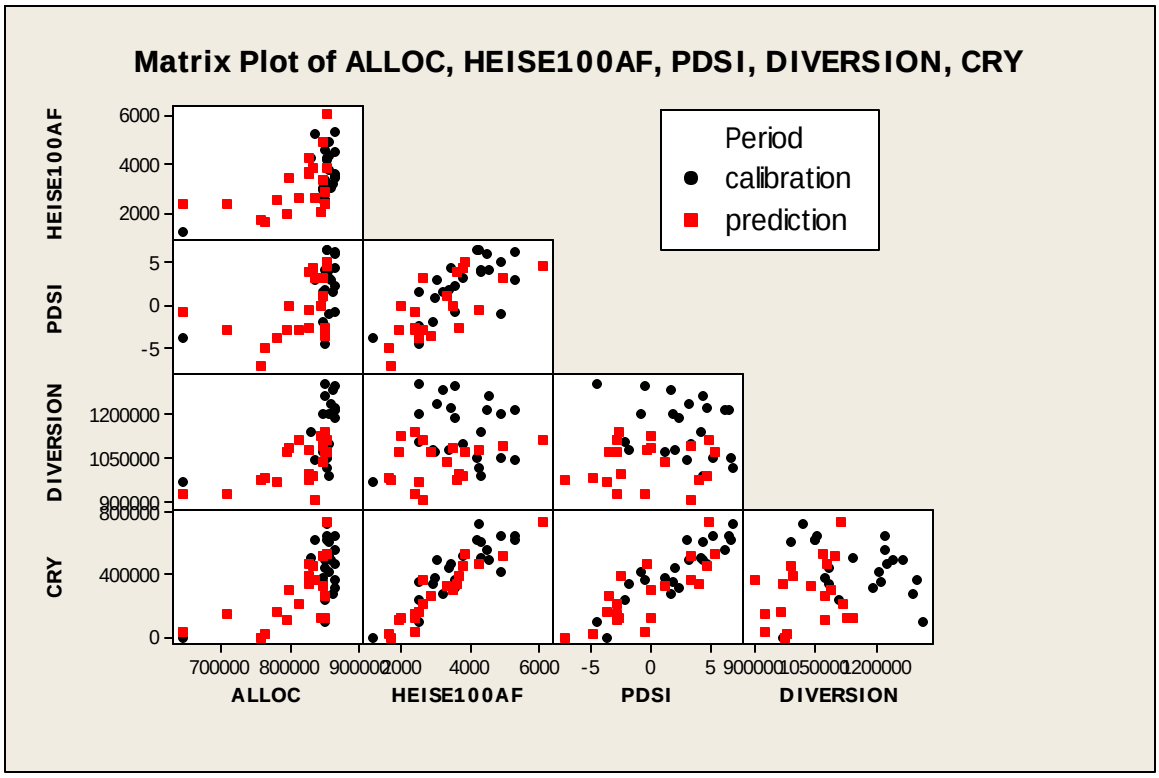
Source       DF       Seq SS
ALLOC         1  1.92E+11
HEISE100AF    1  3.22E+11
PDSI          1  1.26E+11
DIVERSION     1  3.78E+10
```



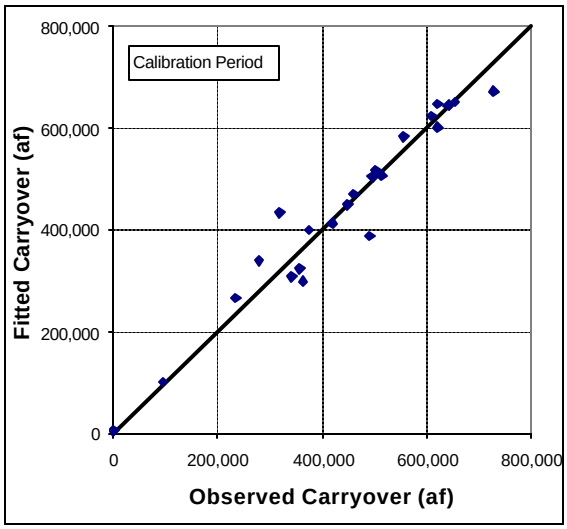
Residual analysis for best model.

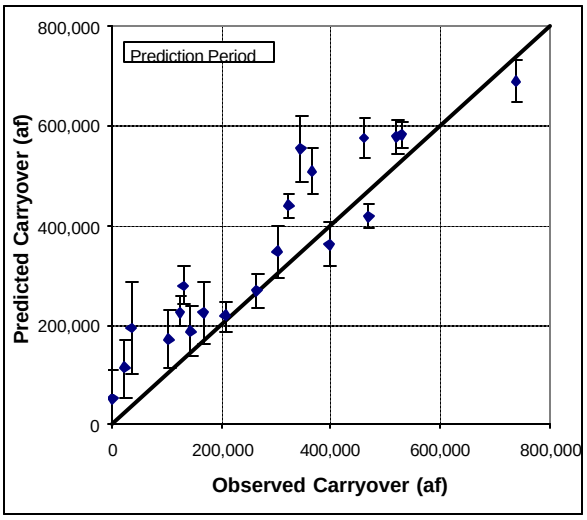


Autocorrelation in best-model residuals.

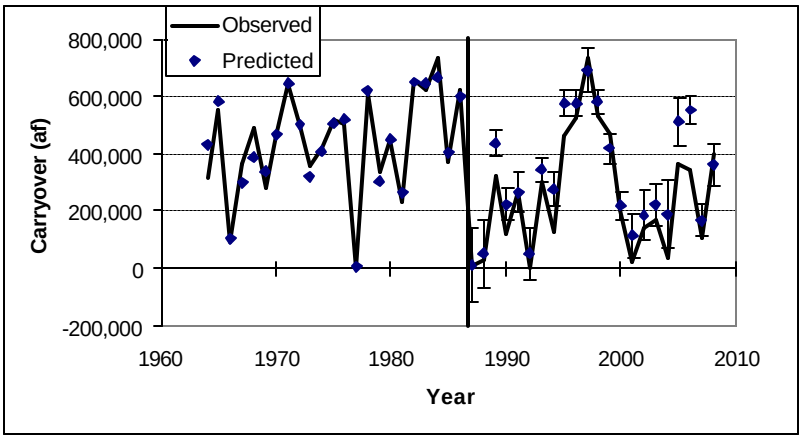


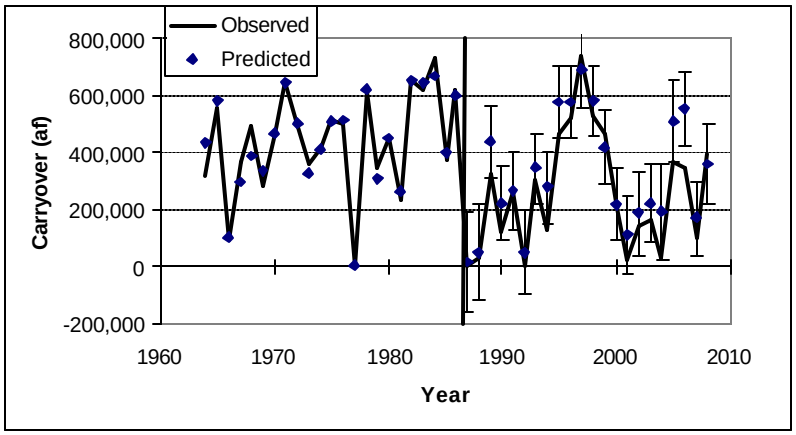
Scatter plots among all independent variables and between carryover and each independent variable. Calibration period is 1964-1986; prediction period is 1989-2008.



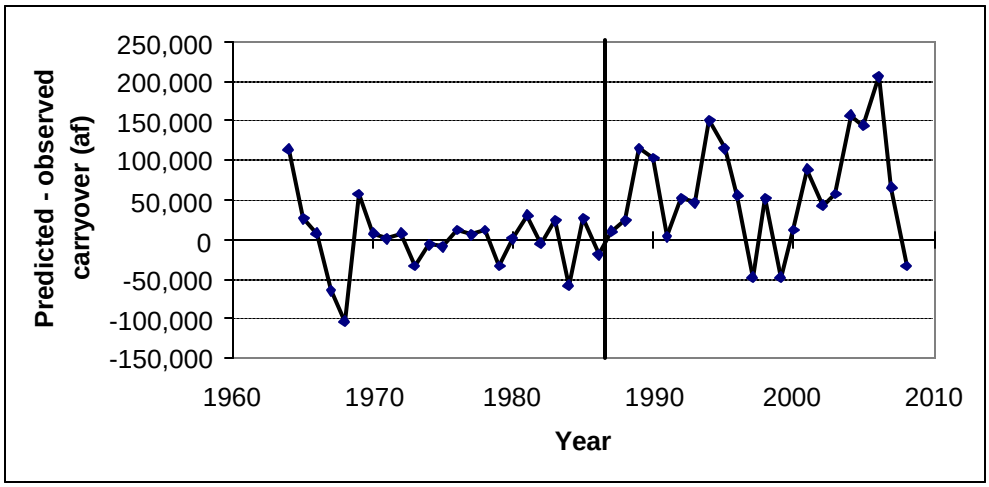


Fitted versus observed carryover (left) for calibration period, and predicted versus observed carryover (right) for prediction period. Error bars show 95% confidence intervals for predicted mean carryover.

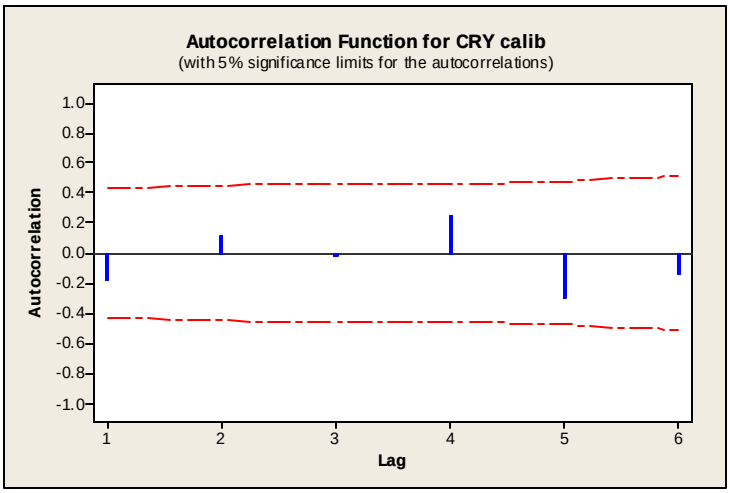




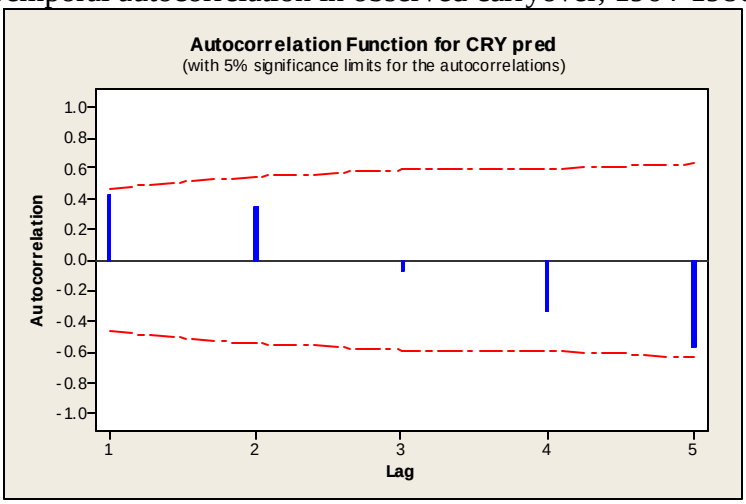
Predicted and observed carryover versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model. Error bars for 1987-2008 values show 95% confidence intervals for predicted mean carryover in top panel and 95% confidence intervals for prediction of new observation in bottom panel.



Prediction residuals (predicted carryover minus observed carryover) versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model.



Temporal autocorrelation in observed carryover, 1964-1986.



Temporal autocorrelation in prediction residuals, 1989-2008.

TWIN FALLS CANAL COMPANY

Best-model Regression Analysis: CRY versus ALLOC, HEISE100AF, PDSI, ETR

```
The regression equation is
CRY = 337465 + 0.406 ALLOC + 26.1 HEISE100AF + 4622 PDSI - 12336 ETR

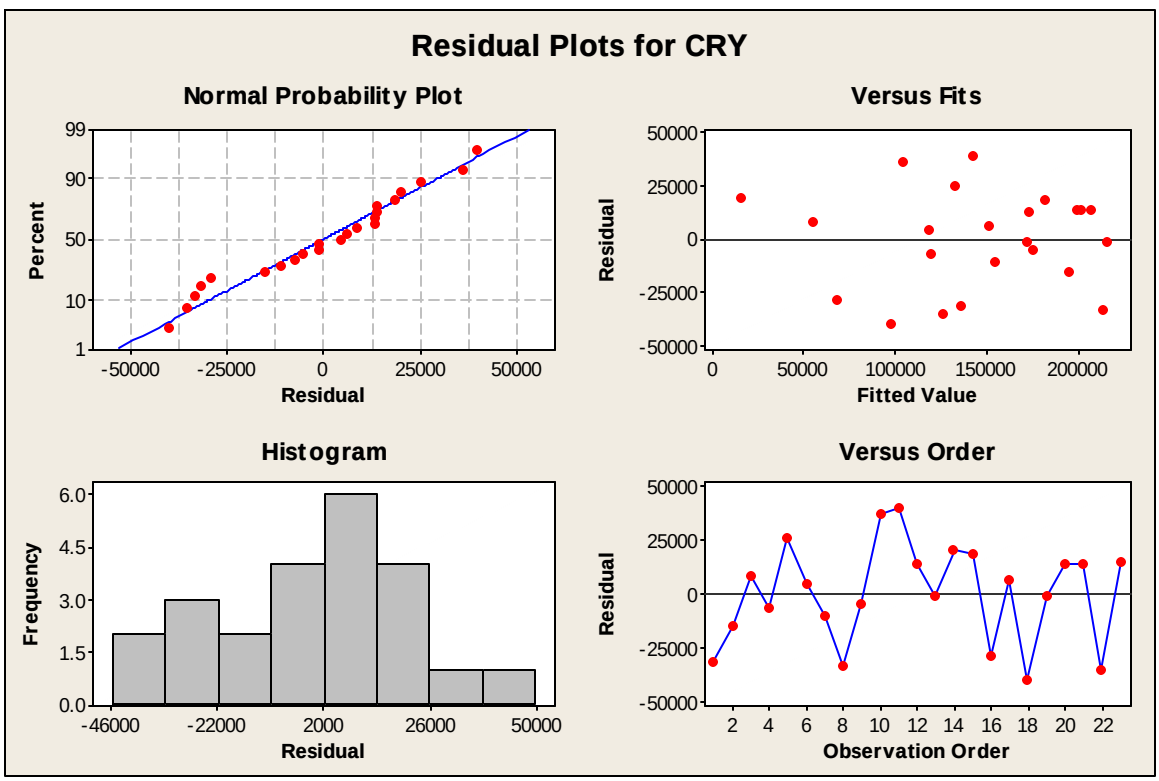
Predictor      Coef  SE Coef      T      P    VIF
Constant     337465   203856   1.66  0.115
ALLOC        0.4065   0.3105   1.31  0.207  1.587
HEISE100AF   26.140    7.756   3.37  0.003  2.184
PDSI           4622     3172   1.46  0.162  3.887
ETR          -12336     6709  -1.84  0.083  2.238

S = 25255.2   R-Sq = 84.6%   R-Sq(adj) = 81.1%

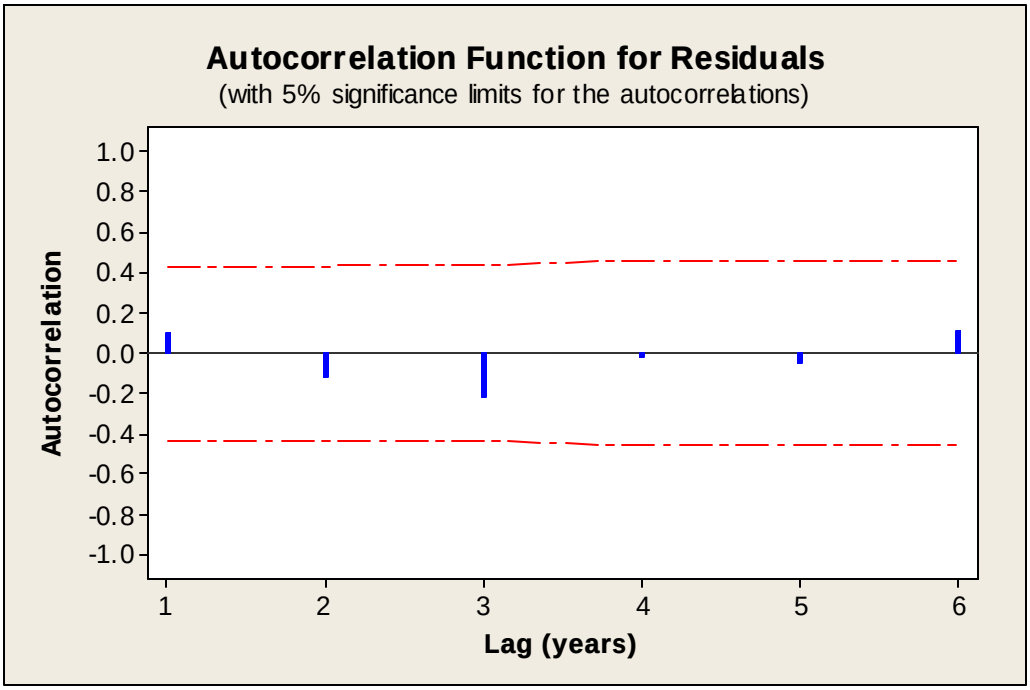
Analysis of Variance

Source          DF           SS           MS      F      P
Regression       4  62912404649  15728101162  24.66  0.000
Residual Error  18  11480890386    637827244
Total           22  74393295035

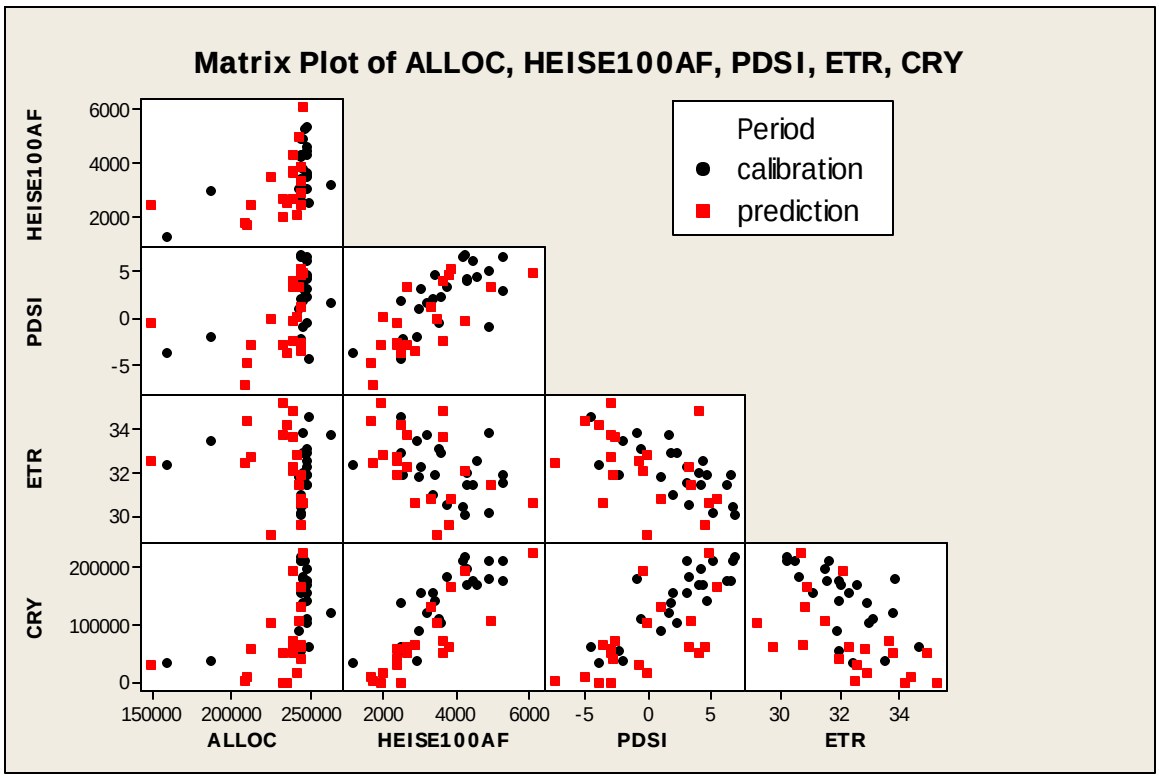
Source      DF  Seq SS
ALLOC        1  2.23E+10
HEISE100AF   1  2.94E+10
PDSI         1  8.99E+09
ETR          1  2.16E+09
```



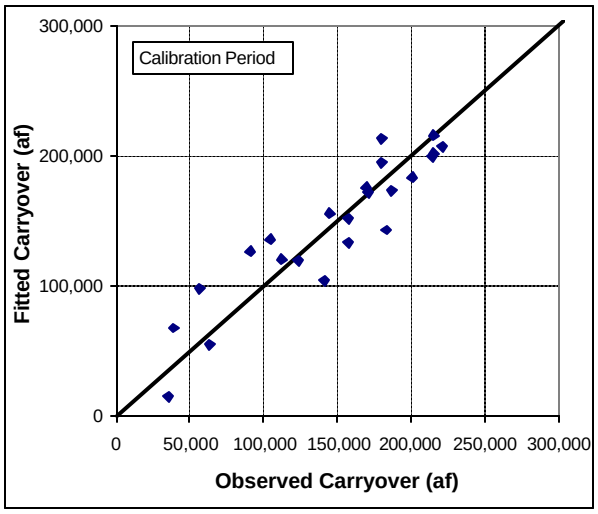
Residual analysis for best model.

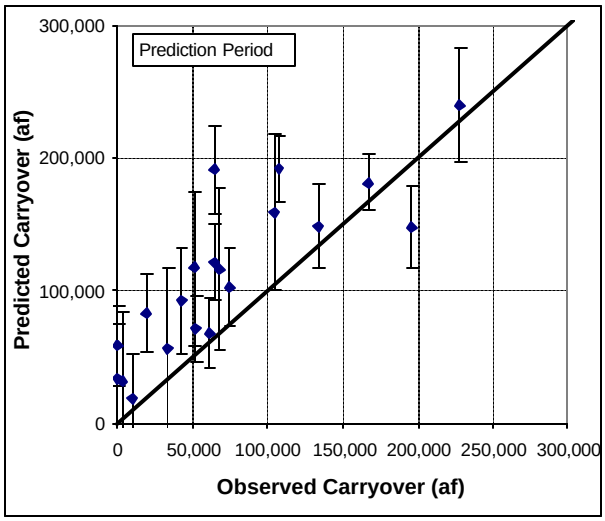


Autocorrelation in best-model residuals.



Scatter plots among all independent variables and between carryover and each independent variable. Calibration period is 1964-1986; prediction period is 1989-2008.





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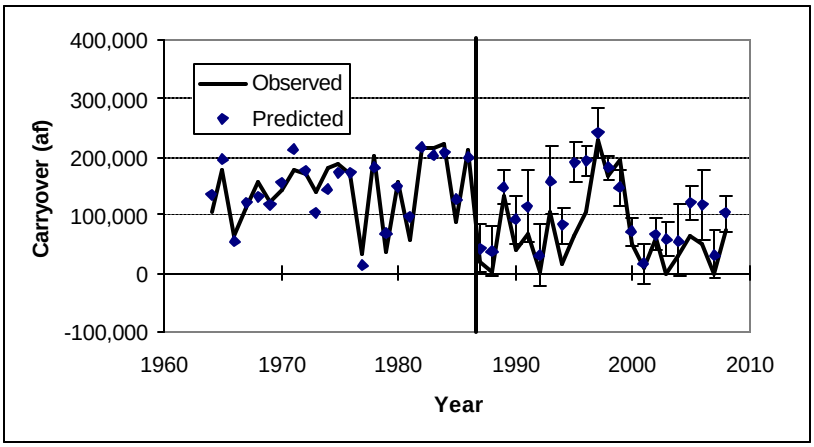

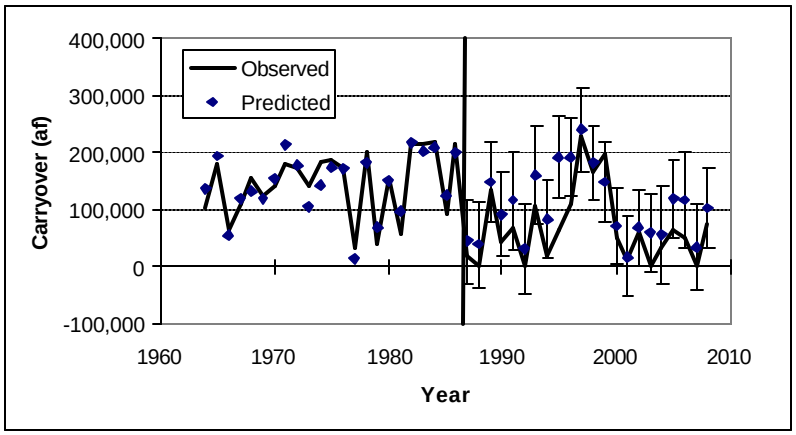

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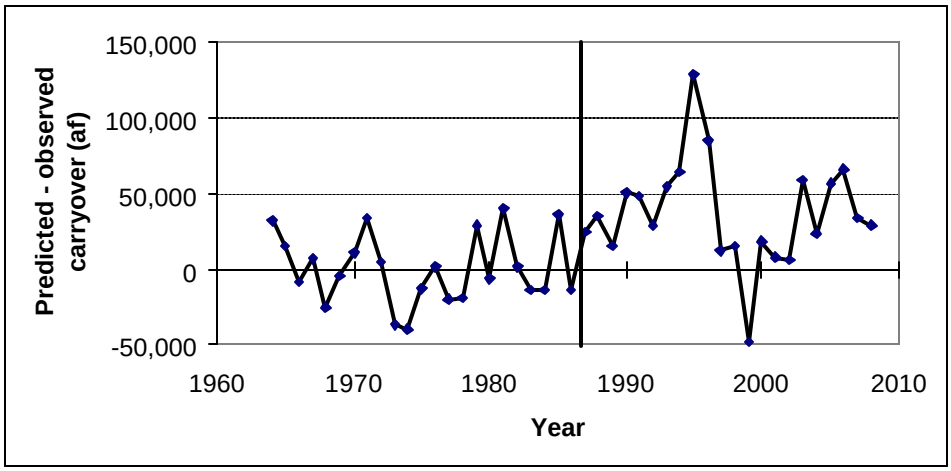
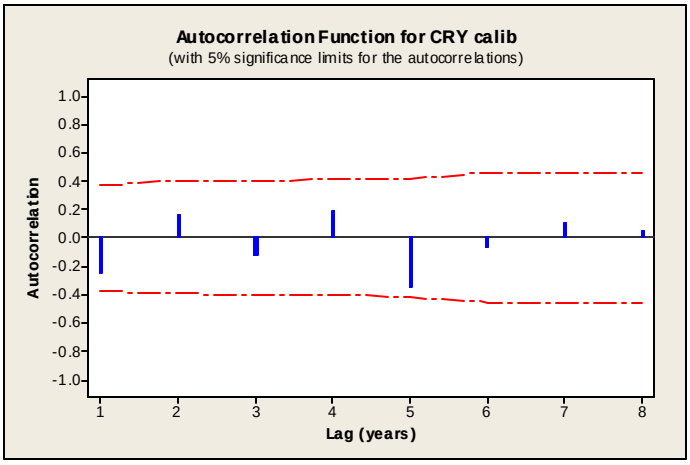
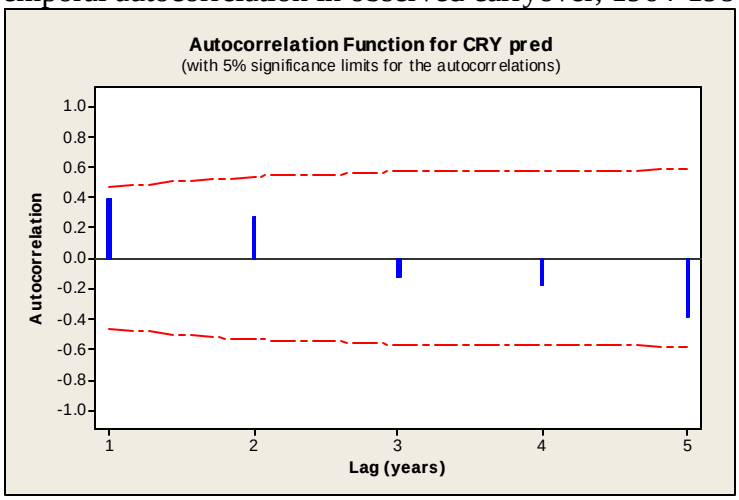


Prediction residuals (predicted carryover minus observed carryover) versus time. "Predicted" values for the 1964-1986 calibration period are values fitted to best regression model.



Temporal autocorrelation in observed carryover, 1964-1986.



Temporal autocorrelation in observed carryover, 1989-2008.