CHESAPEAKE BAY WATERSHED MODEL APPLICATION AND CALCULATION OF NUTRIENT AND SEDIMENT LOADINGS

Appendix A: Phase IV Chesapeake Bay Watershed Model Hydrology Calibration Results

A Report of the
Chesapeake Bay Program
Modeling Subcommittee
Annapolis, MD

Chesapeake Bay Program

May 1998

Printed by the U.S. Environmental Protection Agency for the Chesapeake Bay Program

Principal Authors

Kelly A. Greene
United States Department of Commerce
NOAA Chesapeake Bay Office
Annapolis, MD

Lewis C. Linker
United States Environmental Protection Agency
Chesapeake Bay Program Office
Annapolis, MD

Modeling Subcommittee Members

James R. Collier, Chairman of the Subcommittee,
Program Manager
Water Resources Management Division
Washington, DC

Dr. Joseph Bachman
US Geological Survey
Towson, MD

Mark Bennett
Department of Soil and Water Conservation
Richmond, VA

Dr. Peter Bergstrom
Chesapeake Bay Field Office
US Fish & Wildlife Service
Annapolis, MD

Dr. Arthur Butt
Chesapeake Bay Office
VA Department of Environmental Quality
Richmond, VA

Brian Hazelwood
Metropolitan Washington Council of Governments
Washington, DC

Dr. Albert Y. Kuo
VA Institute of Marine Science
Gloucester Point, VA

Lewis C. Linker, Coordinator of the Subcommittee
US EPA Chesapeake Bay Program Office
Annapolis, MD

Alan Lumb
Hydrologic Analysis Support Section
USGS National Center MS 415
Reston, VA

Dr. Robert Magnien
MD Department of Natural Resources
Assessment Administration
Annapolis, MD

Dr. Ross Mandel
Interstate Commission on the Potomac River Basin
Rockville, MD

Dr. Bruce Parker
National Oceanic and Atmospheric Administration/NOS/OES33
Coastal & Estuarine Oceanography Branch
Silver Spring, MD

Kenn Pattison
PA Department of Environmental Protection
Bureau of Water Quality Protection
Harrisburg, PA

Ron Santos
US Army Corps of Engineers
Baltimore, MD

Tom Stockton
MD Department of Environmental Resources
Watershed Modeling & Analysis Division
Annapolis, MD

Paul Welle
USDA Soil Conservation Service
Northeast National Technical Center
Chester, PA

LIST OF PHASE IV WATERSHED MODEL REFERENCE APPENDICES

Appendix A	Phase IV Chesapeake Bay Watershed Model Hydrology Calibration Results
Appendix B	Phase IV Chesapeake Bay Watershed Model Water Quality Calibration
Appendix C	Phase IV Chesapeake Bay Watershed Model Nonpoint Source Simulation
Appendix D	Phase IV Chesapeake Bay Watershed Model Precipitation and Meteorological Data Development and Atmospheric Nutrient Deposition
Appendix E	Phase IV Chesapeake Bay Watershed Land Use & Model Linkages to the Airshed & Estuarine Models
Appendix F	Phase IV Chesapeake Bay Watershed Model Point Source Loads and Water Supply Diversions
Appendix G	Observed Water Quality Data Used for Calibration, A Simulation of Regression Loads, and a Confirmation Scenario of the Phase IV Chesapeake Bay Watershed Model
Appendix H	Development of BMP Input Parameters To Track Nutrient Reduction Goals with the Phase IV Chesapeake Bay Watershed Model

Acknowledgments

This is to acknowledge the substantial contribution of the United States Geological Survey offices of Virginia, Maryland, Pennsylvania, and West Virginia for their timely processing of seemingly endless data requests. The scientists, engineers, and managers of the Modeling Subcommittee and the Model Evaluation Group are acknowledged for their guidance and review. This document and other Chesapeake Bay Program modeling documents can be found on the Modeling Subcommittee web page:
http://www.chesapeakebay.net/bayprogram/committ/mdsc/model.htm

APPENDIX SUMMARY

Appendix A documents in detail the Phase IV Watershed Model hydrology calibration. The results are presented as plots and statistical tables that compare the simulated and observed flows for the 8 years of calibration (1984-1991) for 17 flow calibration stations of the Chesapeake Bay. Specifically, this appendix includes the following plots: (1) Observed and Simulated Flows; (2) Actual Error of the Flow; (3) Observed and Simulated Cumulative Flows; (4) Actual Error versus Percentile Sample Population; (5) Paired Frequency Distribution of Simulated and Observed Data versus Percentile of Population; and (6) Scatter Plot and Regression of Simulated versus Observed with Ideal Line. The appendix also contains the following statistical tables: (1) Comparison of Annual Total Observed and Simulated Flows; (2) Comparison of Daily and Average Monthly Total Flow Observed and Simulated Regressions; and (3) Average Seasonal Regressions. Regression statistics include r-squared, intercept, and slope statistics for the entire data set, on an annual basis, on a seasonal basis..

The daily observed and simulated flow plots generally show good to excellent agreement between the model and data. The differences are mainly attributable to storm events and high-flow, snow-melt events of the spring freshet.

The observed and simulated cumulative flows vs. time show both under and over estimation relative to the observed flow, but no particular bias for any of these stations.

The actual error plots generally display a flat curve around 0 cubic feet per second (cfs) and a sigmoidal shape indicating the errors are normally distributed. A sigmoidal plot centered on 50% of the population indicates a lack of bias in the simulation.

The frequency distribution of paired simulated and observed flow plotted against percentile of sample population show good agreement, with the greatest differences between simulated and observed during very high flows (95th percentile or higher) or very low flows (5th percentile or lower). Note that in the scatter plots the ideal line is drawn (slope = 1, intercept = 0) as a point of reference for the flow data and that the flow regression statistics are displayed. As a point of comparison, the tabular regression statistics are for the log flow regression and the regression statistics displayed on the scatter plot are for untransformed flow data.

Table of Contents

Section		Page
A.1.0	Susquehanna River Basin	
	A.1.1 East Branch Susquehanna River	19
	A.1.2 West Branch Susquehanna River	28
	A.1.3 Juniata River	37
	A.1.4 Lower Susquehanna River	46
	A.1.5 Susquehanna River at Conowingo Dam	55
A.2.0	Patuxent River Basin	65
A.3.0	Potomac River Basin	
	A.3.1 Upper Potomac River	75
	A.3.2 Shenandoah River	84
	A.3.3 Lower Potomac River	93
A.4.0	Rappahannock River Basin	103
A.5.0	York River Basin	
	A.5.1 Mattaponi River	113
	A.5.2 Pamunkey River	122
A.6.0	James River Basin	
	A.6.1 James River	132
	A.6.2 Appomattox River	141
A.7.0	Nanticoke River Basin	151
A.8.0	Choptank River Basin	160
A.9.0	Patapsco River Basin	170

List of Figures

Figure		Page
A.1	Monitoring Stations in Chesapeake Bay Watershed Phase IV Model Segments: Susquehanna River Basin	18
A.2	Monitoring Stations in Chesapeake Bay Watershed Phase IV Model Segments: Patuxent River Basin	64
A.3	Monitoring Stations in Chesapeake Bay Watershed Phase IV Model Segments: Potomac River Basin	74
A.4	Monitoring Stations in Chesapeake Bay Watershed Phase IV Model Segments: Rappahannock River Basin	102
A.5	Monitoring Stations in Chesapeake Bay Watershed Phase IV Model Segments: York River Basin	112
A.6	Monitoring Stations in Chesapeake Bay Watershed Phase IV Model Segments: James River Basin	131
A.7	Monitoring Stations in Chesapeake Bay Watershed Phase IV Model Segments: Eastern Shore Maryland Basin	150
A.9	Monitoring Stations in Chesapeake Bay Watershed Phase IV Model Segments: Western Shore Maryland Basin	169

List of Tables

Table		Page
A	Characteristics of Stations used in Hydrology Calibration.	14
East Branch Susquehanna River		
A.1.1.1	Comparison of annual total observed and simulated flows.	26
A.1.1.2	Regression of log simulated flow on log observed flow daily and monthly r-squared.	26
A.1.1.3	Seasonal r-squared.	27
West Branch Susquehanna River		
A.1.2.1	Comparison of annual total observed and simulated flows.	35
A.1.2.2	Regression of log simulated flow on log observed flow daily and monthly r-squared.	35
A.1.2.3	Seasonal r-squared.	36
Juniata River		
A.1.3.1	Comparison of annual total observed and simulated flows.	44
A.1.3.2	Regression of log simulated flow on log observed flow daily and monthly r-squared.	44
A.1.3.3	Seasonal r-squared.	45
Lower Susquehanna River		
A.1.4.1	Comparison of annual total observed and simulated flows.	53
A.1.4.2	Regression of log simulated flow on log observed flow daily and monthly r-squared.	53
A.1.4.3	Seasonal r-squared.	54
Susquehanna River at Conowingo, Maryland		
A.1.5.1	Comparison of annual total observed and simulated flows.	62

A.1.5.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 62

A.1.5.3 Seasonal r-squared. 63

Patuxent River

A.2.1.1 Comparison of annual total observed and simulated flows. 72

A.2.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 72

A.2.1.3 Seasonal r-squared. 73

Upper Potomac River

A.3.1.1 Comparison of annual total observed and simulated flows. 82

A.3.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 82

A.3.1.3 Seasonal r-squared. 83

Shenandoah River

A.3.2.1 Comparison of annual total observed and simulated flows. 91

A.3.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 91

A.3.2.3 Seasonal r-squared. 92

Lower Potomac River

A.3.3.1 Comparison of annual total observed and simulated flows. 100

A.3.3.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 100

A.3.3.3 Seasonal r-squared. 101

Rappahannock River

A.4.1.1 Comparison of annual total observed and simulated flows. 110

A.4.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 110

A.4.1.3 Seasonal r-squared. 111

Mattaponi River

A.5.1.1 Comparison of annual total observed and simulated flows. 120

A.5.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 120

A.5.1.3 Seasonal r-squared. 121

Pamunkey River

A.5.2.1 Comparison of annual total observed and simulated flows. 129

A.5.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 129

A.5.2.3 Seasonal r-squared. 130

James River

A.6.1.1 Comparison of annual total observed and simulated flows. 139

A.6.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 139

A.6.1.3 Seasonal r-squared. 140

Appomattox River

A.6.2.1 Comparison of annual total observed and simulated flows. 148

A.6.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 148

A.6.2.3 Seasonal r-squared. 149

Nanticoke River

A.7.1.1 Comparison of annual total observed and simulated flows. 158

A.7.1.2 Regression of log simulated flow on log observed flow 158

daily and monthly r-squared.

A.7.1.3 Seasonal r-squared. 159

Choptank River

A.8.0.1 Comparison of annual total observed and simulated flows. 167

A.8.0.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 167

A.8.0.3 Seasonal r-squared. 168

Patapsco River

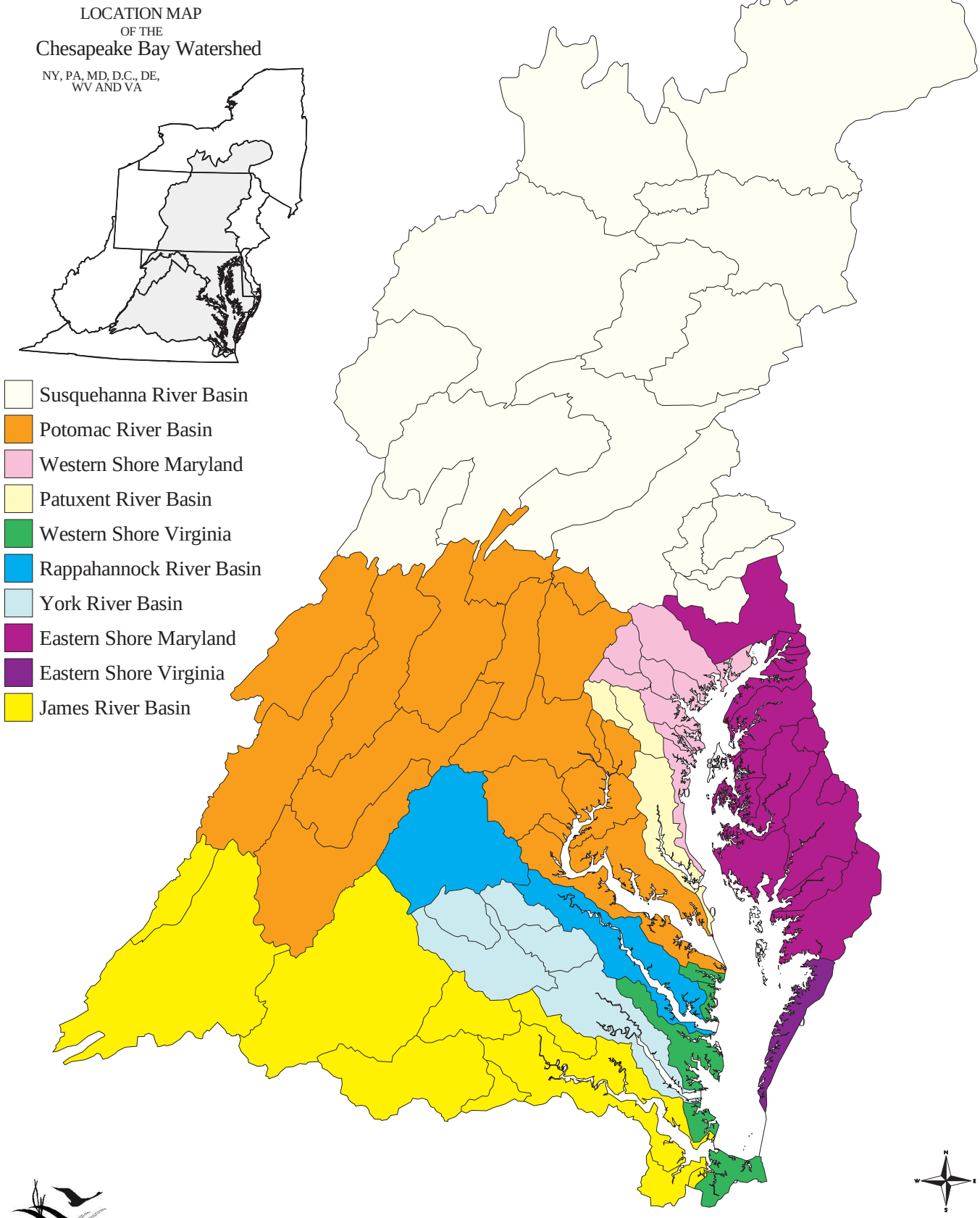
A.9.0.1 Comparison of annual total observed and simulated flows. 177

A.9.0.2 Regression of log simulated flow on log observed flow daily and monthly r-squared. 177

A.9.0.3 Seasonal r-squared. 178

Major Basins of the Chesapeake Bay Watershed

with Phase IV Watershed Model Segments



Chesapeake Bay Program

KJH Map Date: January, 1998

Source: U.S. E.P.A. Chesapeake Bay Program

Table A
Characteristics of Stations Used in Hydrology Calibration

Phase IV Model Segment	Station No.	Location	Latitude	Longitude	Drainage Area (mi^2)	Gauge (ft. above NGVD)	Average Discharge
40	1540500	Montour County, PA, on right bank 200 ft upstream from Mill Street bridge on State Highway 54 at Danville and 0.8 mi upstream from Mahoning Creak.	40°57'29"	76°37'10"	11220	431.29	89 years, 15,270 cfs, 18.48 in/yr as 1988.*
70	1553500	Northumberland County, PA, at down-stream side of left abutment of Market Street bridge on State Highway 45 at Lewisburg, 0.2 mi downstream from Buffalo Creek and 7.4 mi upstream from mouth.	40°58'05"	76°52'25"	6847	428.20. 10/20/87 - 9/30/88, nonrecord-ing gauge at same site and datum.	62 years, 757 cfs, 23.21 in/yr as 1991.*
100	1567000	Perry County, PA, on right bank at downstream side of bridge on State Highway 34 at Newport and 1,000 ft upstream from Little Buffalo Creek.	40°28'42"	77°07'46"	3354	363.93	89 years, 4,280 cfs, 17.37 in/yr as 1988.
710	1570500	Dauphin County, PA, on east bank of City Island, 60 ft downstream from Market Street bridge in Harrisburg, 3,670 ft upstream from sanitary dam, and 1.7 mi upstream from Paxton Creek.	40°15'17"	76°53'11"	24100	290.01	98 years, 34,220 cfs, 19.28 in/yr as 1988.

175	1613000	Washington County, MD, on left bank, 0.2 mi downstream from Little Tonoloway Creek, 0.5 mi downstream from bridge on US Highway 522 at Hancock, 1.1 mi upstream from Tonoloway Creek (formerly called Great or Big Tonoloway Creek), and at mile 239.	39°41'49"	78°10'39"	4073	383.68	56 years, 4,154 cfs, 13.85 in/yr as 1988.
140	1578310	Harford County, MD, on downstream side of Conowingo Dam, 1.0 mi southwest of Conowingo, and 9.9 mi upstream from mouth.	39°39'31"	76°10'28"	27100	5.00	19 years, 41,870 cfs, 20.98 in/yr as 1986.
220	1646580	Arlington County, DC, under right downstream side of bridge on Virginia State Highway 123, and at river mile 115.9.	38°55'46"	77°07'02"	11570	N/A	N/A
200	1636500	Jefferson County, WV, on left bank 0.4 mi downstream from Cattail Run, 1.0 mi upstream from Millville, 5.0 mi upstream from Harpers Ferry, and at mile 5.0.	39°16'55"	77°47'22"	3040	293.00	71 years, 2699 cfs, 12.06 in/yr as 1986.
780	1487000	Bridgeville, DE, on left bank at downstream side of highway bridge, 800 ft downstream from Gum Branch, 2.5 mi southeast of Bridgeville, and 50.5 mi upstream from mouth.	38°43'42"	75°33'44"	75	13.64	45 years, 89.8 cfs, 16.17 in/yr as of 1988.

280	2035000	Goochland County, VA, on left bank, 200 ft downstream from bridge at State Highway 45 between Pemberton and Cartersville, 1.8 mi downstream from Willis River and at mile 156.4.	37°40'15"	78°05'10"	6257	163.90	89 years, 7,087 cfs, 15.38 in/yr as 1988.
760	1589000	Baltimore County, on left bank at downstream side of highway bridge at Hollofield, 0.3 mi downstream from Dogwood Run, 3.0 mi north of Ellicott City and 28 mi upstream from mouth.	39°18'36"	76°47'34"	285	187.70	N/A
310	2041650	Chesterfield County, VA, on left bank at upstream side of bridge on State Highway 600, 0.2 mi south of Matoaca, 2.0 mi upstream from Rohoic Creek, 2.8 mi downstream from Lake Chesdin, 3.5 mi west of Petersburg, and at mile 15.9.	37°13'28"	77°28'32"	1344	68.30	18 years, 1,476 cfs, 14.91 in/yr as 1987. (minimum, 41 cfs, Oct. 4, 1981.)
230	1668000	Spotsylvania County, VA, on right bank 1.6 mi upstream from dam of Virginia Power, 2.2 mi downstream from Motts Run, and 3.8 mi upstream from Fredericksburg.	38°19'20"	77°31'05"	1596	55.18	80 years, 1,660 cfs, 14.12 in/yr as 1988.
240	1674500	King and Queen County, VA, on left bank 0.4 mi upstream from bridge on State Highway 628, 2.4 mi north of Beulahville, and 2.7 mi downstream from Maracossic Creek.	37°53'16"	77°09'48"	601	12.43	46 years, 591 cfs, 13.35 in/yr as 1987.

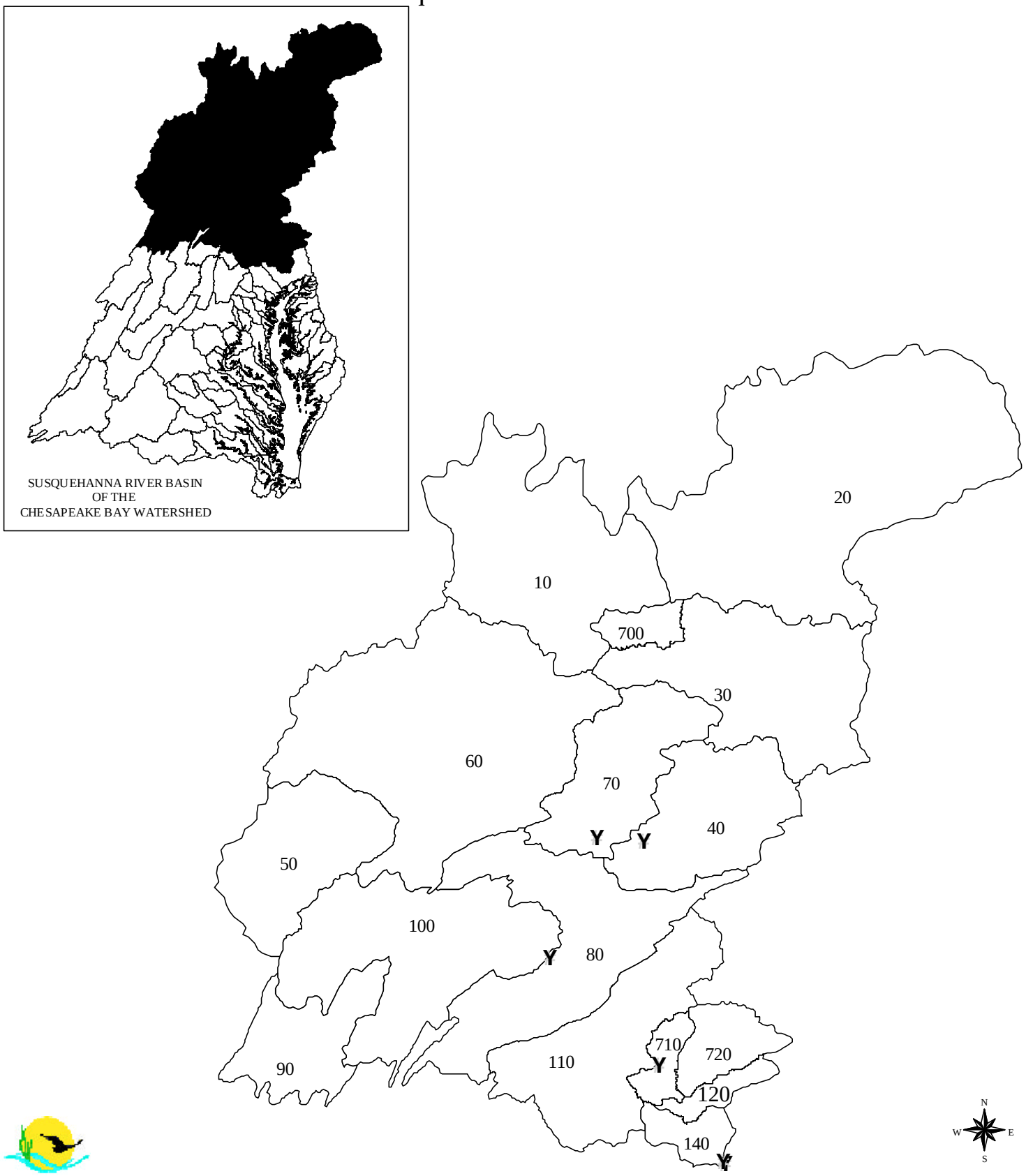
260	1673000	Hanover County, VA, on right bank 100 ft downstream from bridge on State Highway 614, 0.3 mi upstream from Mechumps Creek, 2.0 mi east of Hanover, and 7.0 mi upstream from Millpond Creek.	37°46'03"	77°19'57"	1081	14.72	46 years, 1,006 cfs, 12.64 in/yr as 1988.
340	1594440	Anne Arundel County, MD, on left bank 45 ft upstream from bridge on U.S. Highway 50, 3.0 mi west of Bowie City Hall, 3.1 mi downstream from mouth of Little Patuxent River, 4.2 mi northwest of Davidsonville, and 60 mi upstream from mouth.	38°57'21"	76°41'36"	348	13.10	11 years, 362 cfs, 14.13 in/yr as 1988.
770	1491000	Caroline County, MD, on left bank at highway bridge, 0.1 mi upstream from Gravelly Branch, 2.0 mi northeast of Greensboro, and 60 mi upstream from mouth.	38°59'50"	75°47'09"	113	3.51	41 years, 130 cfs, 15.62 in/yr as 1989.

*: Datum of gauge, above National Geodetic Vertical Datum of 1929; Water-stage recorder, if not otherwise indicated.

Figure A.1

Monitoring Stations

Chesapeake Bay Watershed
Phase IV Model Segments:
Susquehanna River Basin



KAG Map Date: January 1998

Source: USGS and Chesapeake Bay Program Modeling Team

A.1.1 EAST BRANCH SUSQUEHANNA RIVER NEAR DANVILLE, PA AT SEGMENT 40 (1540500)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

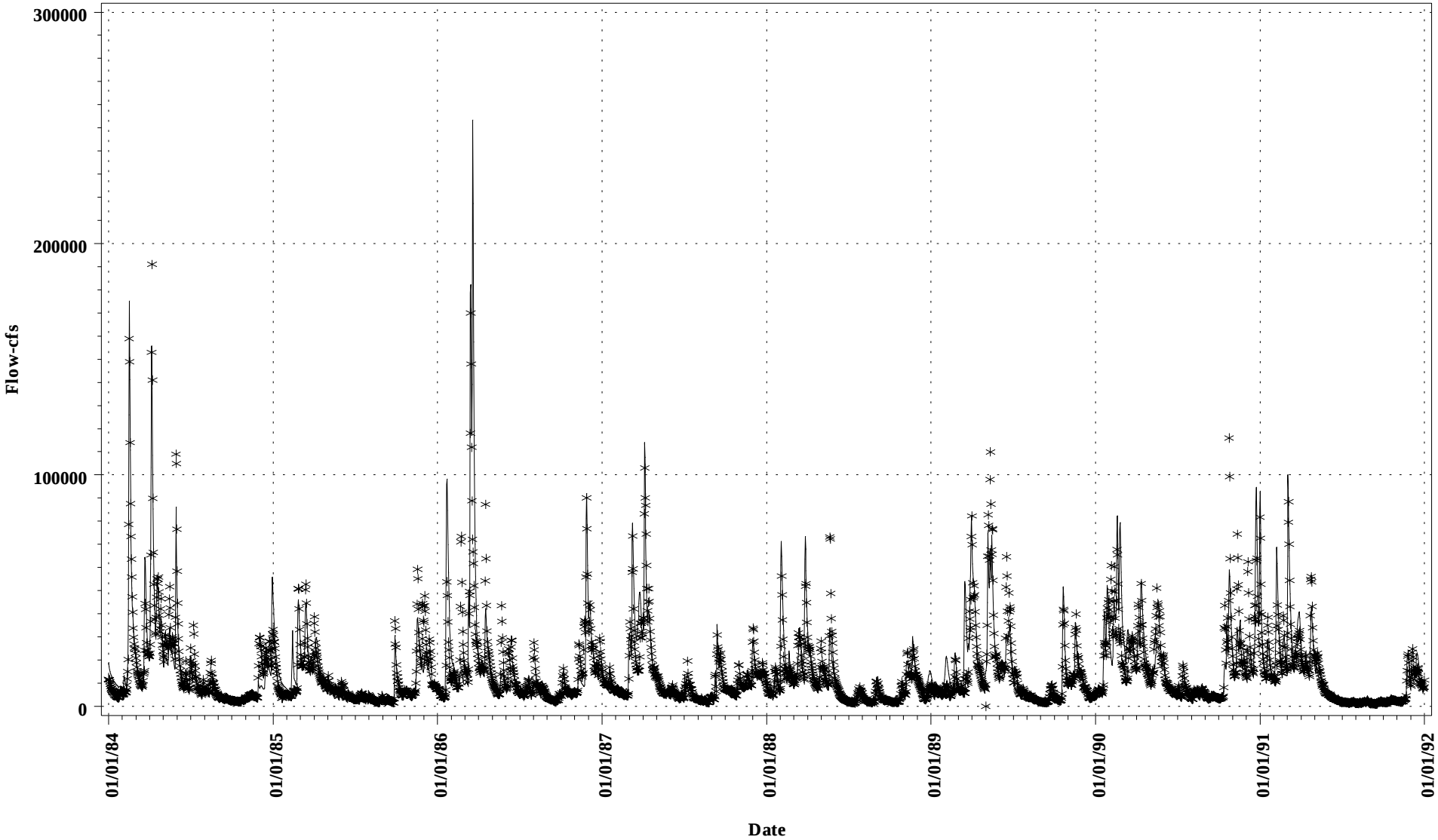
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

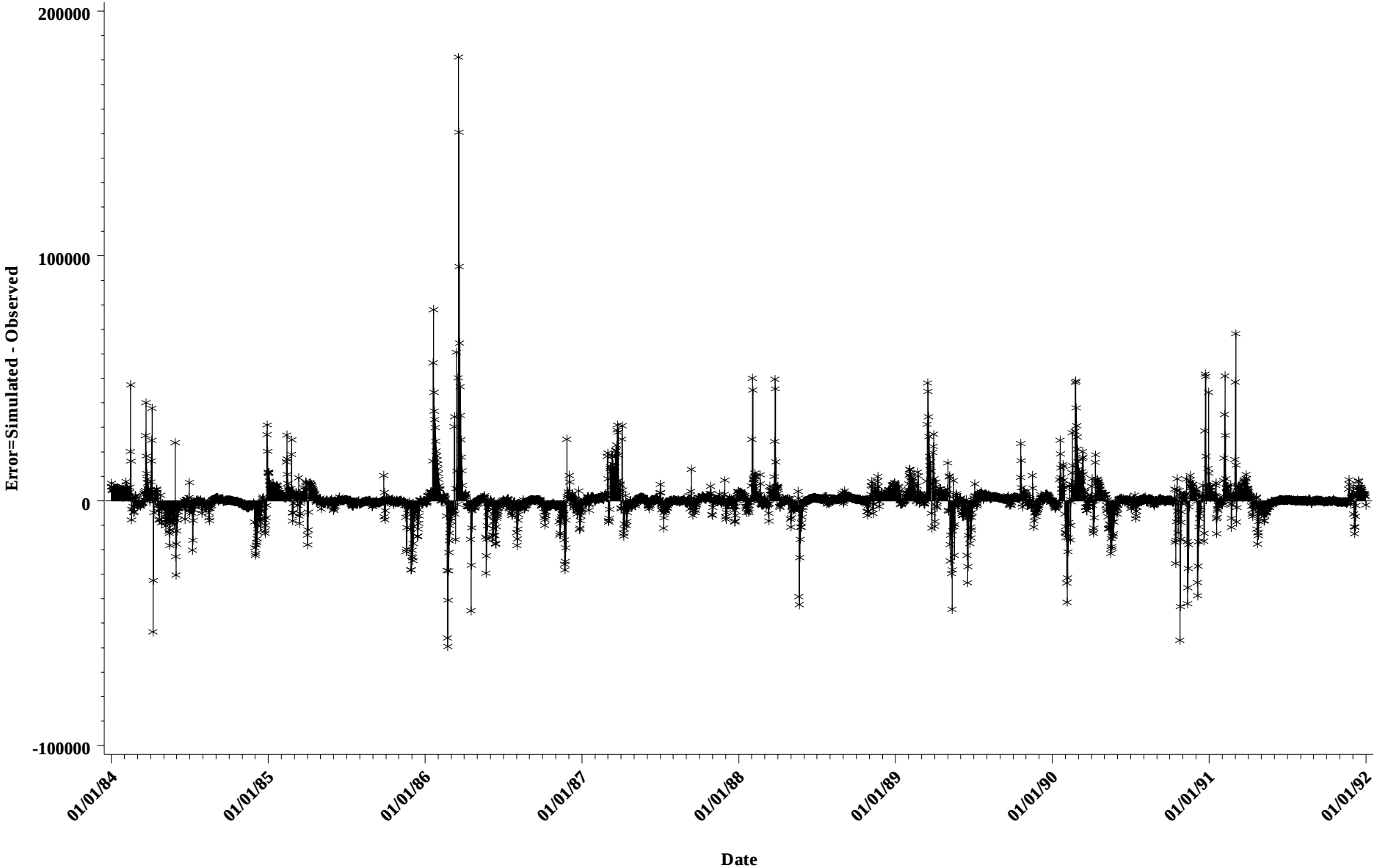
East Branch Susquehanna River at Segment 40
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(ebsus2.drv 12JUN98 14:03)

East Branch Susquehanna River at Segment 40
Actual Error versus Time
Flow-cfs



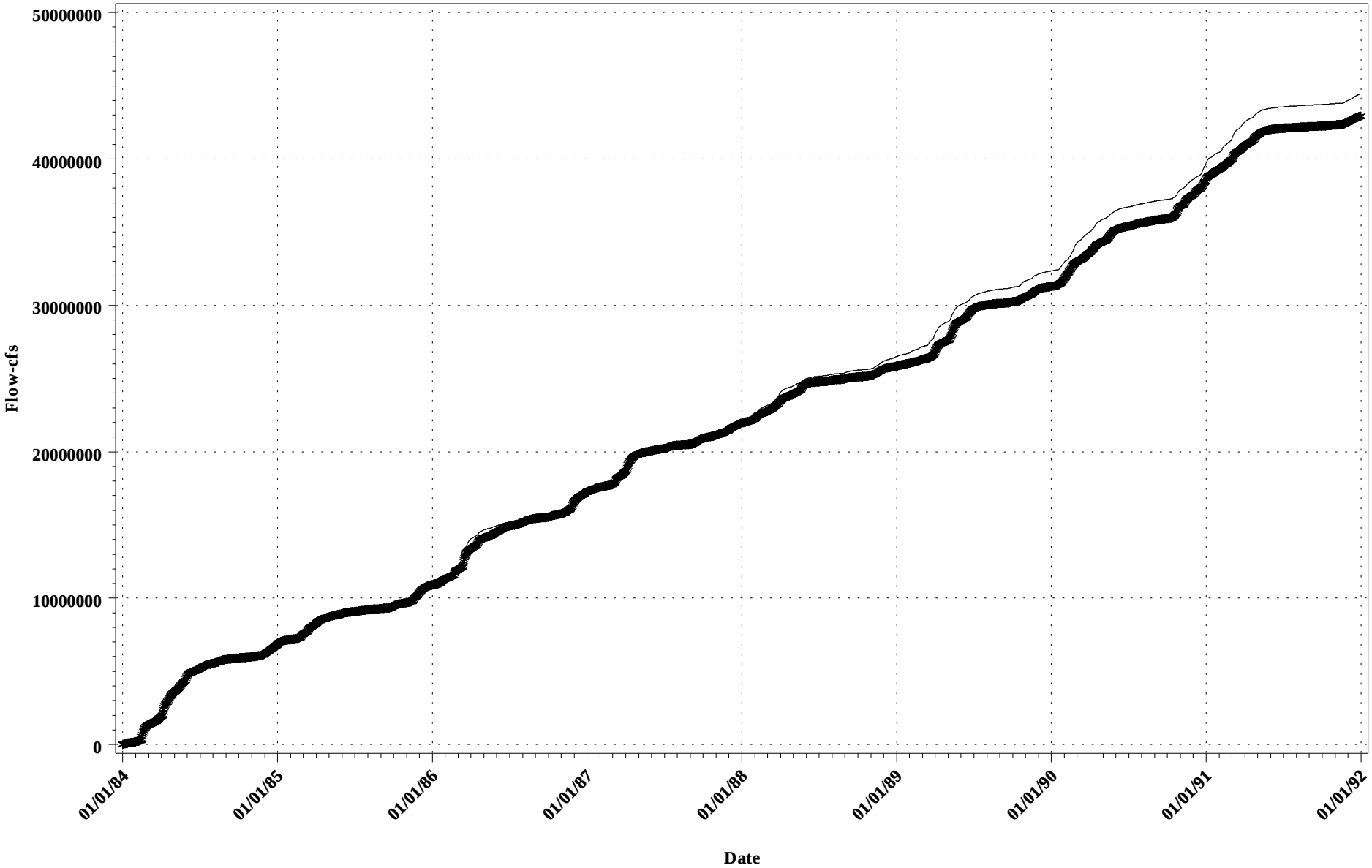
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(ebsus2.drv 12JUN98 14:03)

East Branch Susquehanna River at Segment 40

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

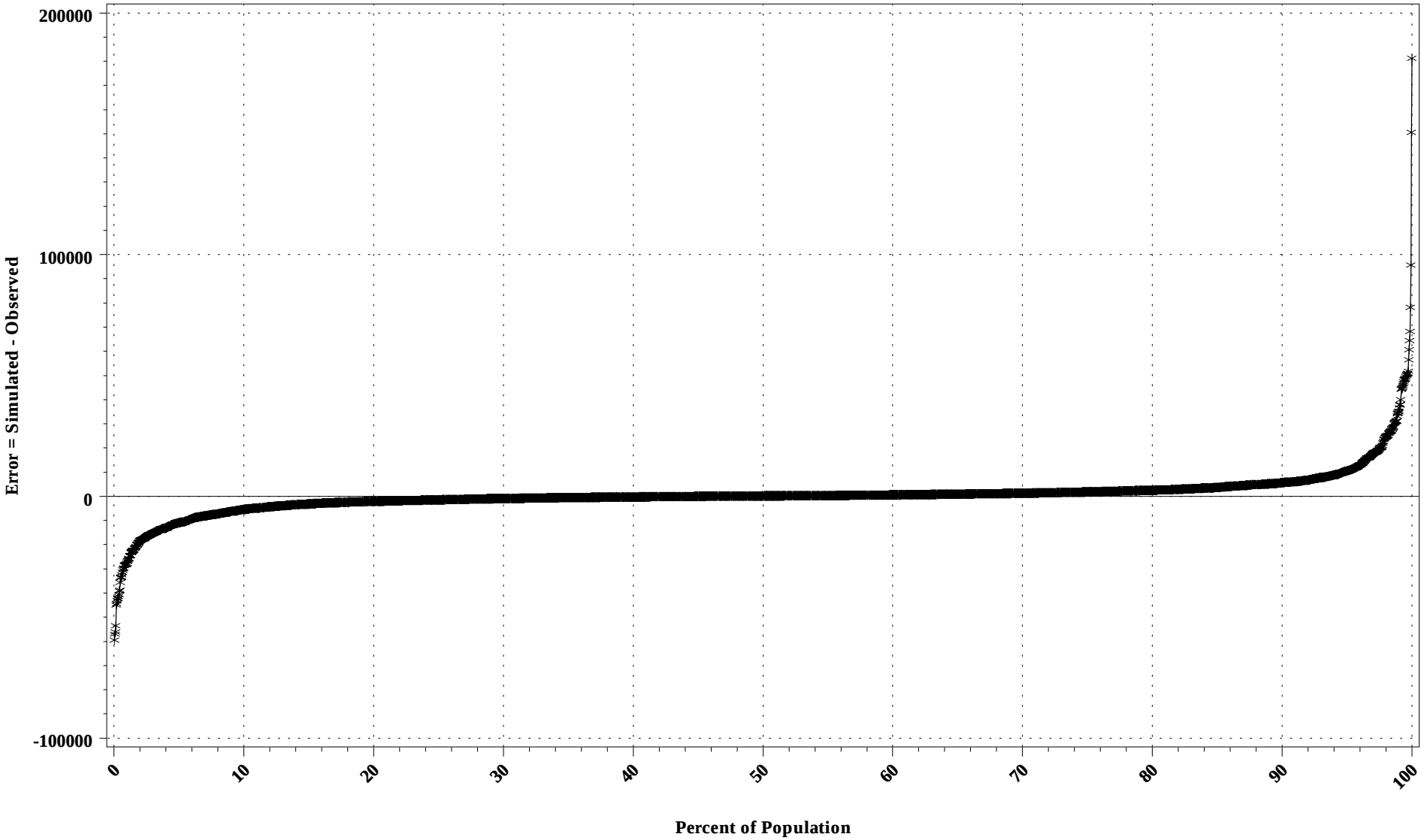
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(ebsus2.drv 12JUN98 14:03)

East Branch Susquehanna River at Segment 40
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

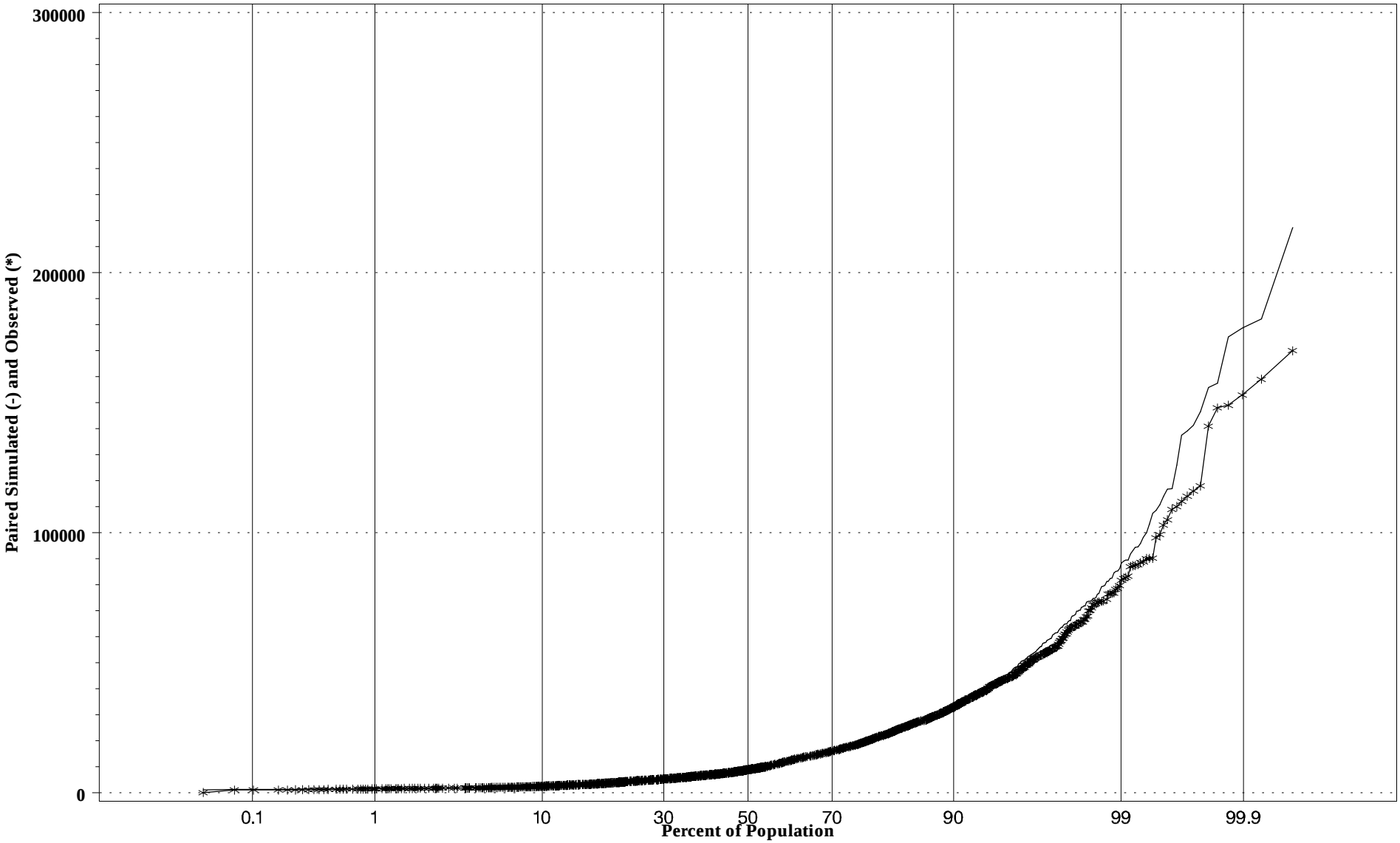


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(ebsus2.drv 12JUN98 14:03)

East Branch Susquehanna River at Segment 40

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

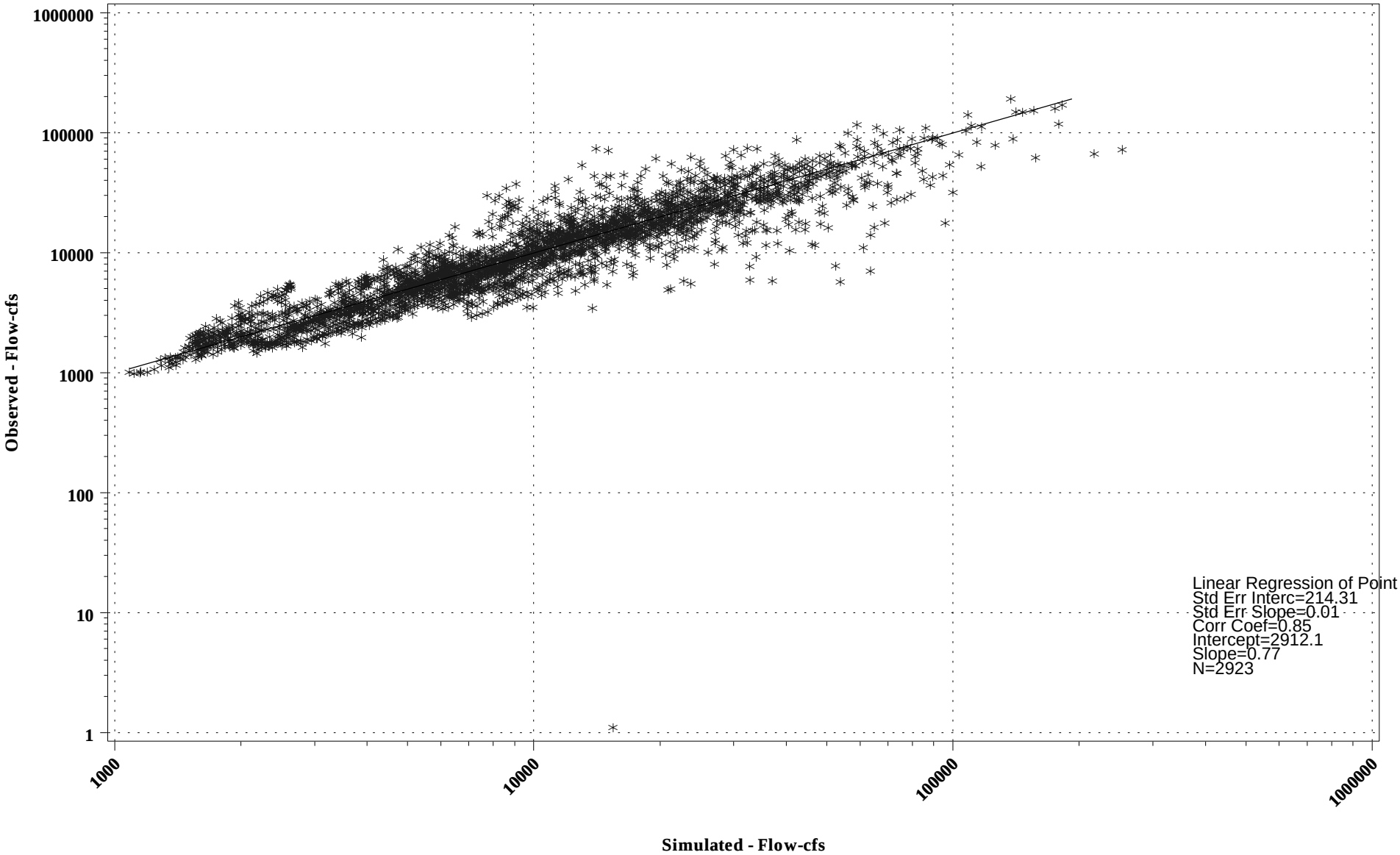


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(ebsus2.drv 12JUN98 14:03)

East Branch Susquehanna River at Segment 40

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(ebsus2.drv 12JUN98 14:03,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
EAST BRANCH SUSQUEHANNA RIVER, PA (Segments 10, 20, 700, 30, and 40)

Table A.1.1.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	22.64	20.94
1985	13.59	13.16
1986	21.02	20.93
1987	15.59	16.27
1988	12.87	14.08
1989	18.10	18.91
1990	23.93	23.50
1991	14.62	15.46
Mean	17.80	17.91

* Observed flow from Susquehanna River near Danville, PA

** Simulated outflow from RCH 40

Table A.1.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.92	0.36	0.86	0.91	11.80	0.88
1985	0.90	0.40	0.85	0.90	11.98	0.88
1986	0.81	0.80	0.73	0.82	23.50	0.84
1987	0.94	0.22	0.90	0.94	6.65	0.96
1988	1.03	-0.18	0.88	1.08	-11.61	0.93
1989	1.08	-0.40	0.85	1.07	-11.86	0.90
1990	0.93	0.27	0.85	0.98	2.41	0.96
1991	0.94	0.20	0.96	0.97	3.66	0.98
1984-1991	0.94	0.21	0.86	0.96	4.57	0.92

Table A.1.1.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	1.23	-1.14	0.96	0.87	0.61	0.82	1.14	-0.52	0.94	0.98	0.24	0.83
1985	1.00	-0.22	0.76	0.91	0.35	0.91	0.79	0.79	0.69	1.20	-0.71	0.91
1986	0.61	1.55	0.32	0.76	1.02	0.77	1.63	-2.27	0.89	0.82	0.85	0.87
1987	0.97	0.03	0.56	0.91	0.34	0.86	1.04	-0.14	0.87	1.21	-0.87	0.79
1988	0.71	1.09	0.63	0.78	0.95	0.66	1.20	-0.82	0.93	0.93	0.15	0.85
1989	0.47	1.98	0.32	0.98	-0.02	0.69	1.35	-1.42	0.96	1.13	-0.56	0.89
1990	0.73	1.17	0.75	0.85	0.62	0.41	1.20	-0.75	0.88	0.97	0.15	0.82
1991	0.78	0.93	0.63	0.76	1.03	0.81	1.00	-0.02	0.89	0.85	0.56	0.94
1984-1991	0.78	1.01	0.69	0.90	0.46	0.77	0.80	0.74	0.89	0.90	0.37	0.85

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.1.2 WEST BRANCH SUSQUEHANNA RIVER AT LEWISBURG, PA SEGMENT 70 (1553500)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

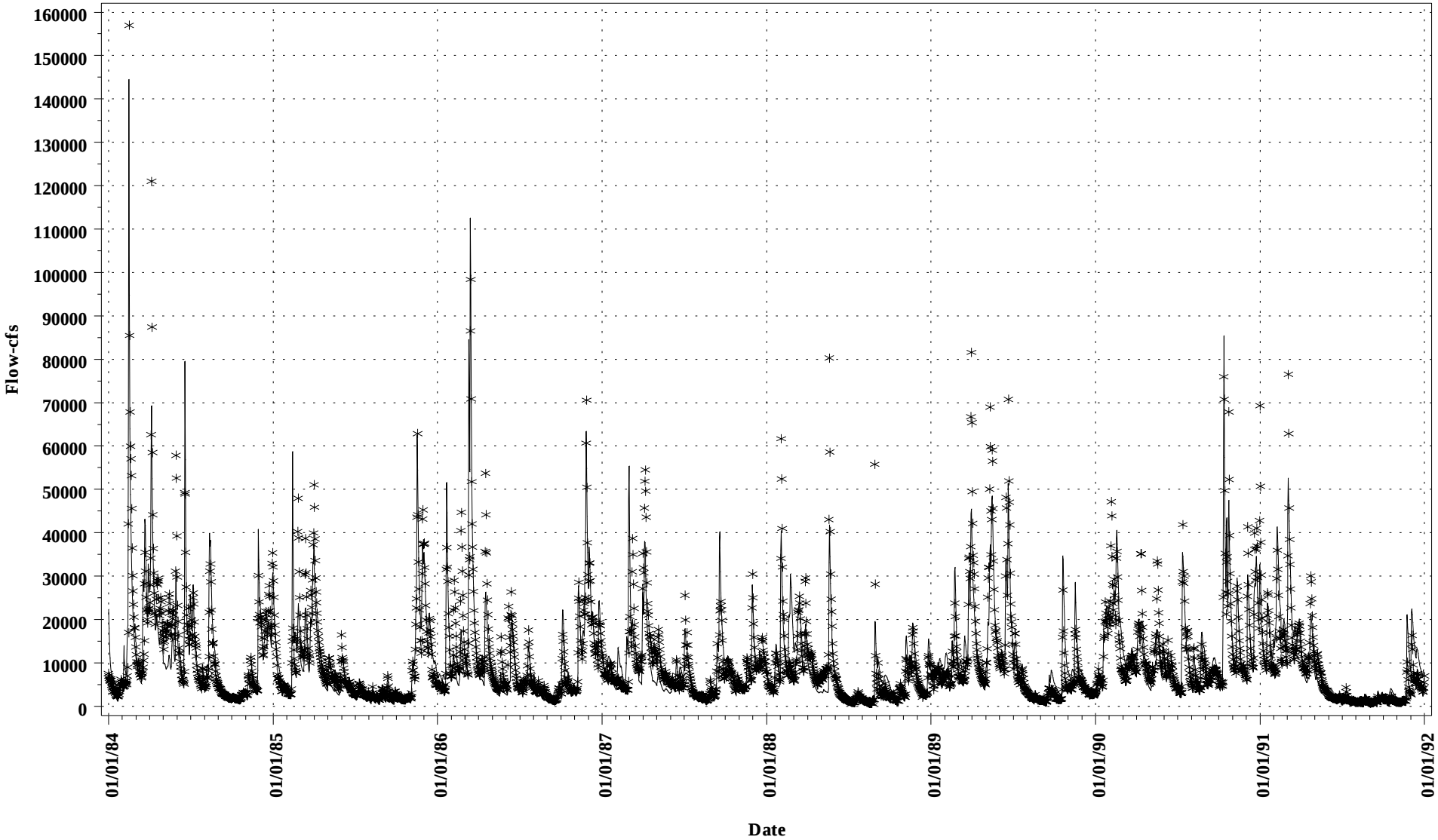
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

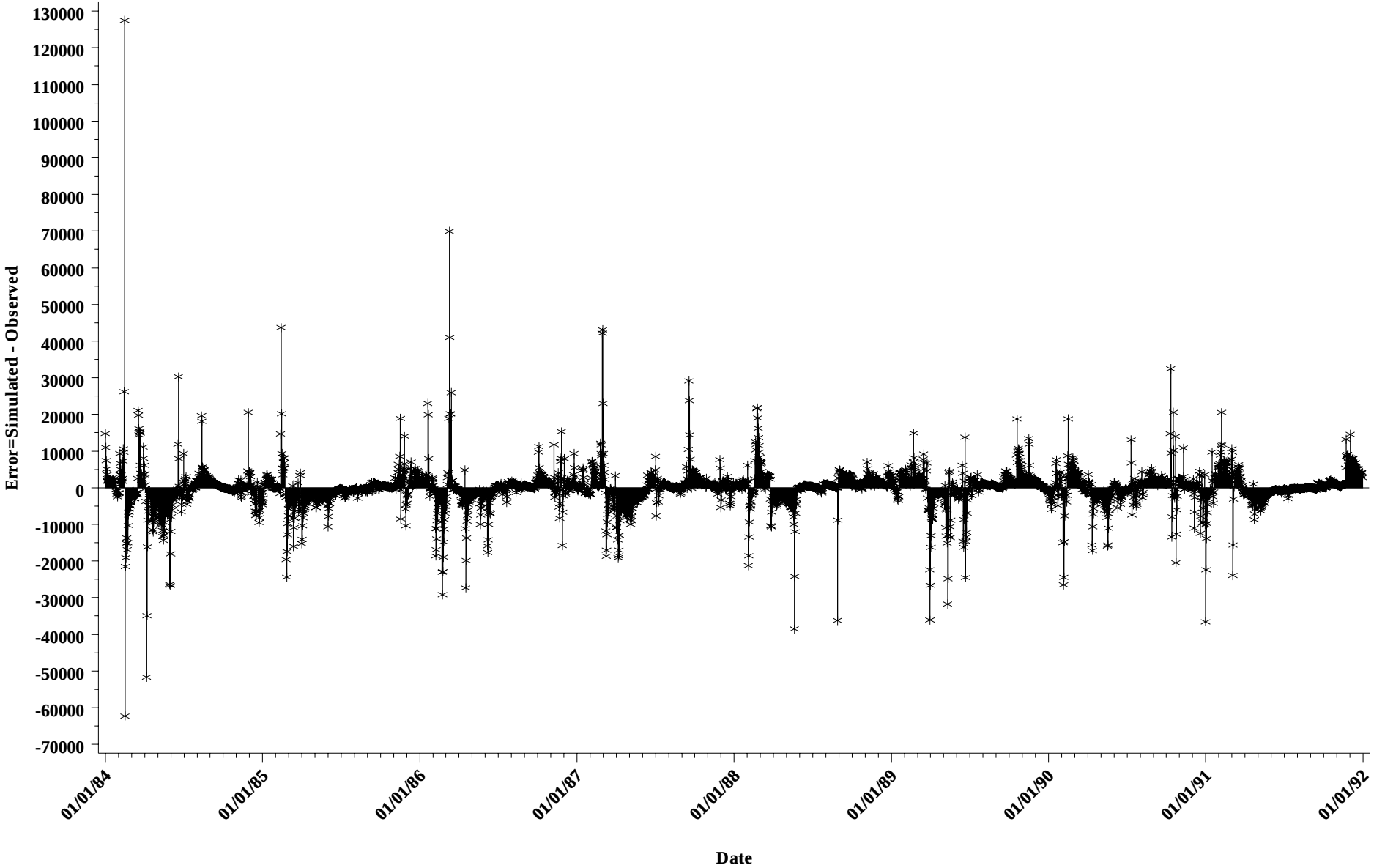
West Branch Susquehanna at Segment 70
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(susq70n.drv 12JUN98 15:03)

West Branch Susquehanna at Segment 70
Actual Error versus Time
Flow-cfs



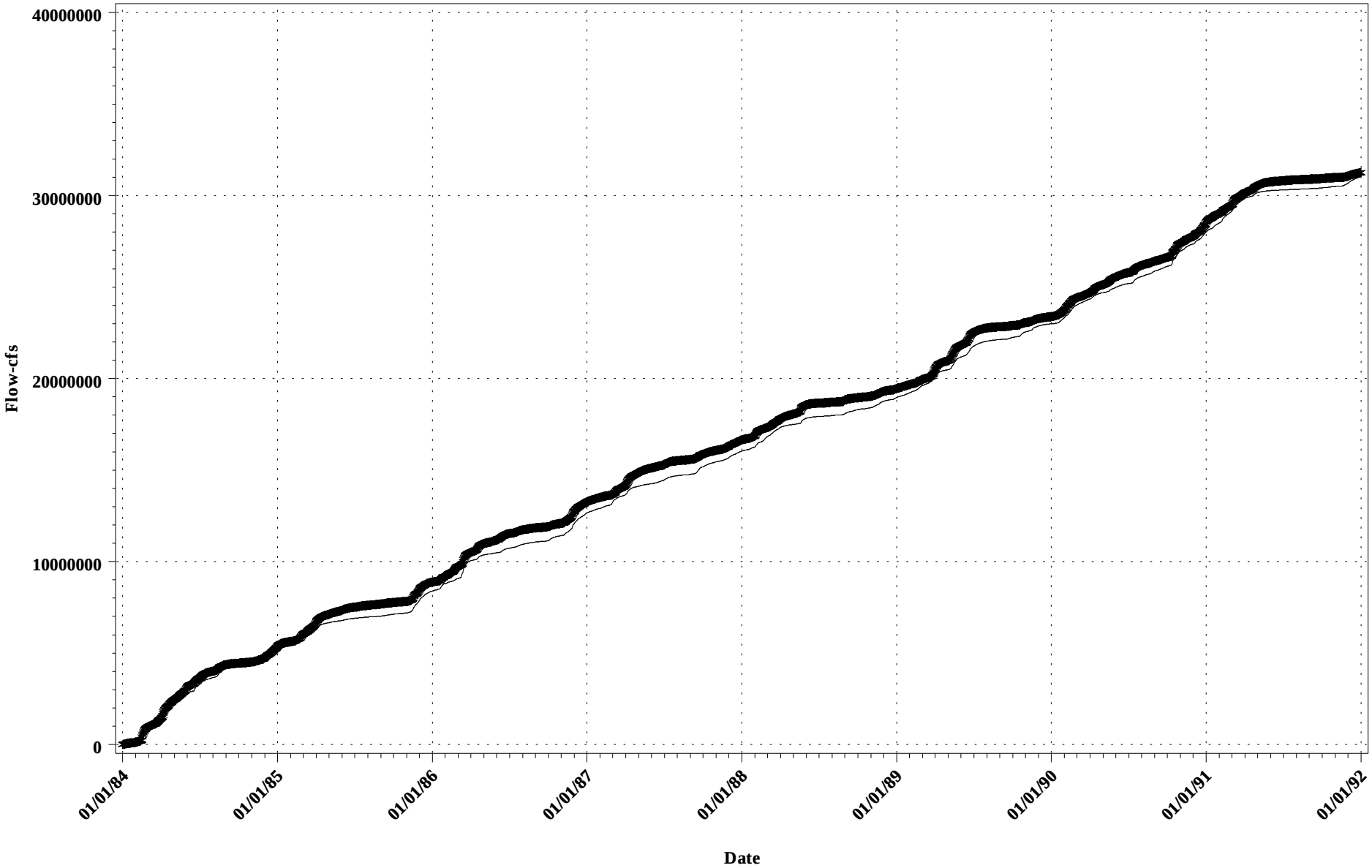
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(susq70n.drv 12JUN98 15:03)

West Branch Susquehanna at Segment 70

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

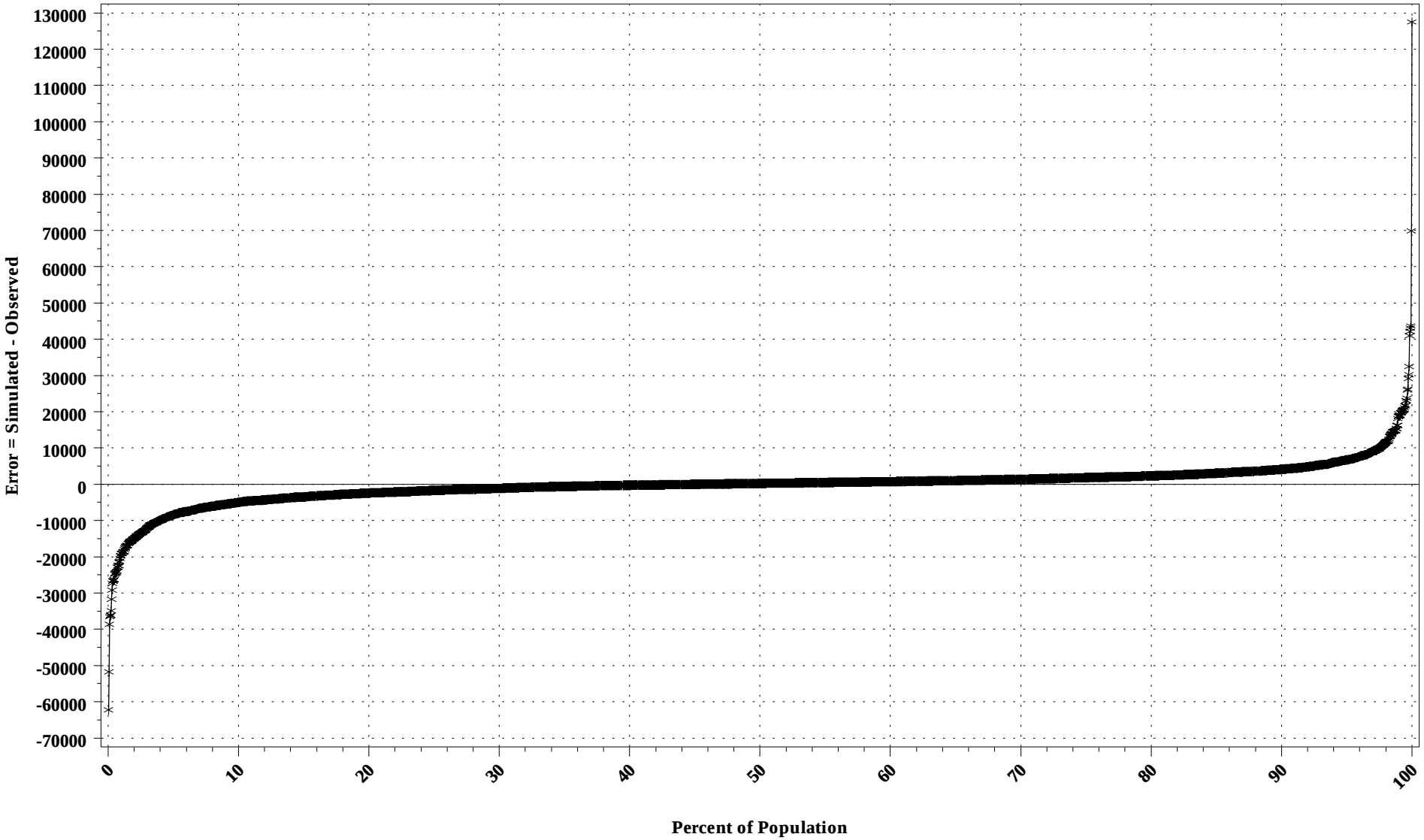
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(susq70n.drv 12JUN98 15:03)

West Branch Susquehanna at Segment 70
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

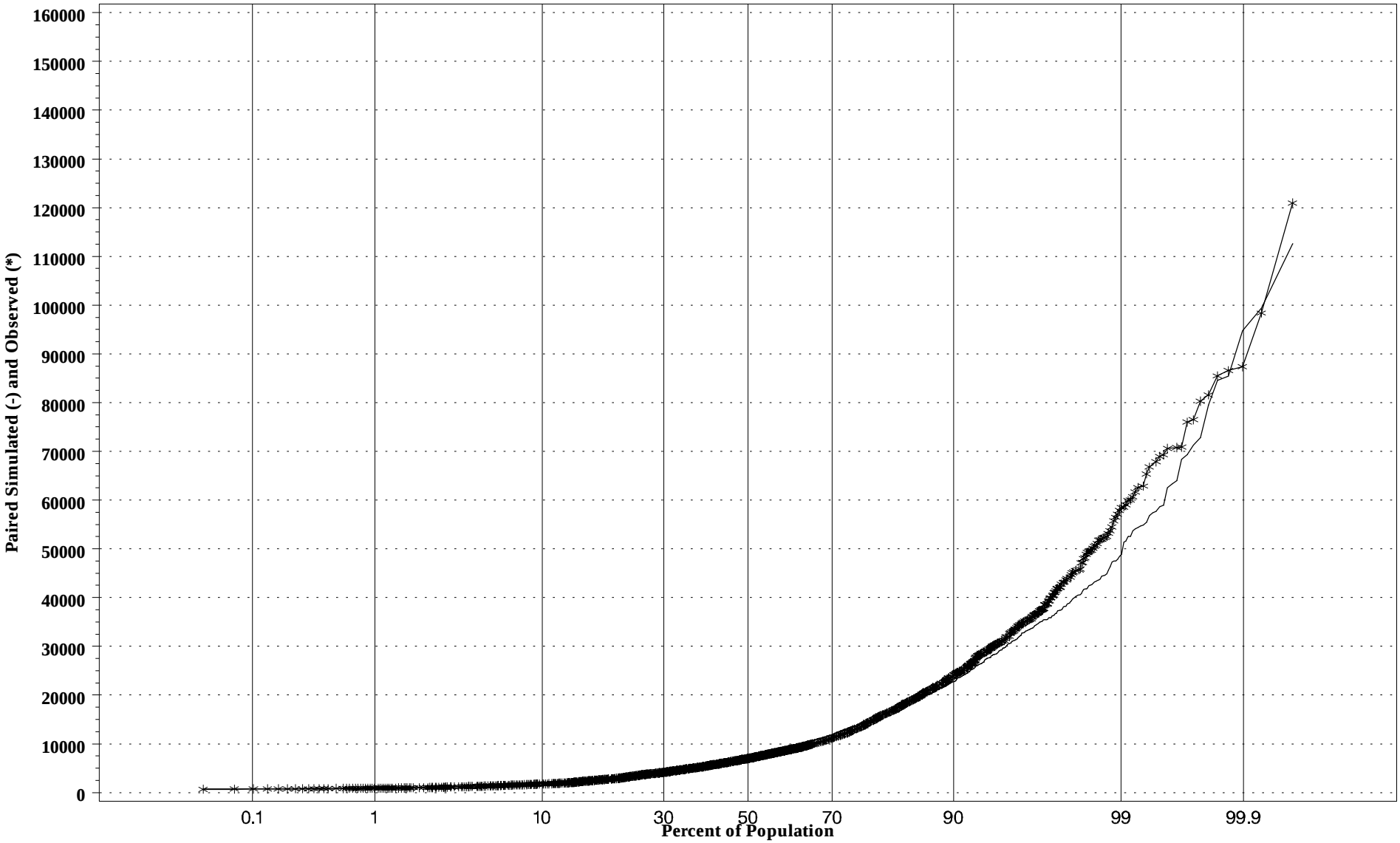


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(susq70n.drv 12JUN98 15:03)

West Branch Susquehanna at Segment 70

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

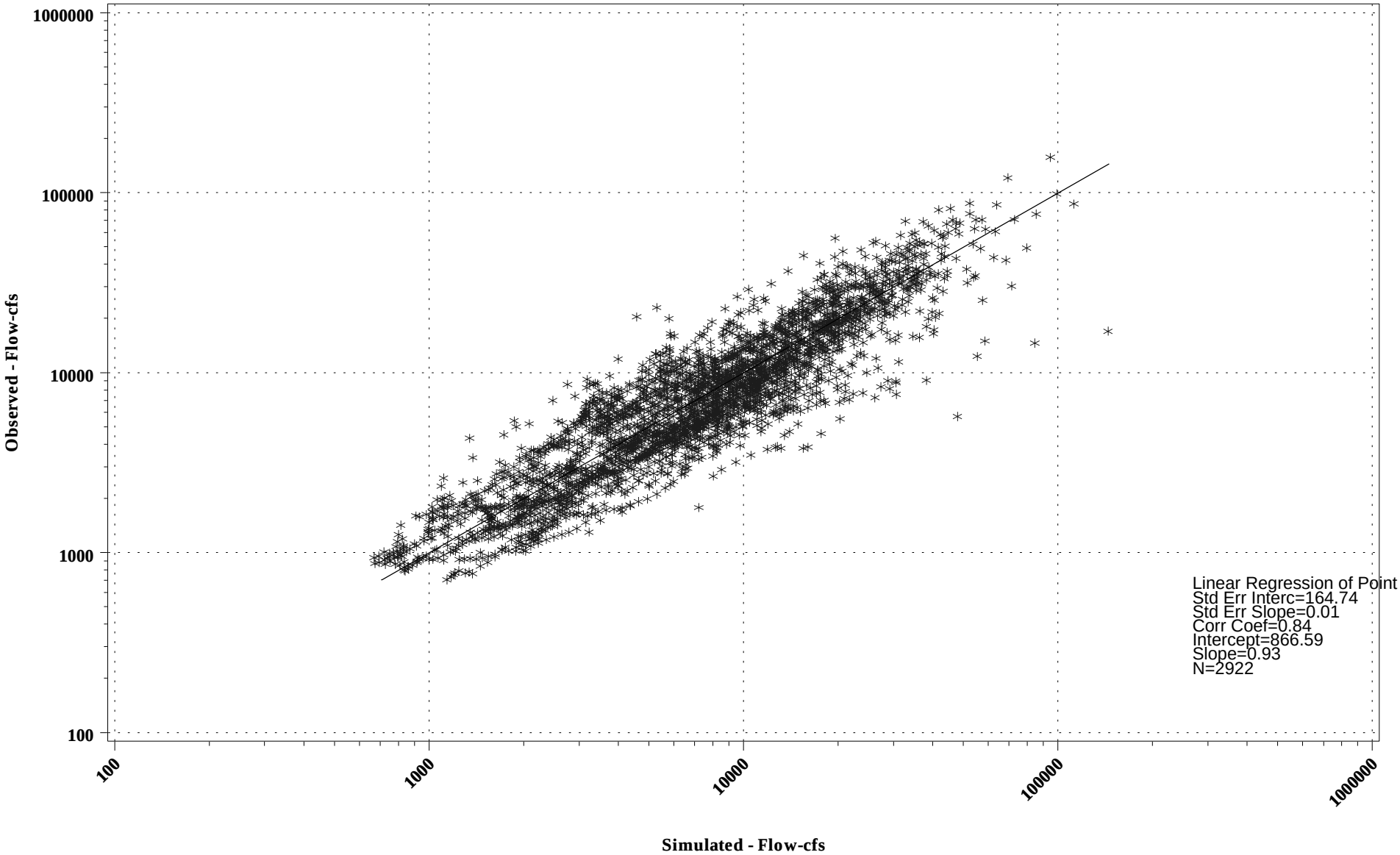


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(susq70n.drv 12JUN98 15:03)

West Branch Susquehanna at Segment 70

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(susq70n.drv 12JUN98 15:03,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
WEST BRANCH SUSQUEHANNA RIVER, PA (Segments 50, 60, and 70)

Table A.1.2.1 Comparison of Annual Total Observed and Simulated flows..

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	29.02	26.75
1985	19.23	17.55
1986	23.83	22.66
1987	18.38	17.94
1988	15.26	15.46
1989	21.34	21.35
1990	27.52	26.47
1991	15.22	16.16
Mean	21.23	20.54

* Observed flow from West Branch Susquehanna River at Lewisburg, PA
** Simulated outflow from RCH 70

Table A.1.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.86	0.54	0.84	0.00	3.90	0.00
1985	0.94	0.18	0.86	1.00	-0.05	0.88
1986	0.84	0.61	0.78	0.84	0.63	0.78
1987	0.76	0.91	0.63	0.99	0.02	0.99
1988	0.81	0.77	0.79	0.83	0.68	0.81
1989	0.81	0.80	0.88	0.75	1.04	0.90
1990	0.89	0.43	0.77	0.90	0.41	0.75
1991	0.99	0.07	0.85	1.00	0.02	0.87
1984-1991	0.86	0.54	0.80	0.79	0.83	0.75

Table A.1.2.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.98	-0.04	0.75	0.66	1.52	0.55	1.06	-0.29	0.89	0.95	0.23	0.95
1985	0.91	0.31	0.79	0.85	0.74	0.96	0.98	0.18	0.64	1.01	-0.14	0.97
1986	0.95	0.23	0.44	0.73	1.18	0.82	1.10	-0.38	0.80	1.14	-0.65	0.93
1987	0.08	3.46	0.00	0.69	1.41	0.74	0.85	0.49	0.84	1.03	-0.19	0.82
1988	0.79	0.76	0.61	0.62	1.62	0.66	0.91	0.19	0.82	1.07	-0.44	0.90
1989	0.72	1.00	0.64	1.05	-0.16	0.85	1.12	-0.54	0.95	0.82	0.51	0.79
1990	0.66	1.42	0.74	0.76	1.00	0.52	0.90	0.38	0.78	1.09	-0.40	0.90
1991	0.95	0.18	0.53	0.70	1.28	0.87	0.69	1.04	0.46	0.85	0.30	0.91
1984-1991	0.75	1.05	0.63	1.02	-0.19	0.77	0.95	0.22	0.87	0.87	0.59	0.90

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.1.3 JUNIATA RIVER AT NEWPORT, PA AT SEGMENT 100 (1567000)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

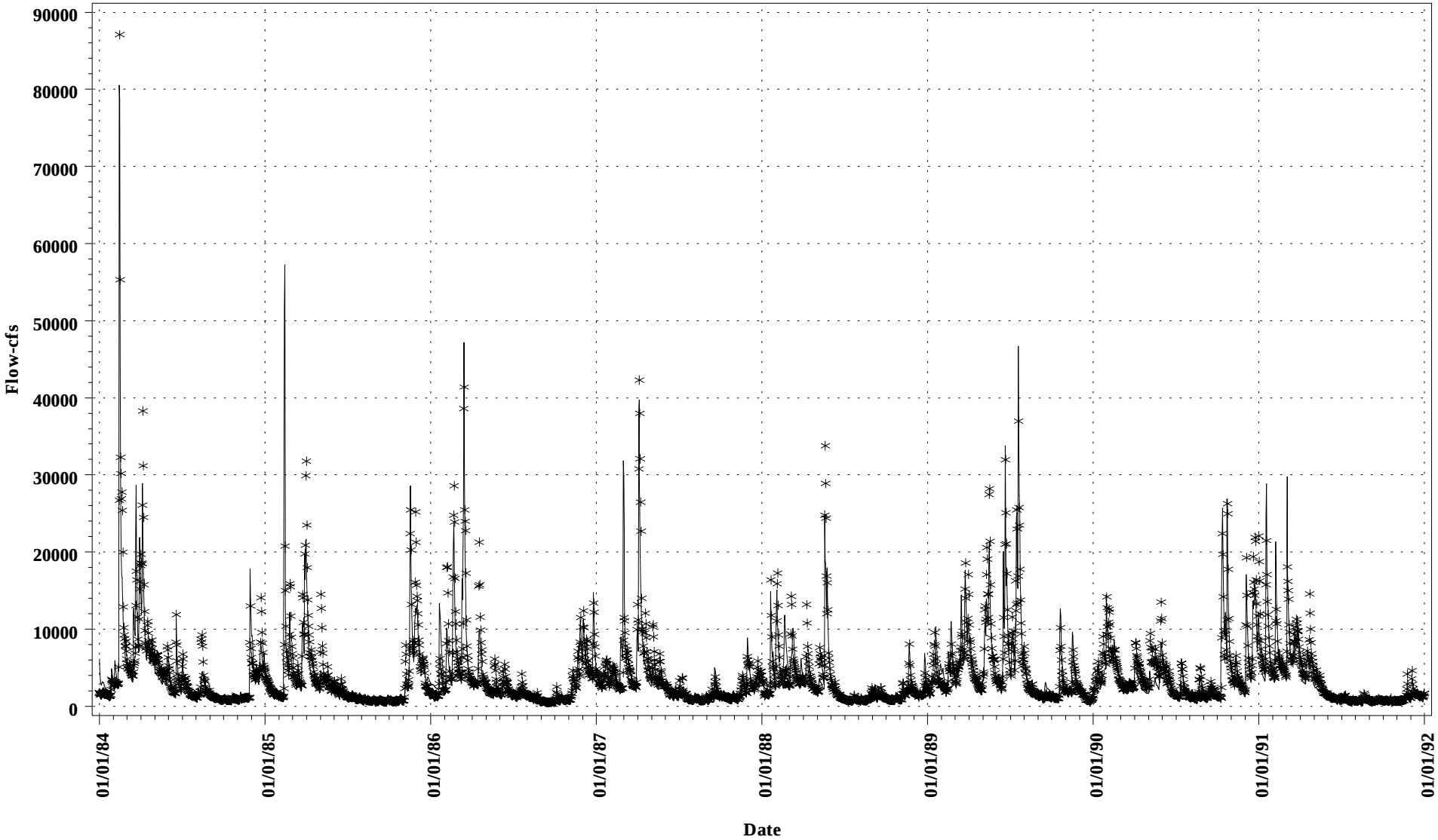
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

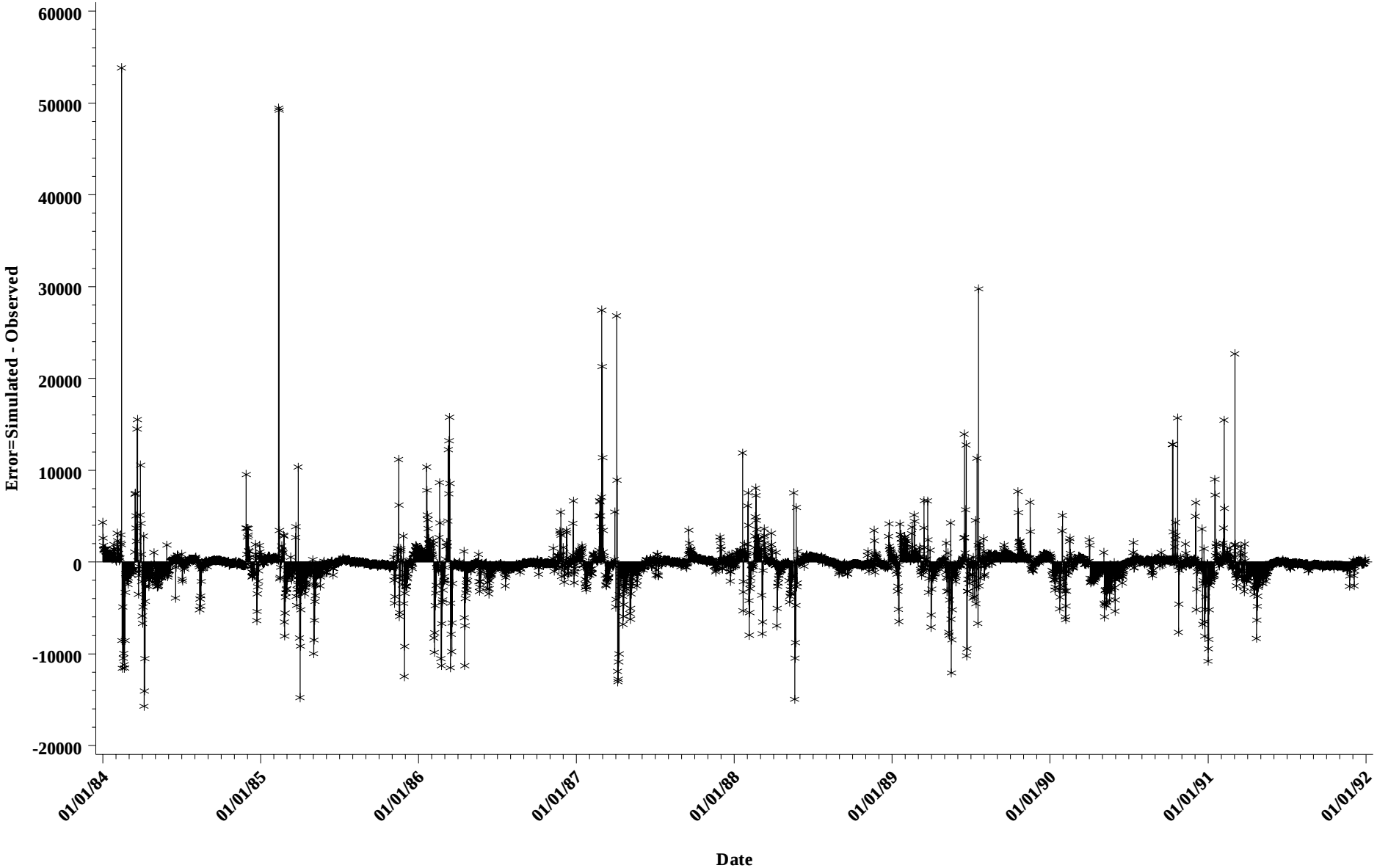
Juniata River at Segment 100
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(susq100n.drv 16JUN98 16:09)

Juniata River at Segment 100
Actual Error versus Time
Flow-cfs



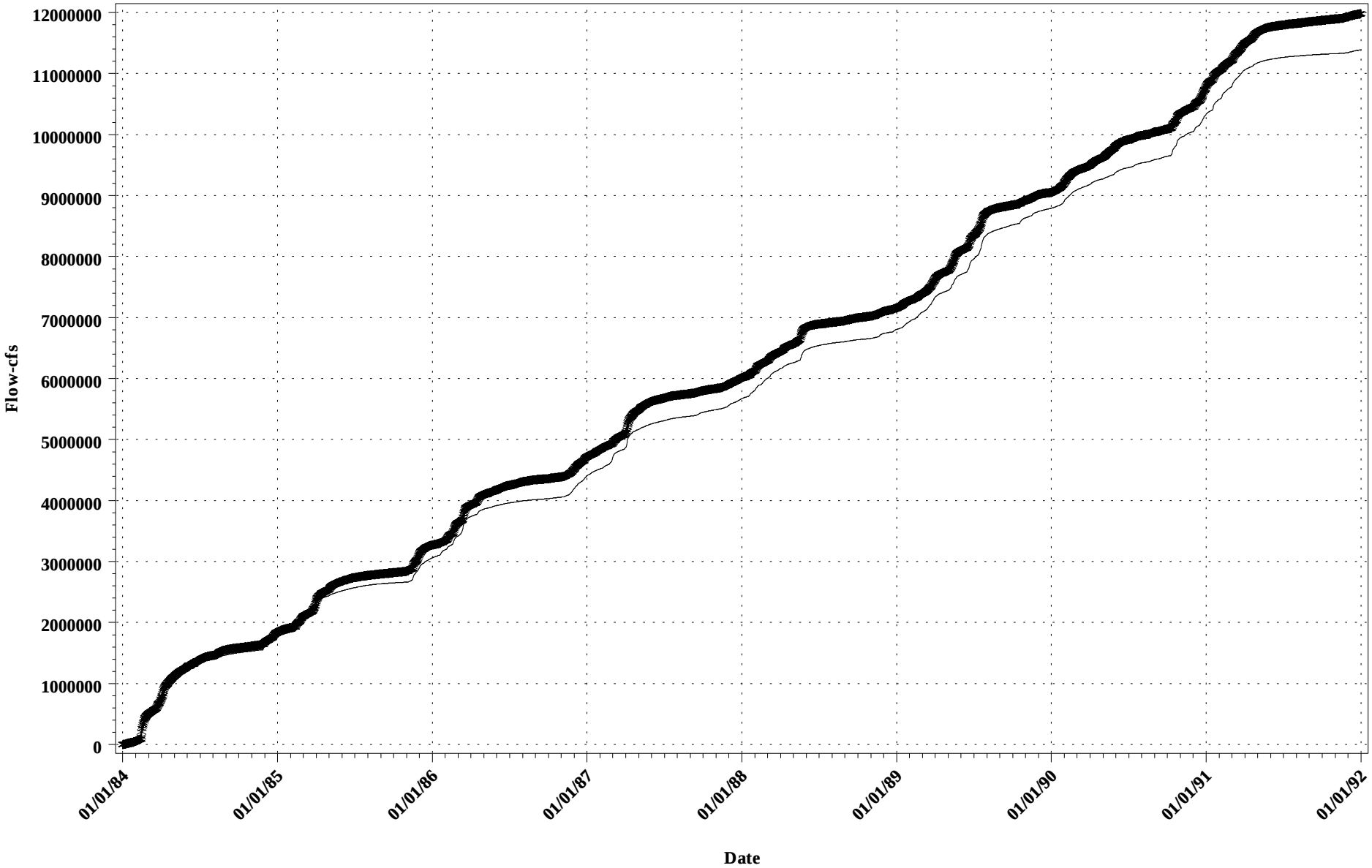
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(susq100n.drv 16JUN98 16:09)

Juniata River at Segment 100

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

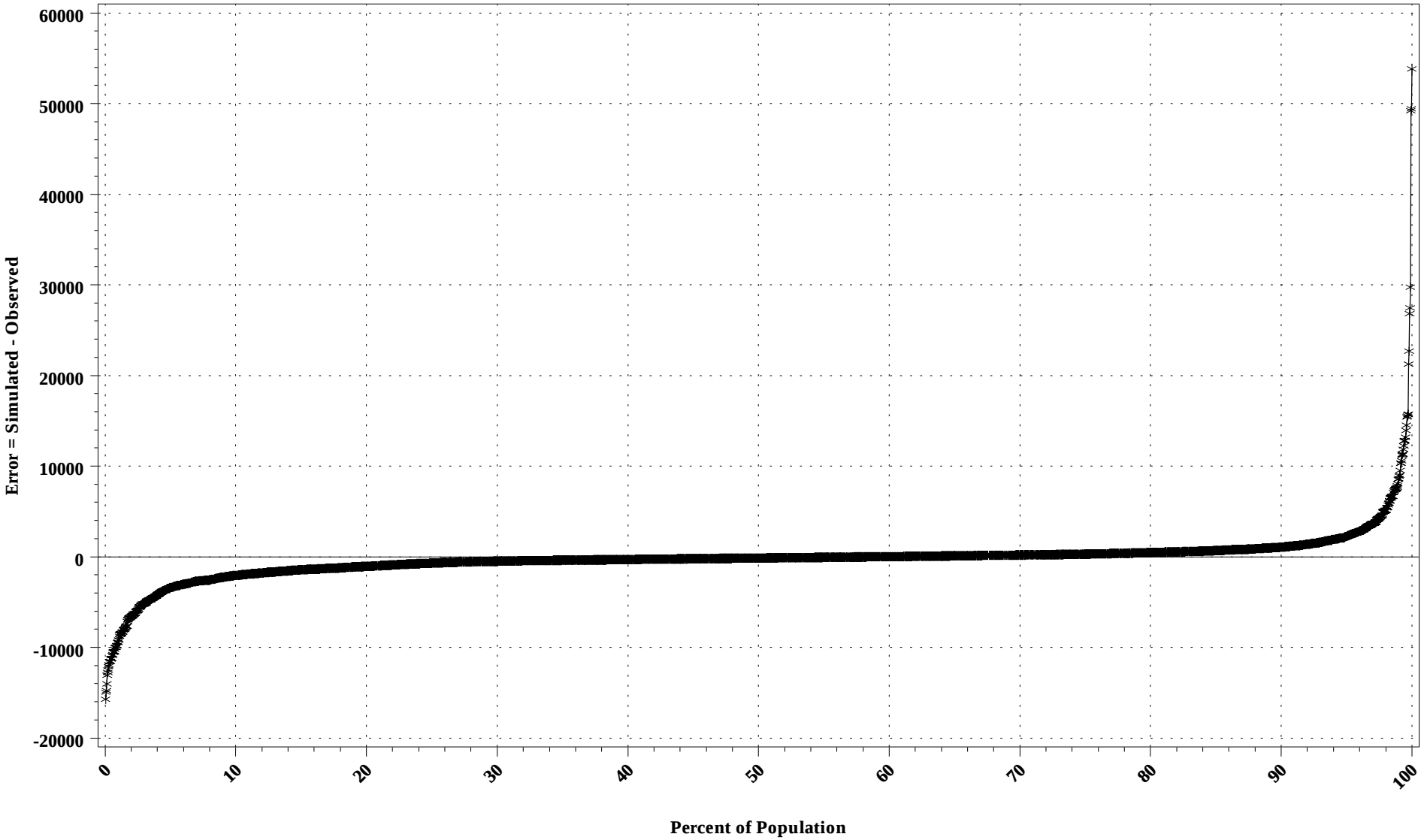
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(susq100n.drv 16JUN98 16:09)

Juniata River at Segment 100
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

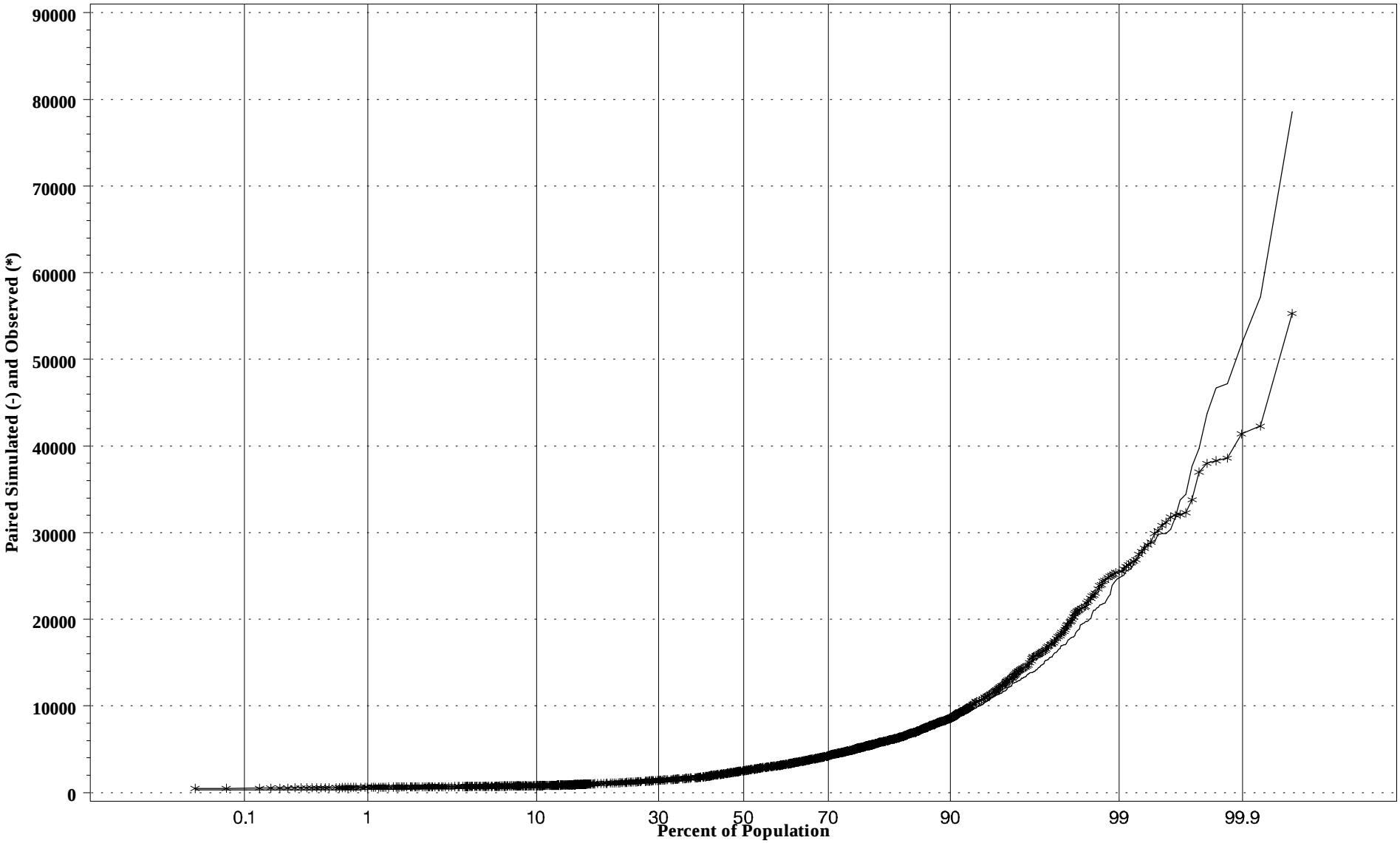


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(susq100n.drv 16JUN98 16:09)

Juniata River at Segment 100

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

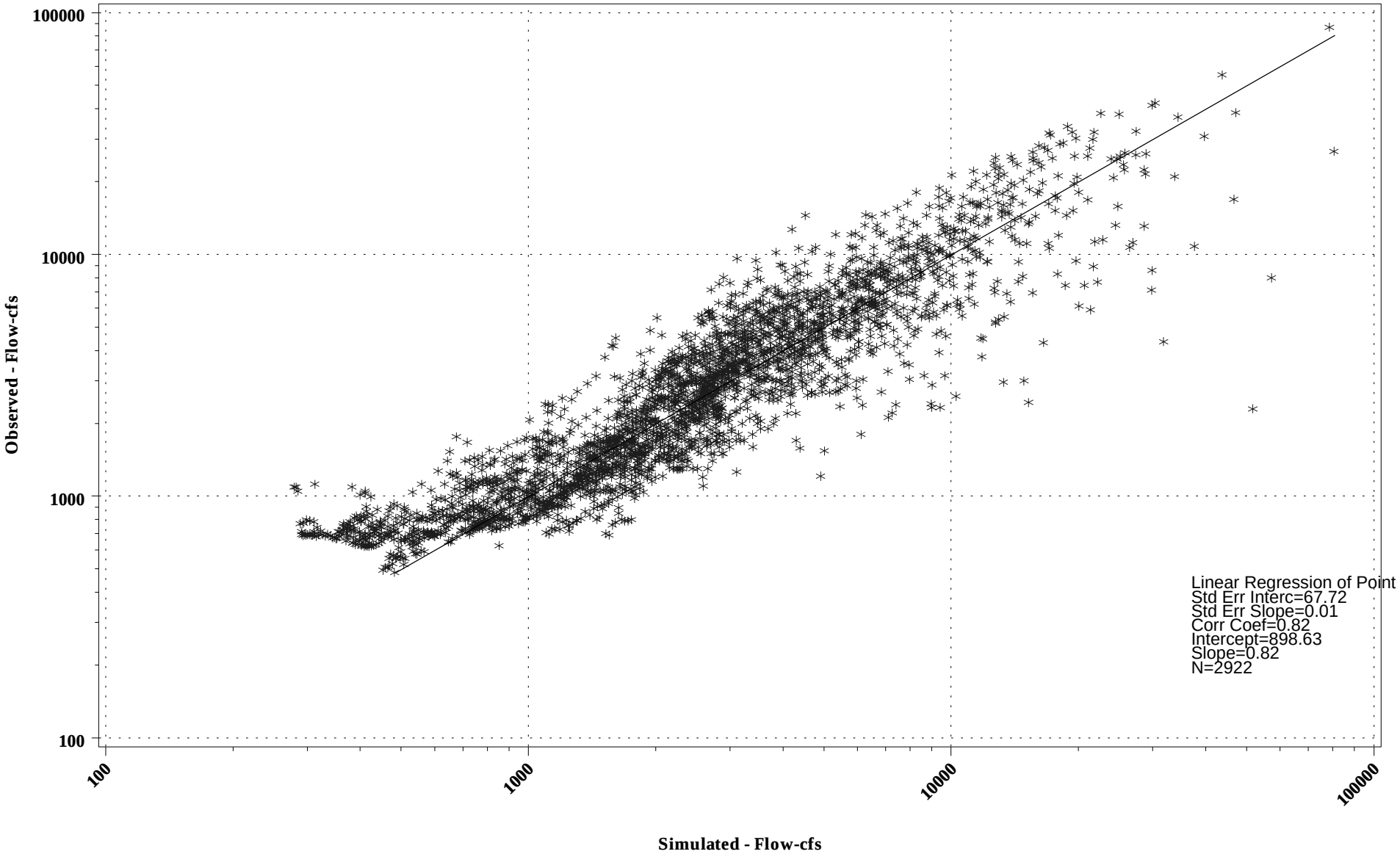


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(susq100n.drv 16JUN98 16:09)

Juniata River at Segment 100

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(susq100n.drv 16JUN98 16:09,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
JUNIATA RIVER, PA (Segments 90 and 100)

Table A.1.3.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	20.44	19.44
1985	15.84	14.39
1986	16.03	14.91
1987	14.40	14.02
1988	12.68	12.52
1989	20.98	22.00
1990	18.93	16.94
1991	13.57	11.81
Mean	16.61	15.75

* Observed flow from Juniata River near Newport, PA
** Simulated outflow from RCH 100

Table A.1.3.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.88	0.38	0.88	0.92	0.27	0.94
1985	0.97	0.05	0.86	1.03	-0.17	0.91
1986	1.00	-0.05	0.85	1.08	-0.34	0.90
1987	0.84	0.55	0.79	0.99	0.01	1.00
1988	0.93	0.24	0.79	1.00	-0.02	0.87
1989	0.77	0.88	0.86	0.73	1.00	0.95
1990	0.82	0.60	0.80	0.81	0.63	0.82
1991	1.12	-0.53	0.92	1.16	-0.66	0.95
1984-1991	0.92	0.27	0.84	0.97	0.09	0.92

Table A.1.3.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	1.19	-0.79	0.80	0.72	1.12	0.71	1.25	-0.84	0.92	0.90	0.34	0.90
1985	0.77	0.73	0.63	0.93	0.40	0.81	0.83	0.55	0.83	0.81	0.72	0.92
1986	1.18	-0.75	0.70	0.86	0.56	0.79	1.26	-0.59	0.87	0.89	0.38	0.95
1987	-0.04	3.68	-0.01	0.78	0.90	0.74	0.82	0.55	0.71	1.09	-0.33	0.91
1988	0.85	0.44	0.54	0.89	0.43	0.72	0.71	0.88	0.45	0.67	1.09	0.87
1989	0.65	1.19	0.42	1.02	-0.02	0.87	1.11	-0.47	0.90	1.04	-0.26	0.80
1990	0.79	0.83	0.63	0.80	0.81	0.34	1.20	-0.66	0.88	0.98	0.05	0.87
1991	0.70	1.14	0.60	0.77	0.95	0.80	0.46	1.66	0.51	0.55	1.48	0.78
1984-1991	0.69	1.19	0.62	0.90	0.26	0.76	0.96	0.09	0.83	1.08	-0.30	0.87

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.1.4 LOWER SUSQUEHANNA RIVER AT HARRISBURG, PA SEGMENT 710 (1570500)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

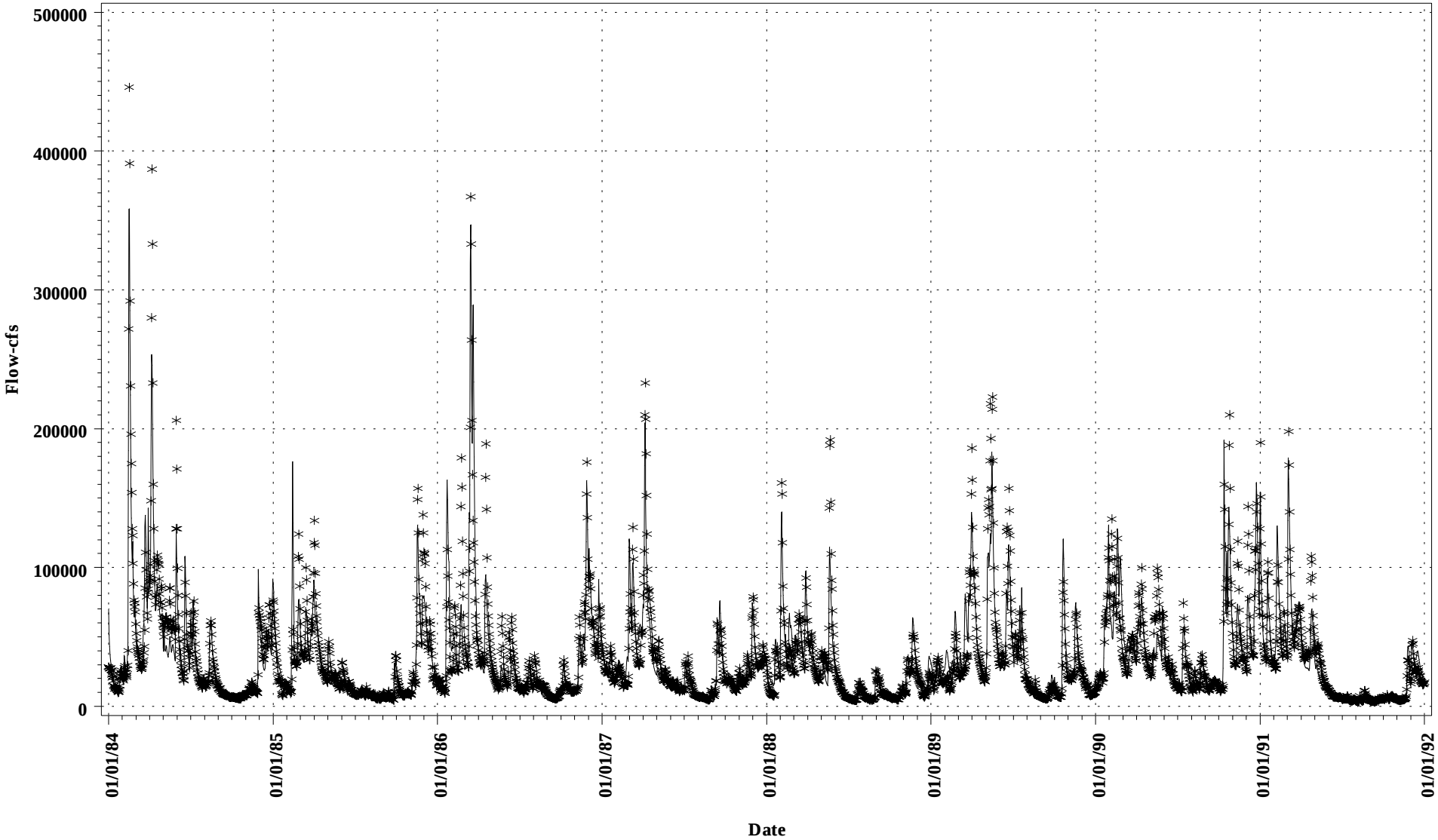
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

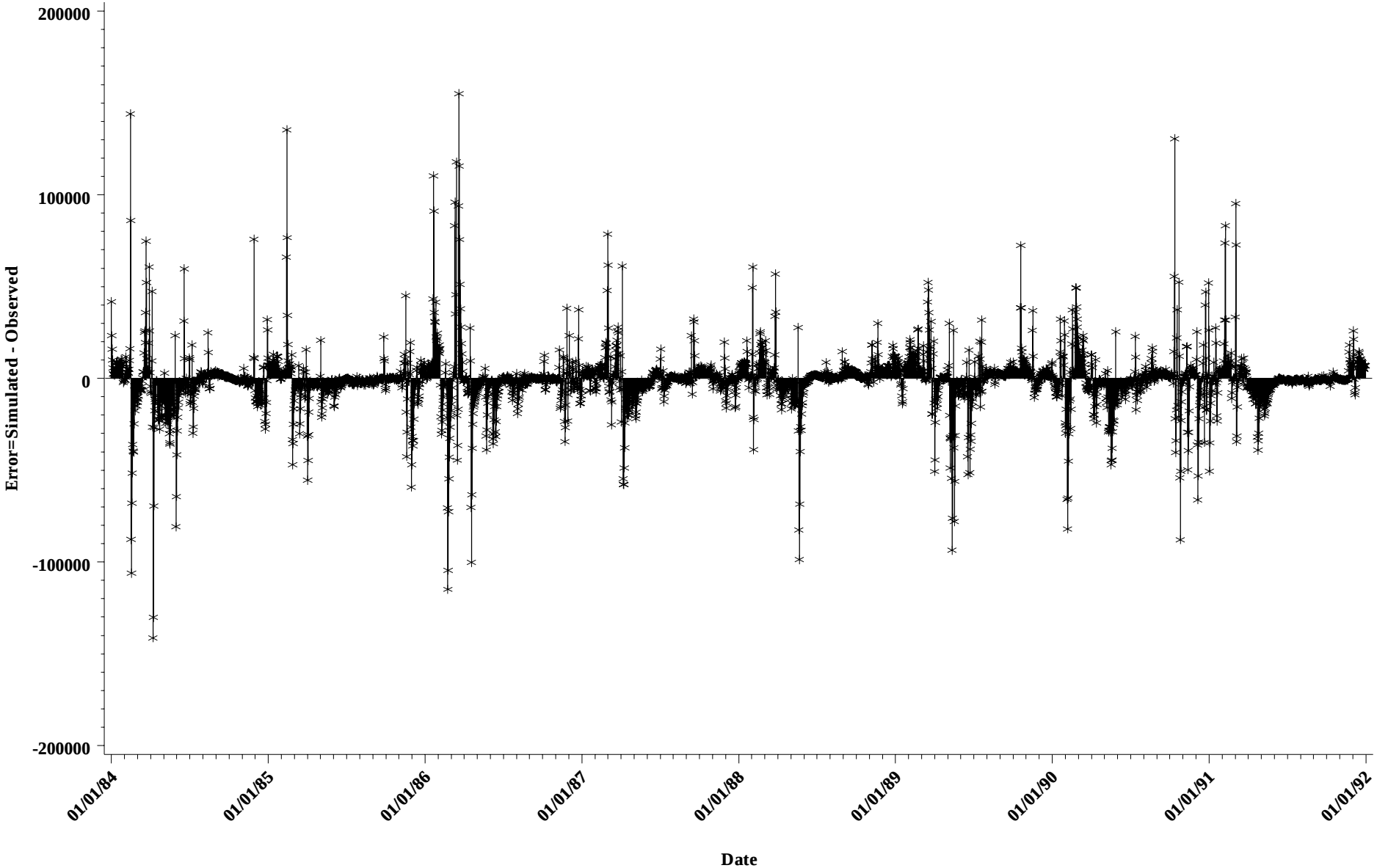
Lower Susquehanna River at Segment 710
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(losus.drv 12JUN98 10:59)

Lower Susquehanna River at Segment 710
Actual Error versus Time
Flow-cfs



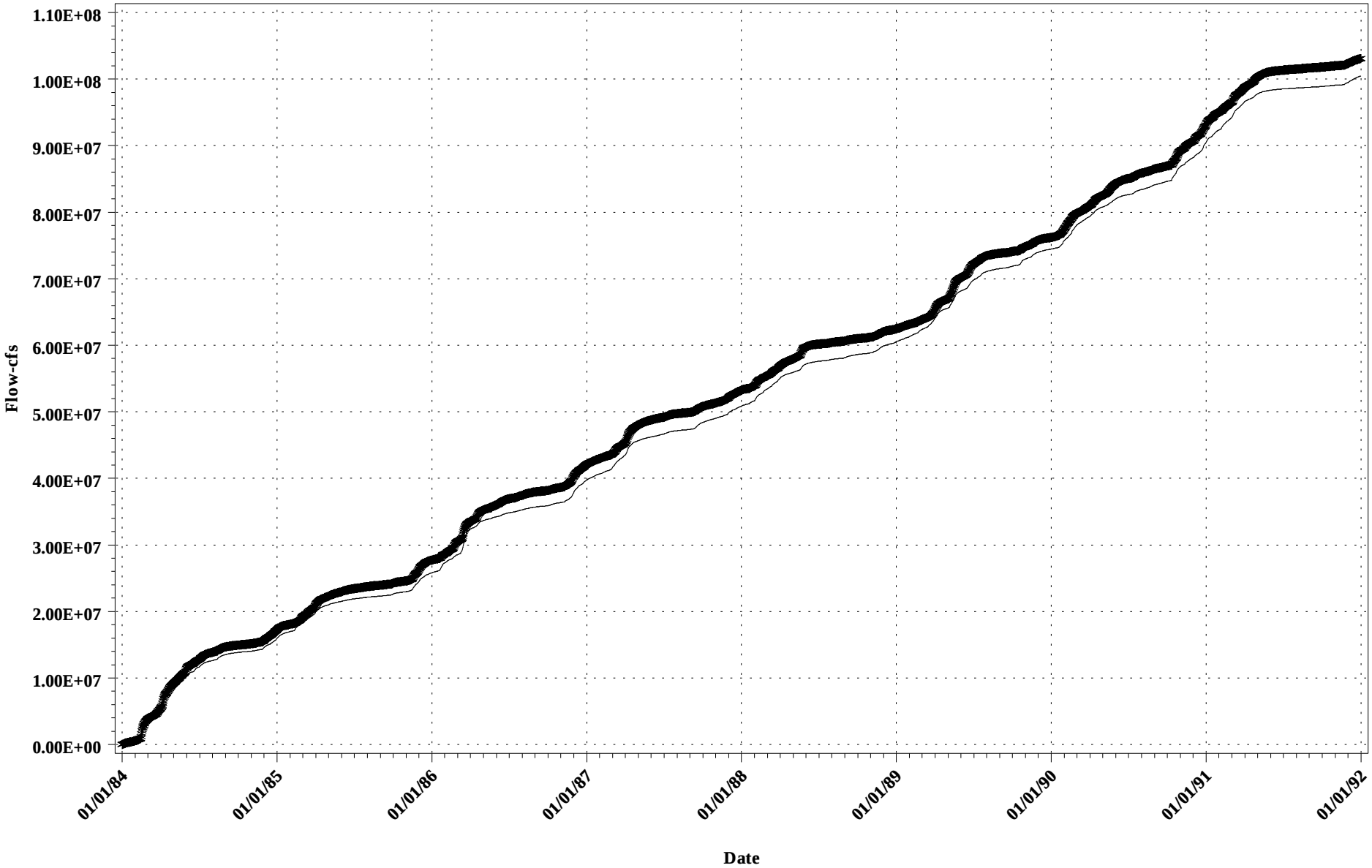
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(losus.drv 12JUN98 10:59)

Lower Susquehanna River at Segment 710

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

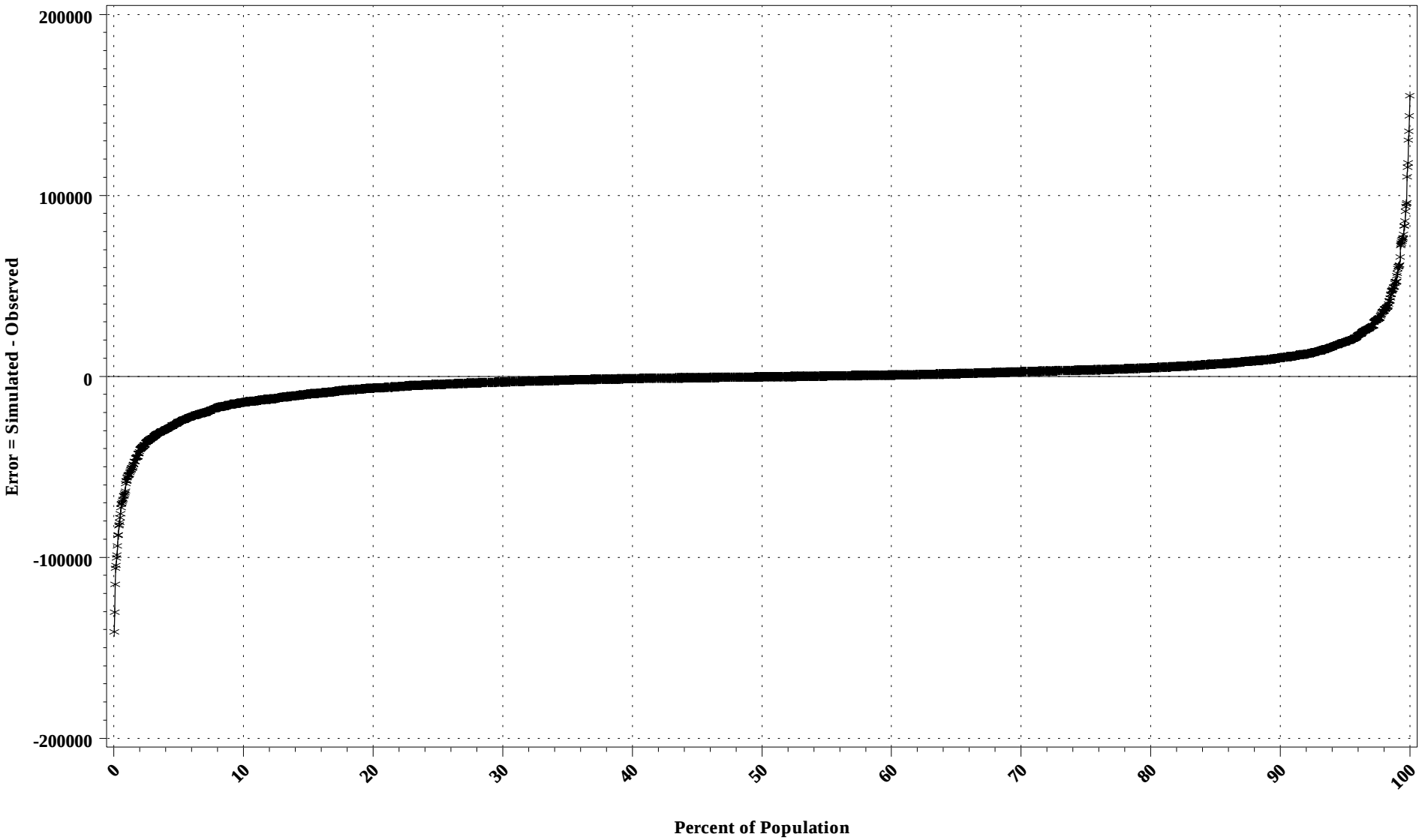
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(losus.drv 12JUN98 10:59)

Lower Susquehanna River at Segment 710
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

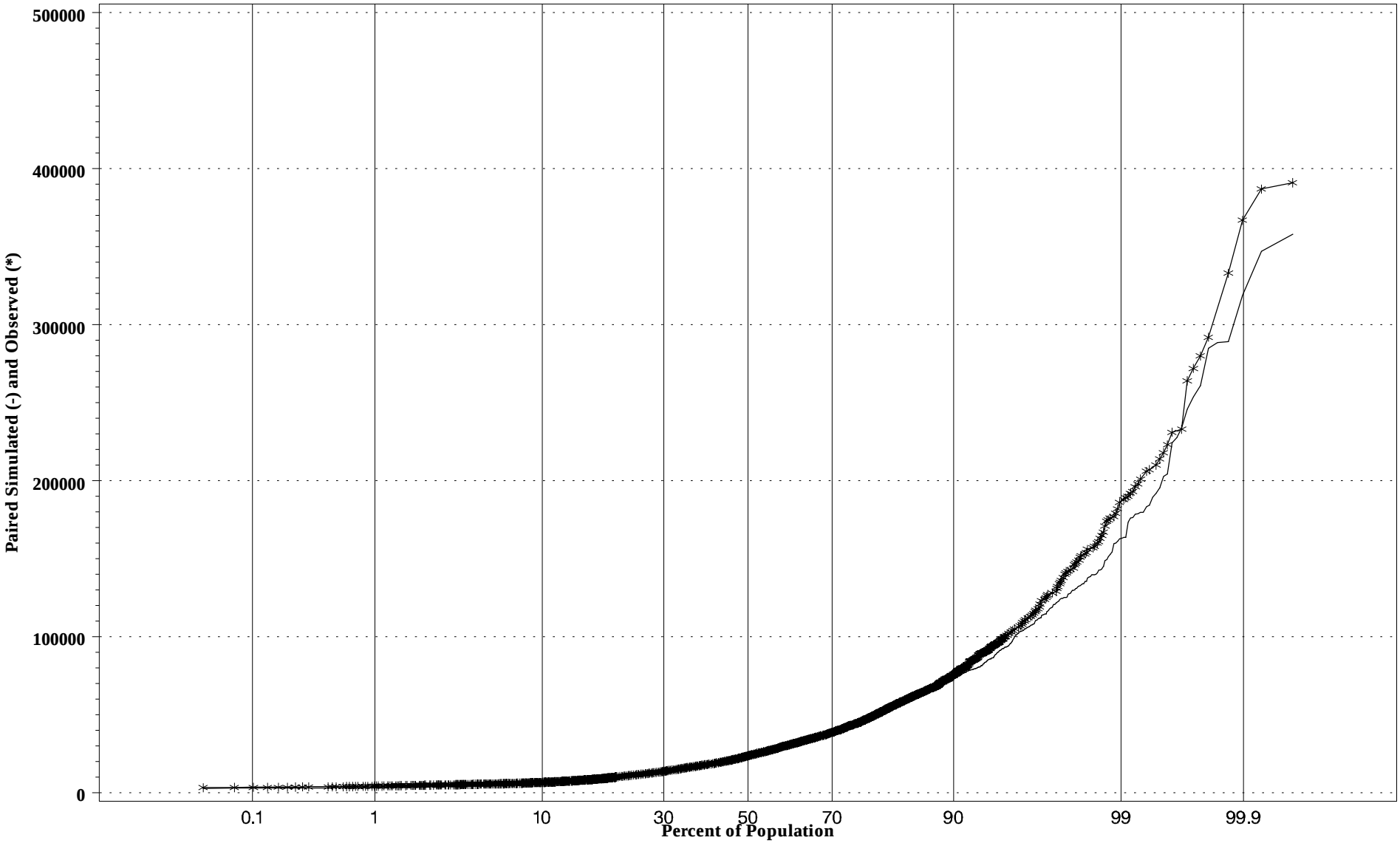


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(losus.drv 12JUN98 10:59)

Lower Susquehanna River at Segment 710

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

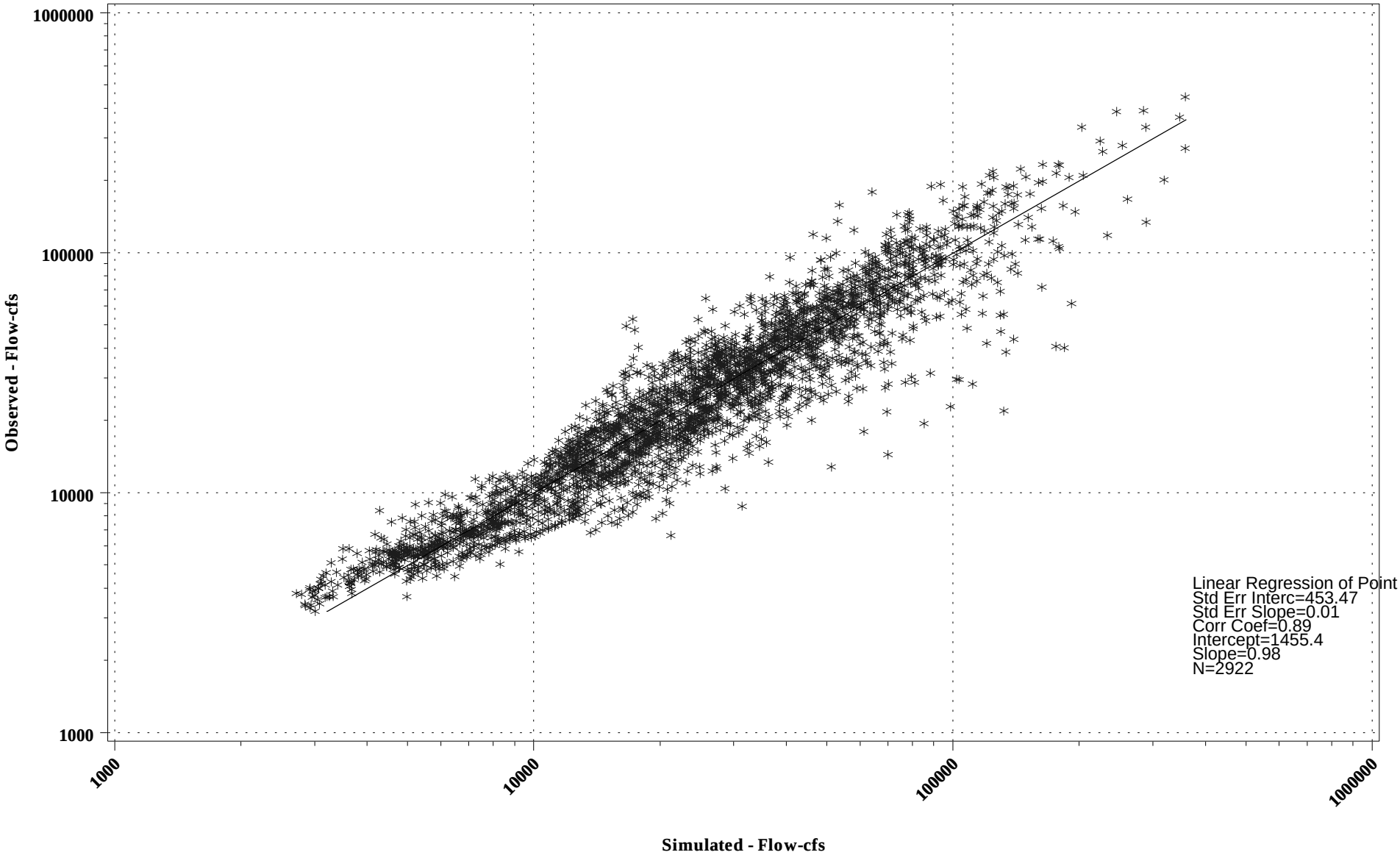


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(losus.drv 12JUN98 10:59)

Lower Susquehanna River at Segment 710

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(losus.drv 12JUN98 10:59,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
LOWER SUSQUEHANNA RIVER, PA (Segments 10, 20 , 30, 40, 50, 60, 70, 80, 90, and 100)

Table A.1.4.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	Simulated Flow
Year	(inches)*	(inches)**
1984	23.6	24.5
1985	14.81	15.31
1986	19.96	21.49
1987	15.58	17.17
1988	13.02	14.91
1989	18.92	21.49
1990	23.33	24.62
1991	13.97	15.52
Mean	17.90	19.38

* Observed flow Susquehanna River at Harrisburg, PA
** Simulated outflow from RCH 710

Table A.1.4.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			Average Monthly		
Year	m	b	r2	m	b	r2
1984	0.90	0.46	0.91	0.90	0.43	0.96
1985	0.97	0.13	0.89	1.05	-0.26	0.95
1986	0.91	0.37	0.84	0.99	0.03	0.91
1987	0.92	0.35	0.88	1.00	0.00	1.00
1988	0.85	0.70	0.88	0.88	0.55	0.91
1989	0.80	0.96	0.90	0.78	1.05	0.94
1990	0.85	0.70	0.81	0.90	0.47	0.92
1991	1.05	-0.25	0.95	1.07	-0.33	0.97
1984-1991	0.91	0.43	0.88	0.95	0.24	0.95

Table A.1.4.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.83	0.86	0.88	0.87	0.55	0.71	0.83	0.75	0.92	0.94	0.20	0.92
1985	0.81	0.96	0.76	0.98	0.04	0.90	0.81	0.69	0.75	0.89	0.50	0.94
1986	0.56	2.02	0.52	1.03	-0.16	0.81	0.67	1.32	0.88	0.95	0.21	0.94
1987	0.54	2.06	0.34	0.99	0.00	0.79	0.97	0.13	0.91	0.66	1.55	0.98
1988	0.65	1.70	0.70	0.89	0.45	0.68	0.86	0.62	0.87	0.97	0.22	0.89
1989	0.52	2.20	0.44	0.77	1.10	0.85	0.79	0.93	0.96	0.85	0.73	0.86
1990	0.95	0.22	0.77	0.49	2.32	0.41	0.75	1.09	0.75	0.80	0.95	0.82
1991	0.70	1.45	0.66	1.13	-0.70	0.83	0.94	0.16	0.84	1.22	-0.84	0.95
1984-1991	0.74	1.25	0.75	0.93	0.27	0.78	0.93	0.28	0.90	0.93	0.34	0.91

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.1.5 SUSQUEHANNA RIVER AT CONOWINGO, MD AT SEGMENT 140 (1578310)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

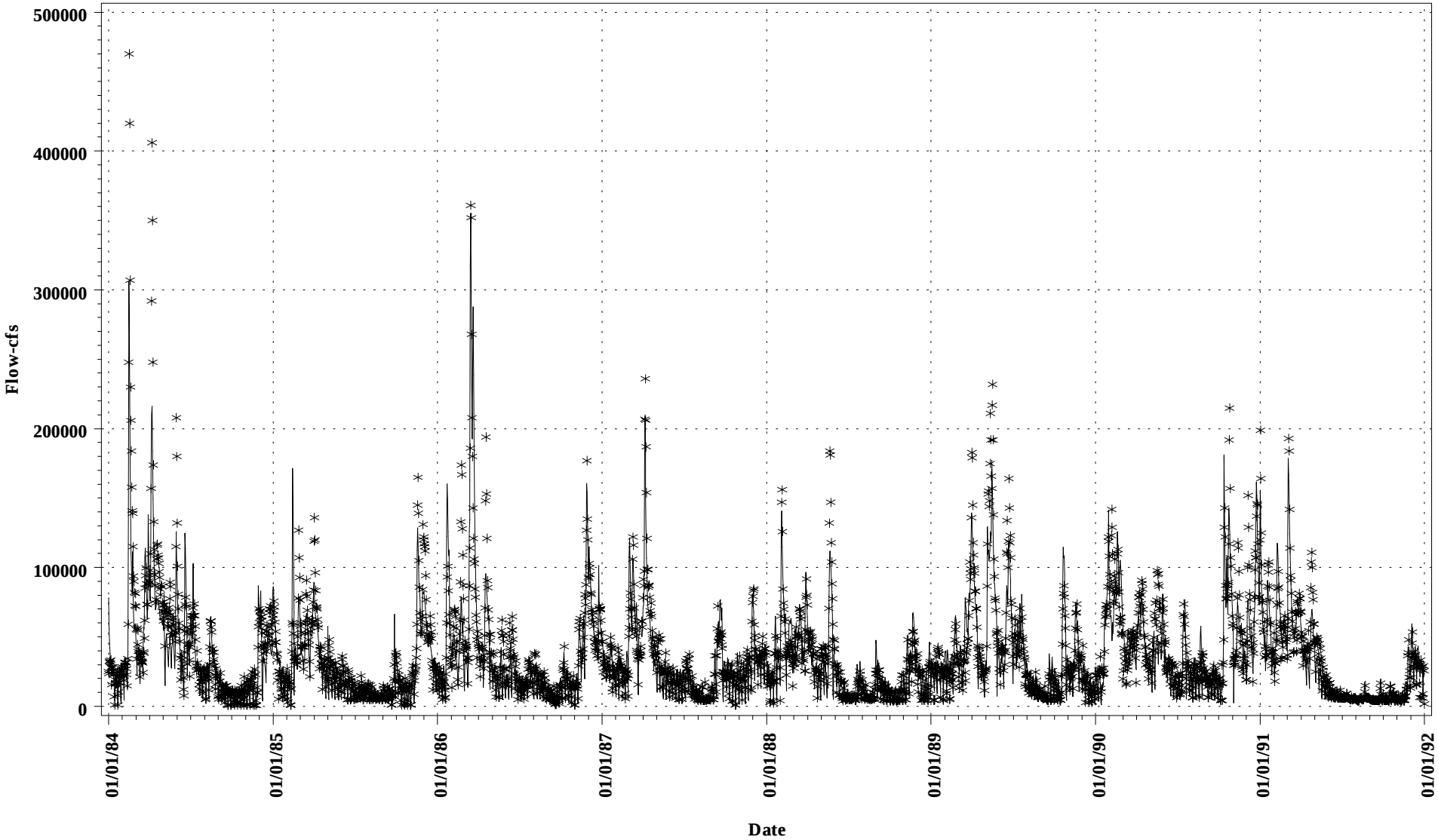
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

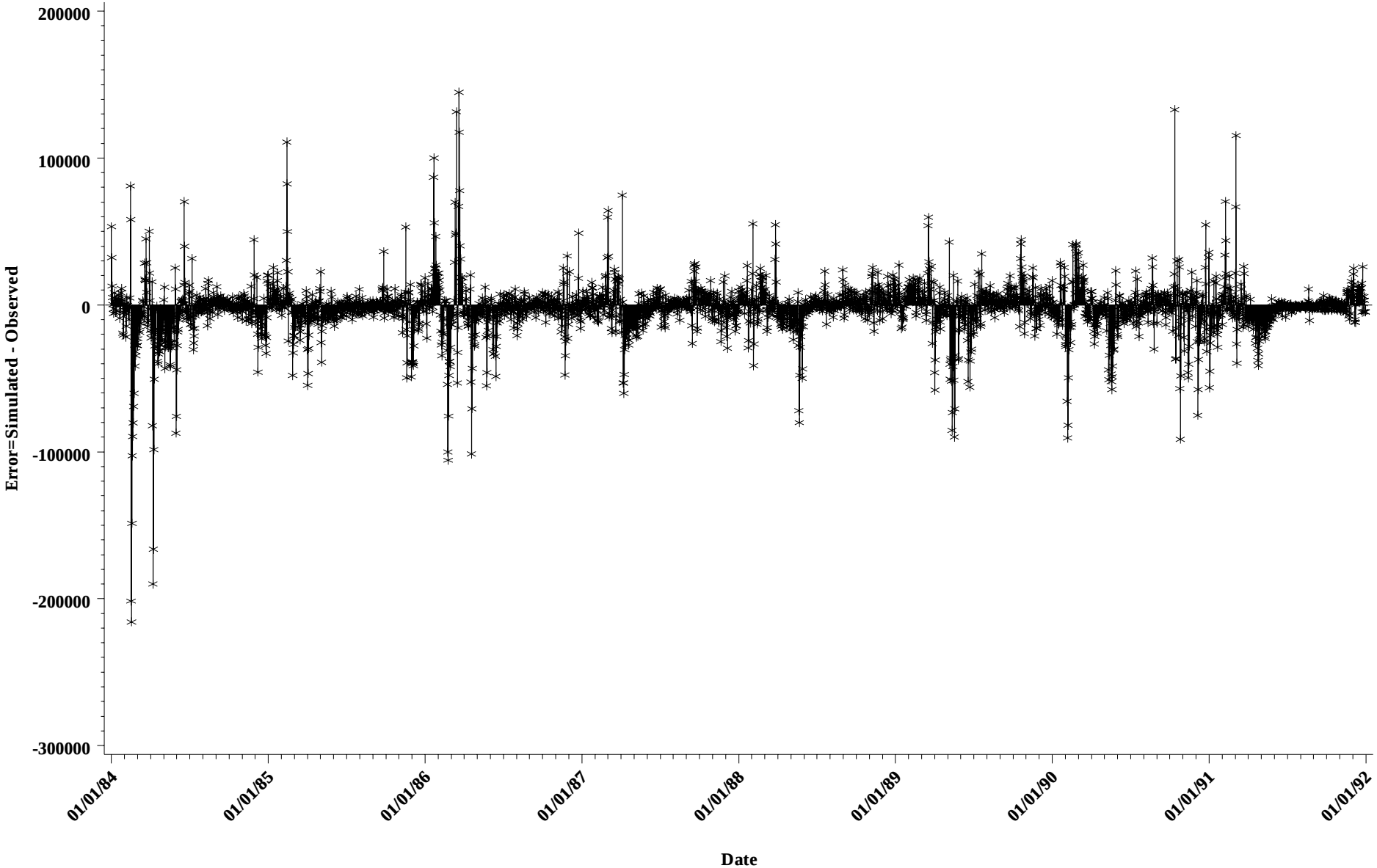
Susquehanna River at Conowingo at Segment 140
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(susq140n.drv 12JUN98 12:43)

Susquehanna River at Conowingo at Segment 140
Actual Error versus Time
Flow-cfs



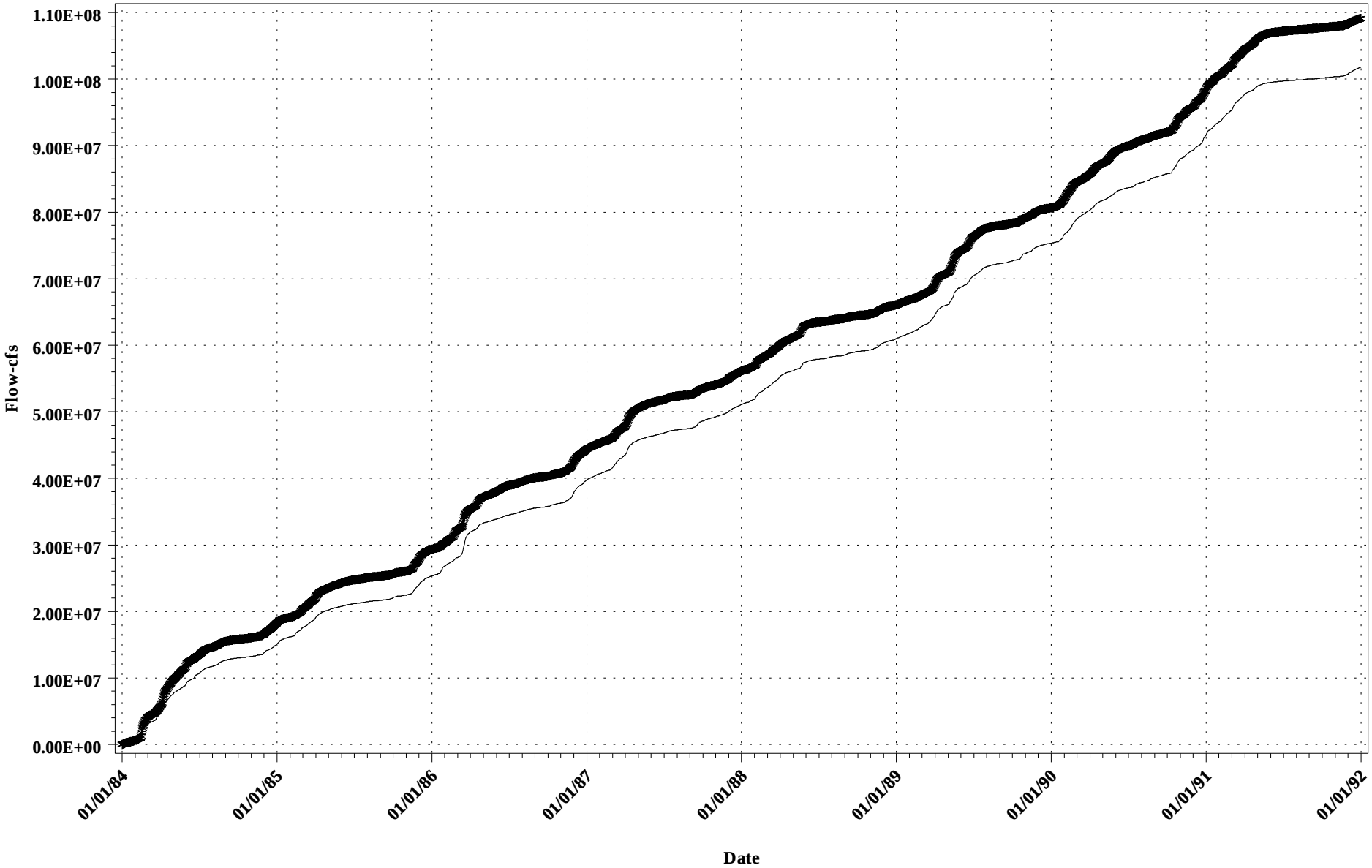
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(susq140n.drv 12JUN98 12:43)

Susquehanna River at Conowingo at Segment 140

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

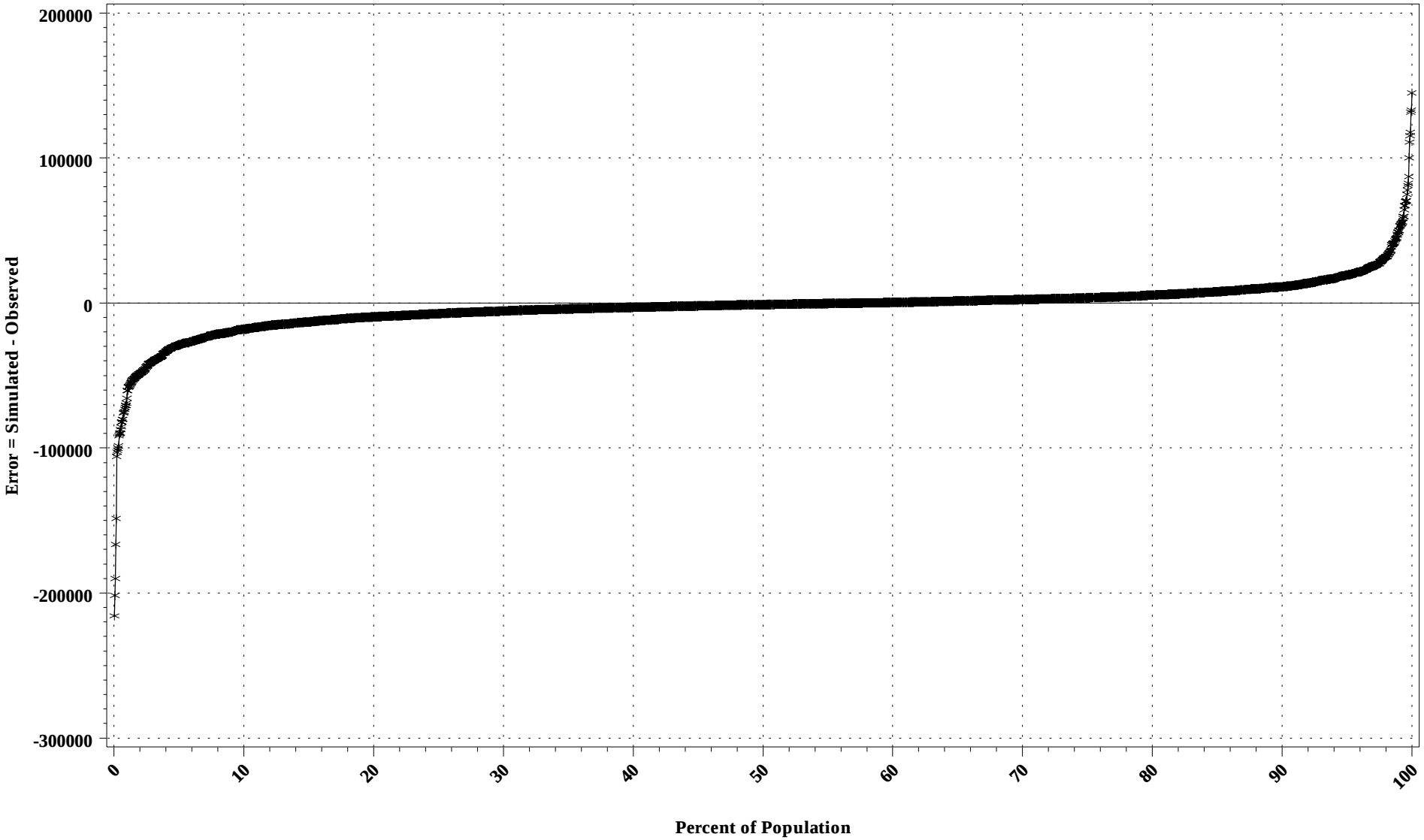
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(susq140n.drv 12JUN98 12:43)

Susquehanna River at Conowingo at Segment 140
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

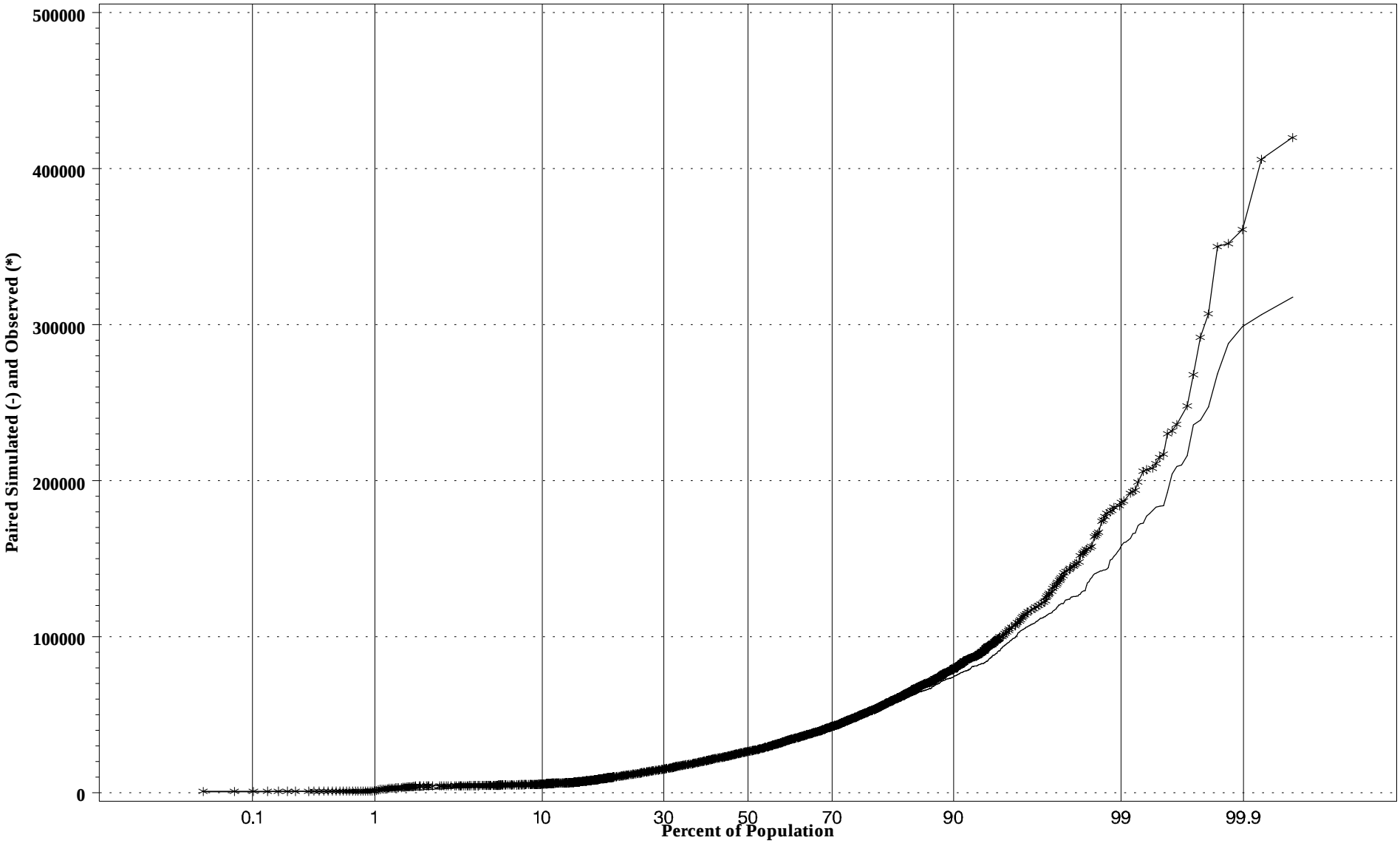


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(susq140n.drv 12JUN98 12:43)

Susquehanna River at Conowingo at Segment 140

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

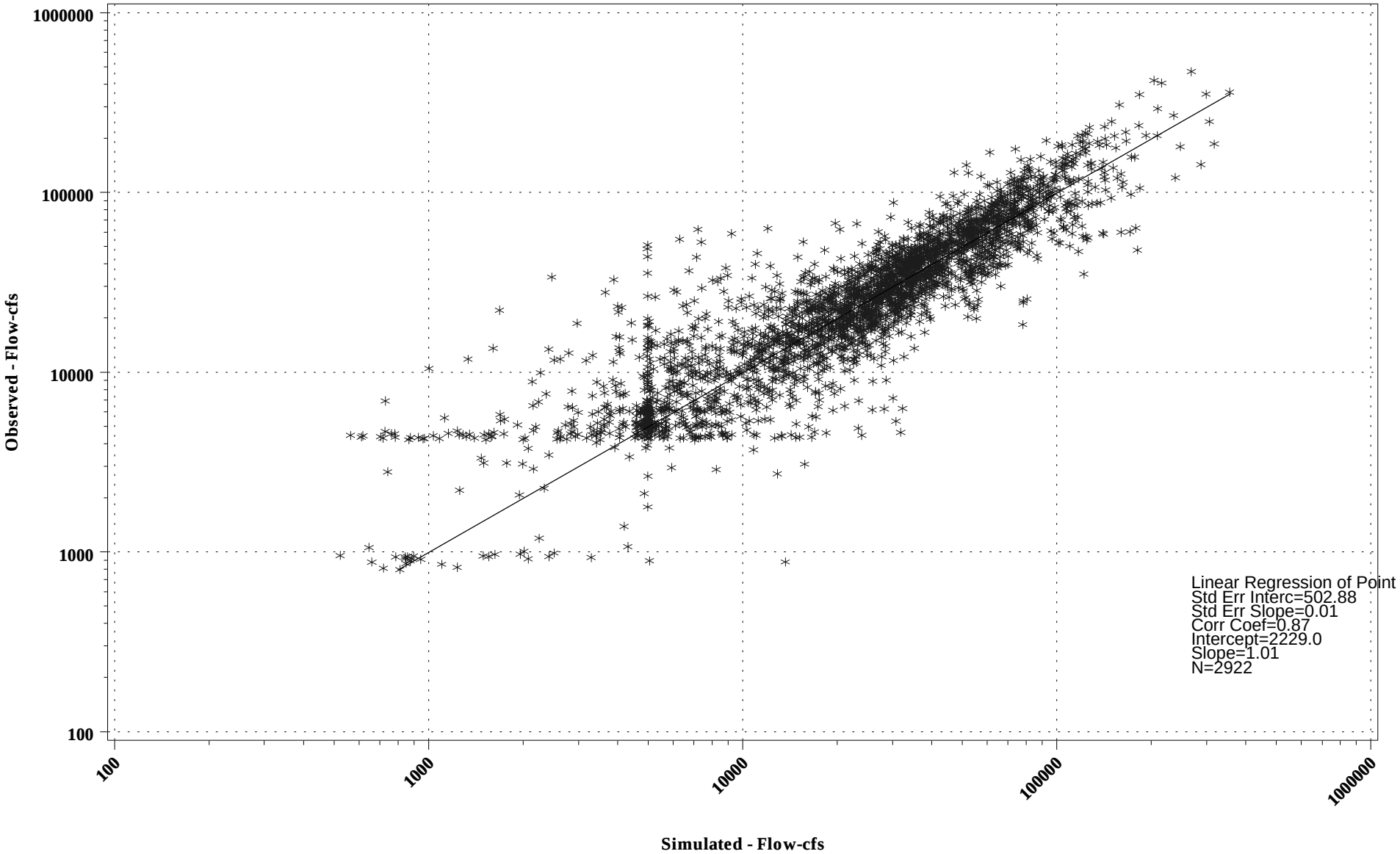


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(susq140n.drv 12JUN98 12:43)

Susquehanna River at Conowingo at Segment 140

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(susq140n.drv 12JUN98 12:43,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION CONOWINGO RESERVOIR, MD (Segments 10, 20 , 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 140, 710, and 720)

Table A.1.5.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	25.01	20.53
1985	15.27	13.83
1986	20.66	19.53
1987	16.16	15.77
1988	13.64	13.53
1989	19.97	19.59
1990	24.21	22.27
1991	14.86	14.08
Mean	18.72	17.39

* Observed flow from Susquehanna River at Conowingo, MD

** Simulated outflow from RCH 140

Table A.1.5.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.51	2.19	0.32	0.91	0.36	0.96
1985	0.91	0.37	0.82	1.02	-0.12	0.93
1986	0.95	0.16	0.77	1.02	-0.18	0.93
1987	0.93	0.27	0.81	0.93	0.28	0.92
1988	0.92	0.35	0.71	0.93	0.29	0.91
1989	0.86	0.63	0.75	0.84	0.72	0.94
1990	0.96	0.12	0.72	0.98	-0.03	0.93
1991	1.05	-0.28	0.85	1.12	-0.58	0.97
1984-1991	0.89	0.48	0.72	0.99	0.02	0.94

Table A.1.5.3 Seasonal r-squared.

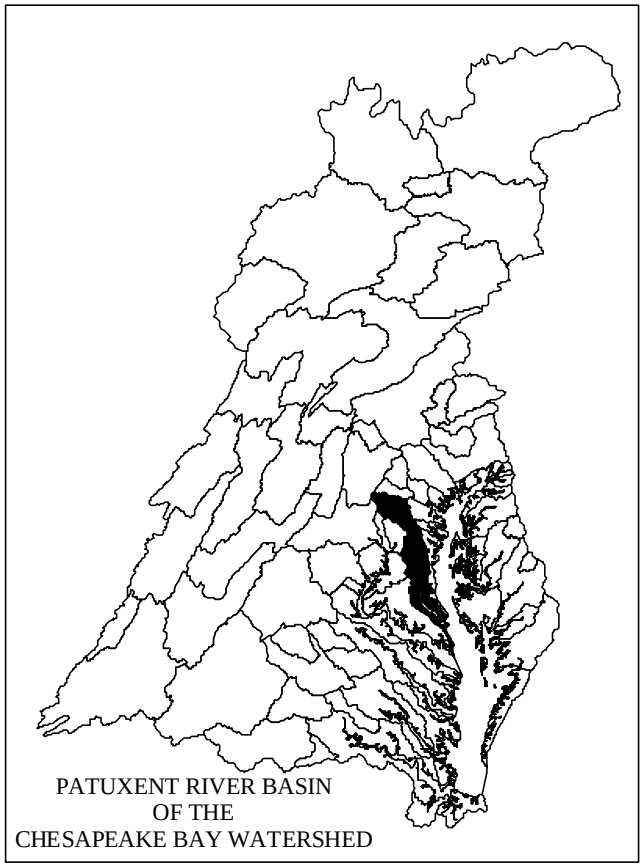
	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.84	0.80	0.70	0.80	1.07	0.71	1.01	-0.02	0.89	0.91	0.45	0.81
1985	0.92	0.26	0.78	0.70	1.46	0.72	0.84	0.72	0.59	0.94	0.33	0.86
1986	0.77	1.08	0.56	0.70	1.45	0.73	0.79	0.99	0.49	0.80	0.95	0.89
1987	0.66	1.47	0.53	0.68	1.53	0.77	0.82	0.77	0.79	0.74	1.14	0.55
1988	0.88	0.48	0.66	0.53	2.21	0.52	0.76	0.97	0.67	0.57	1.78	0.64
1989	0.87	0.46	0.43	0.91	0.44	0.74	0.98	0.09	0.85	0.64	1.54	0.67
1990	0.59	1.97	0.78	0.42	2.71	0.28	0.57	1.91	0.55	0.80	0.98	0.74
1991	0.87	0.63	0.67	0.65	1.68	0.77	0.41	2.23	0.36	0.54	1.88	0.68
1984-1991	0.78	1.02	0.68	0.99	-0.03	0.68	0.93	0.23	0.76	1.00	-0.03	0.74

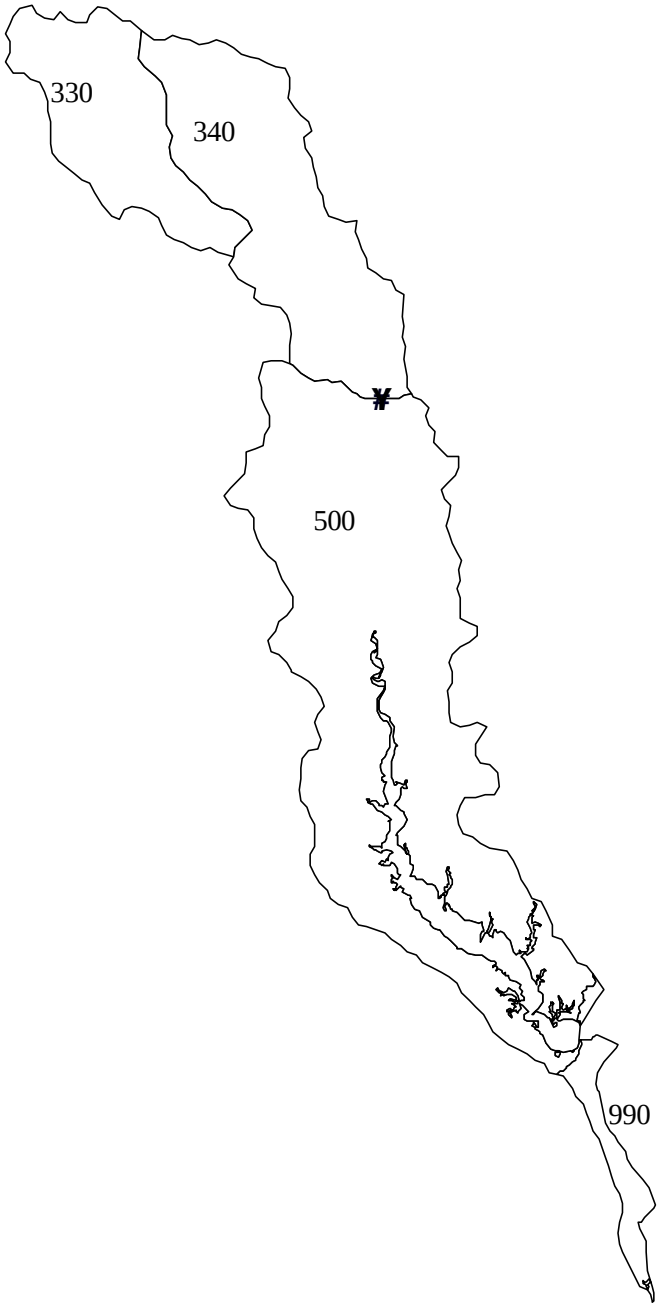
Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

Figure A.2

Monitoring Stations

Chesapeake Bay Watershed
Phase IV Model Segments:
Patuxent River Basin





KAG Map Date: January 1998

Source: USGS and Chesapeake Bay Program Modeling Team

A.2.1 PATUXENT RIVER AT BOWIE, MD AT SEGMENT 340 (1594440)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

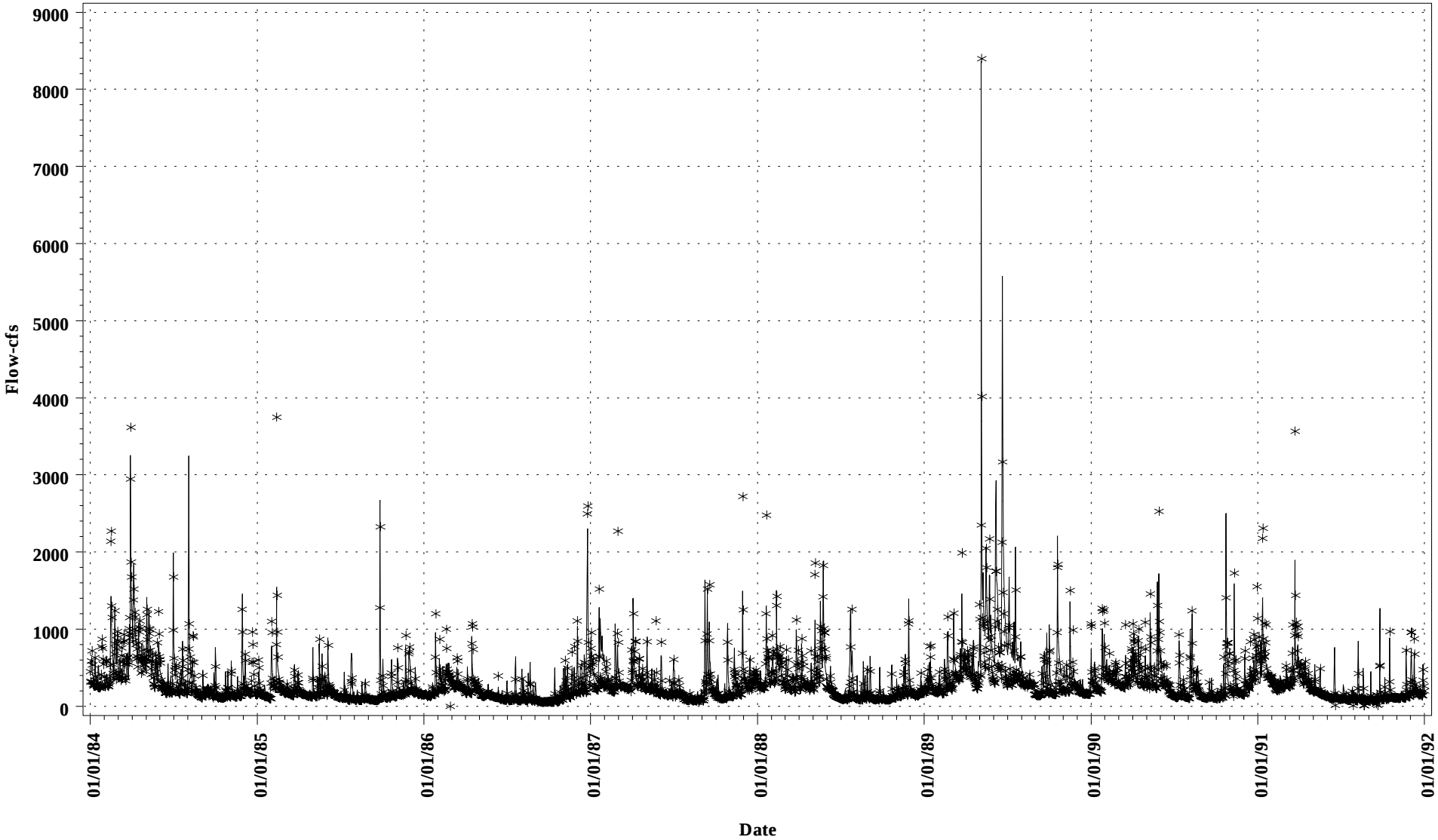
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

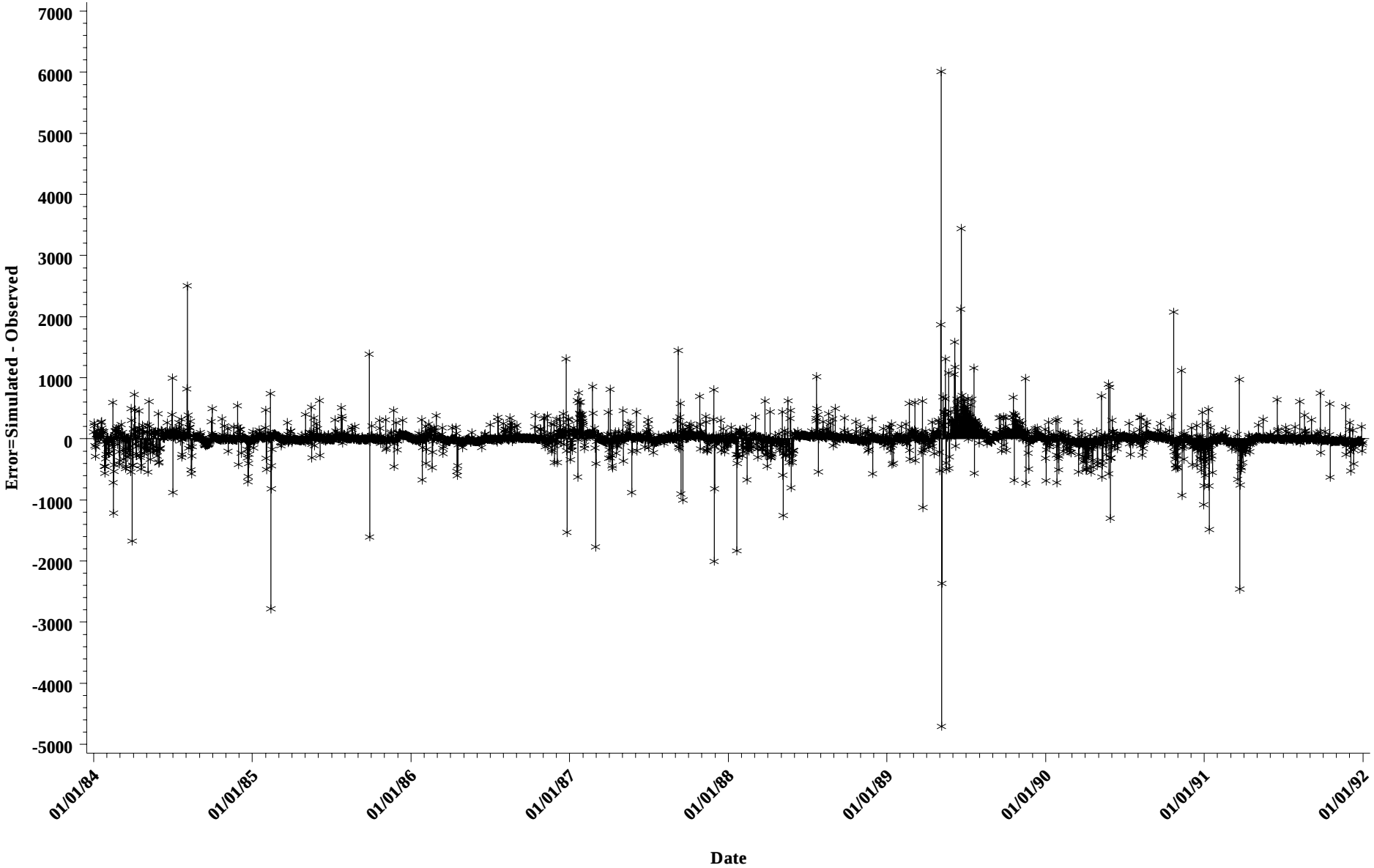
Patuxent River at Segment 340
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(pat_flw.drv 12JUN98 14:45)

Patuxent River at Segment 340
Actual Error versus Time
Flow-cfs



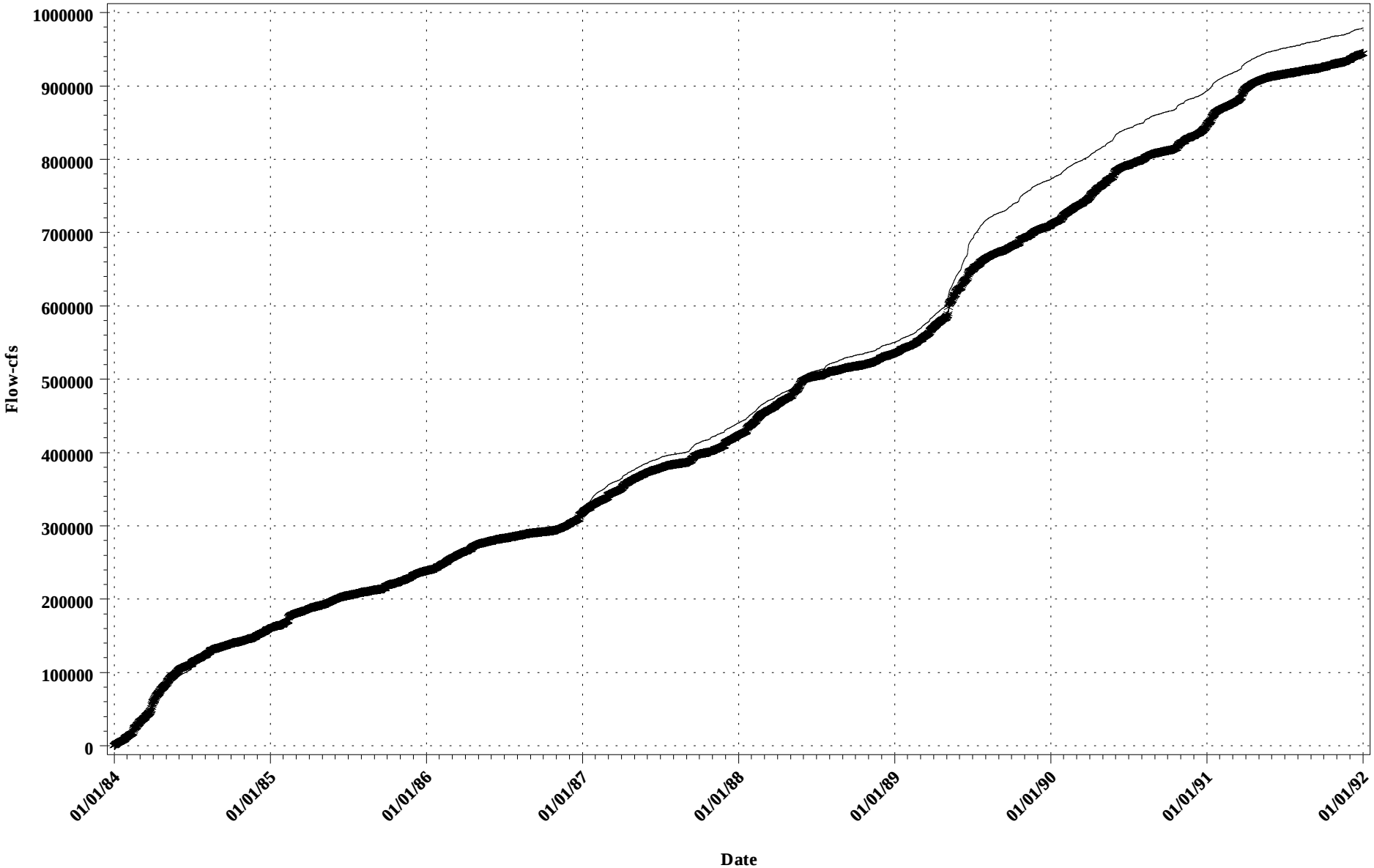
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(pat_flw.drv 12JUN98 14:45)

Patuxent River at Segment 340

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

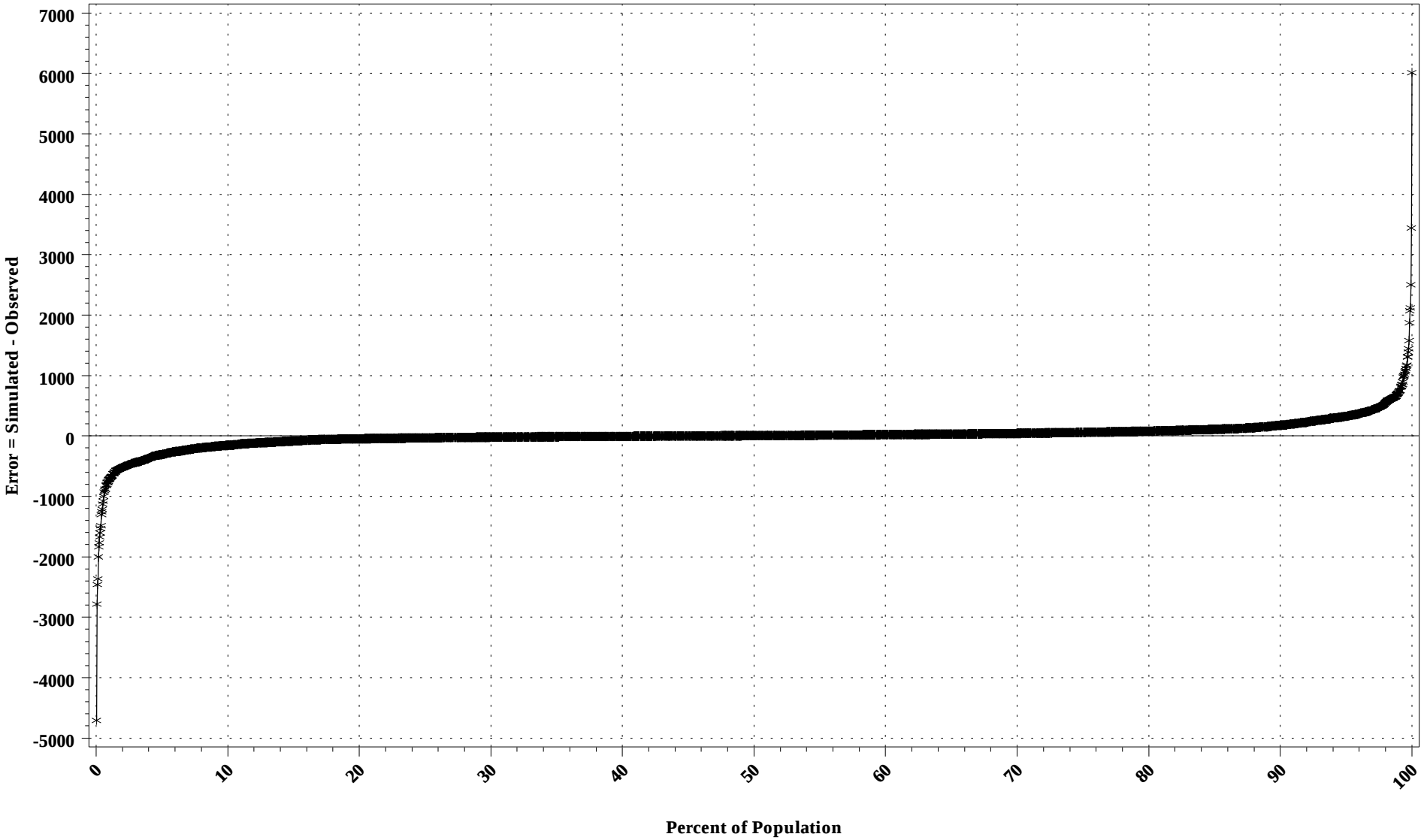
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(pat_flw.drv 12JUN98 14:45)

Patuxent River at Segment 340
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

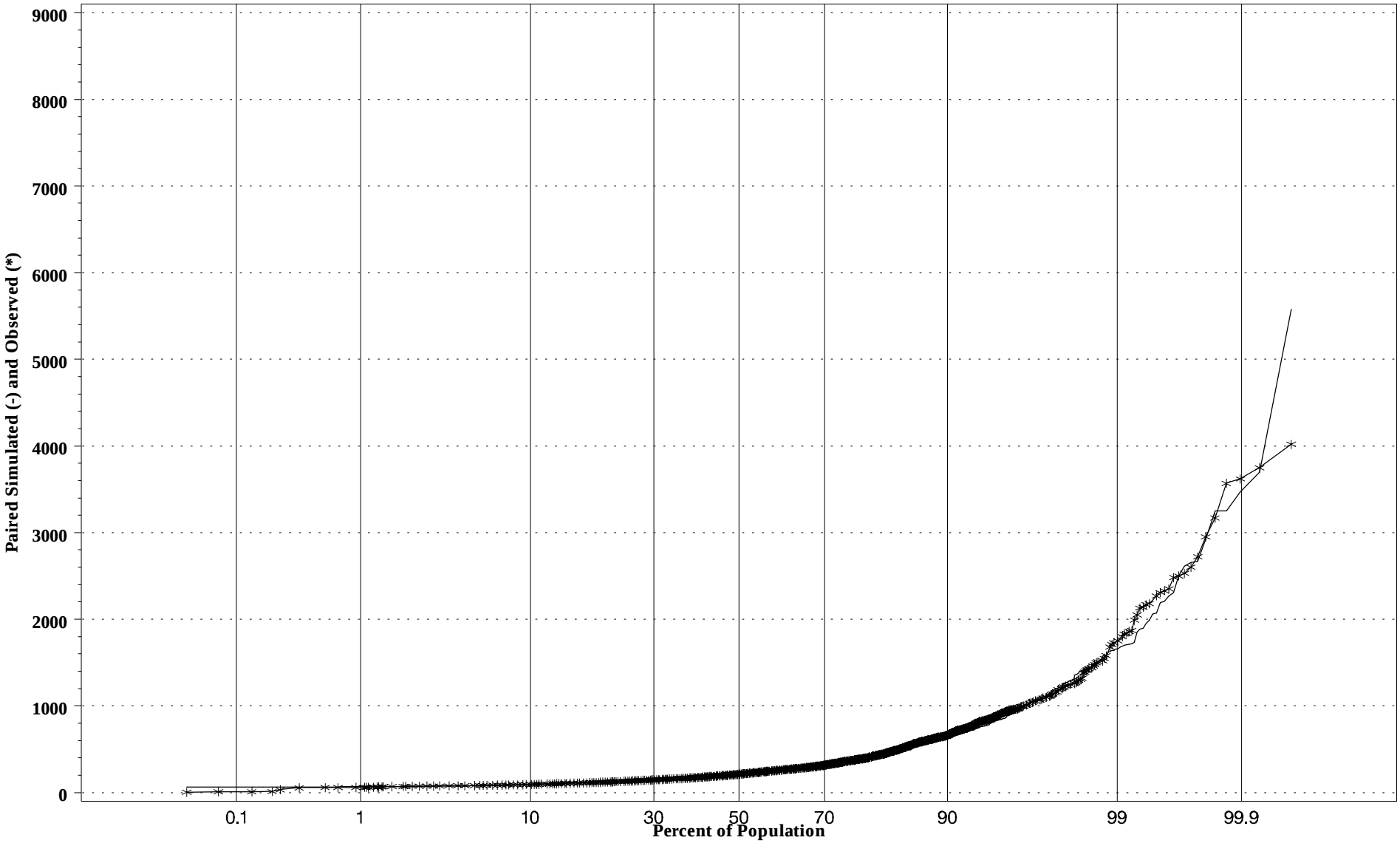


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(pat_flw.drv 12JUN98 14:45)

Patuxent River at Segment 340

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

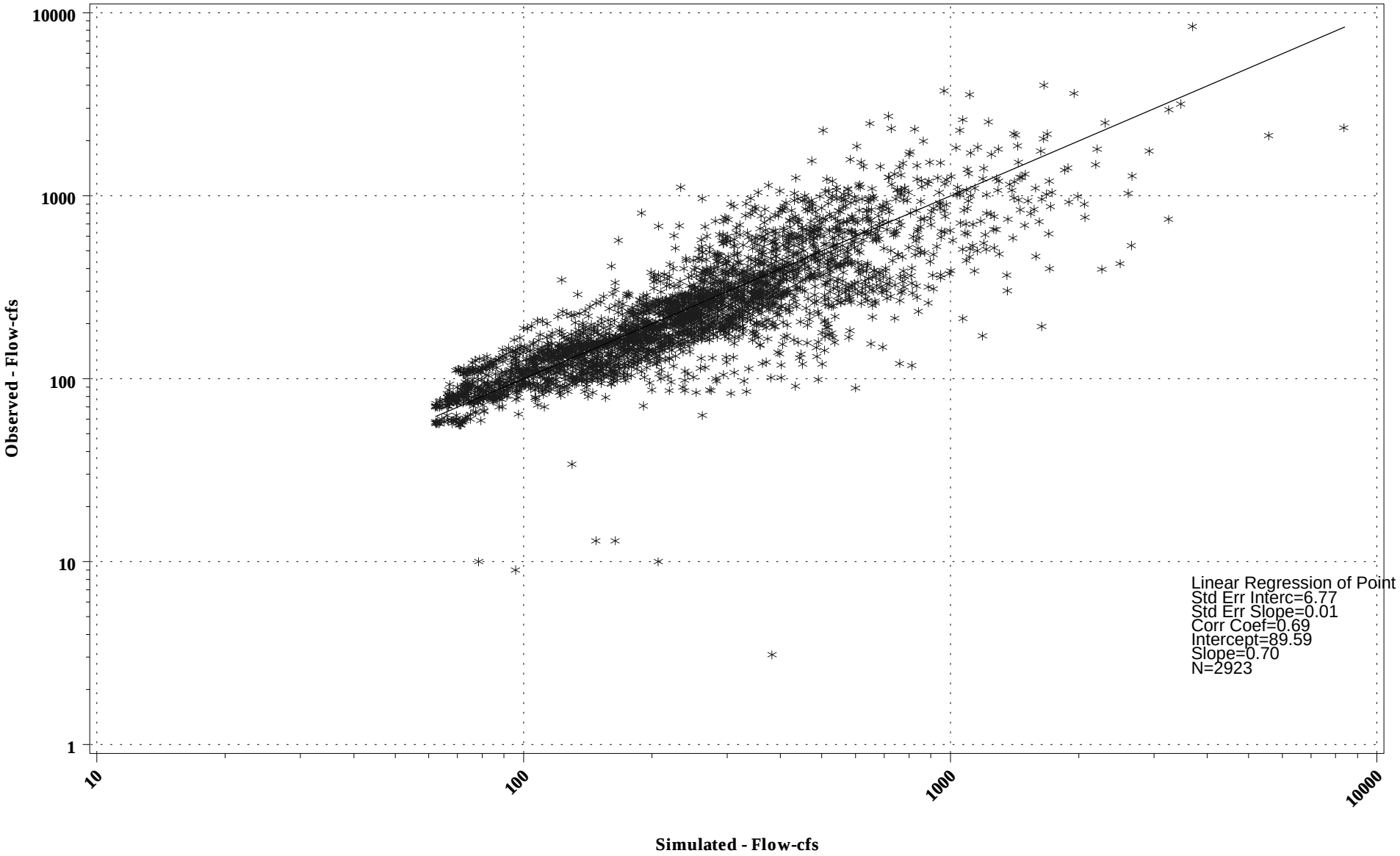


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(pat_flw.drv 12JUN98 14:45)

Patuxent River at Segment 340

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(pat_flw.drv 12JUN98 14:45,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
PATUXENT RIVER, MD (Segments 330 and 340)

A.2.1.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	Simulated Flow
Year	(inches)*	(inches)**
1984	17.12	16.82
1985	8.41	9.13
1986	8.42	8.77
1987	11.39	12.73
1988	11.93	12.14
1989	18.57	24.4
1990	14.59	13.24
1991	10.64	9.38
Mean	12.63	13.33

*Observed flow at Patuxent River near Bowie, MD
**Simulated outflow from RCH 340

Table A.2.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			Average Monthly		
Year	m	b	r2	m	b	r2
1984	0.80	0.51	0.70	0.92	0.21	0.92
1985	0.89	0.29	0.71	0.94	0.16	0.88
1986	0.79	0.49	0.63	0.96	0.12	0.88
1987	0.81	0.49	0.64	0.91	0.26	0.83
1988	0.73	0.68	0.70	0.69	0.75	0.87
1989	0.86	0.48	0.71	1.14	-0.24	0.89
1990	0.67	0.78	0.66	0.62	0.92	0.84
1991	0.72	0.60	0.67	0.79	0.45	0.93
1984-1991	0.78	0.54	0.68	0.91	0.24	0.87

Table A.2.1.3 Seasonal r-squared.

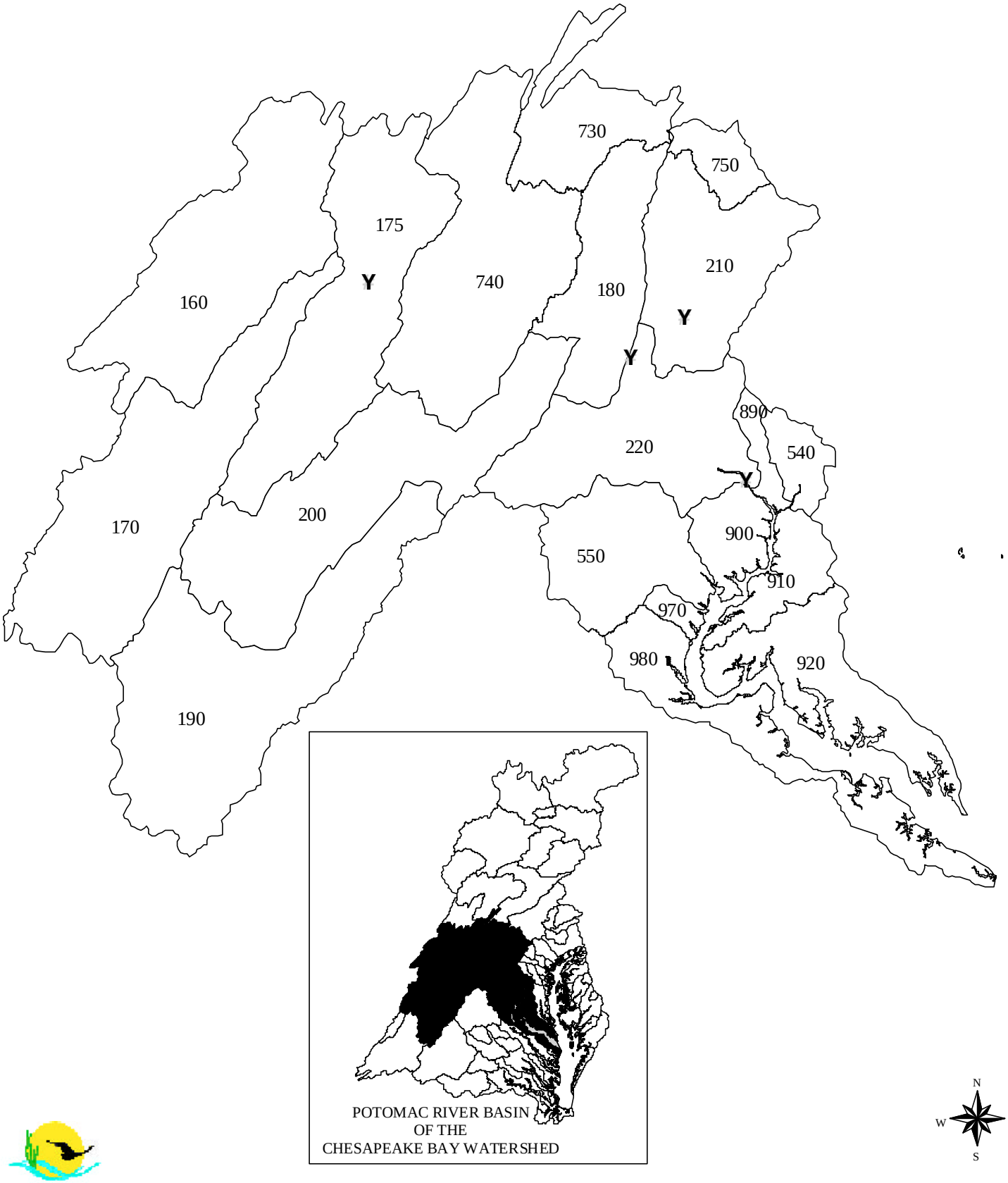
	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.85	0.40	0.42	0.79	0.62	0.55	0.66	0.81	0.52	0.68	0.74	0.48
1985	1.19	-0.49	0.75	0.62	0.86	0.67	0.60	0.82	0.69	0.82	0.37	0.70
1986	0.75	0.56	0.28	0.83	0.45	0.73	0.46	1.04	0.45	0.80	0.38	0.74
1987	0.65	0.79	0.31	0.79	0.53	0.38	0.76	0.50	0.67	0.91	0.15	0.50
1988	1.07	-0.16	0.67	0.80	0.57	0.57	0.78	0.35	0.63	0.79	0.45	0.71
1989	0.80	0.46	0.53	0.83	0.42	0.61	0.75	0.50	0.76	0.85	0.26	0.62
1990	0.93	0.23	0.55	0.81	0.59	0.57	1.03	-0.15	0.80	0.84	0.44	0.57
1991	1.03	0.00	0.62	1.10	-0.16	0.75	0.42	1.12	0.16	0.57	0.98	0.26
1984-1991	0.57	1.11	0.53	0.84	0.39	0.73	0.94	0.22	0.72	0.82	0.44	0.62

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

Figure A.3

Monitoring Stations

Chesapeake Bay Watershed
Phase IV Model Segments:
Potomac River Basin



KAG Map Date: January 1998

Source: USGS and Chesapeake Bay Program Modeling Team

A.3.1 UPPER POTOMAC RIVER AT HANCOCK, MD AT SEGMENT 175 (1613000)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

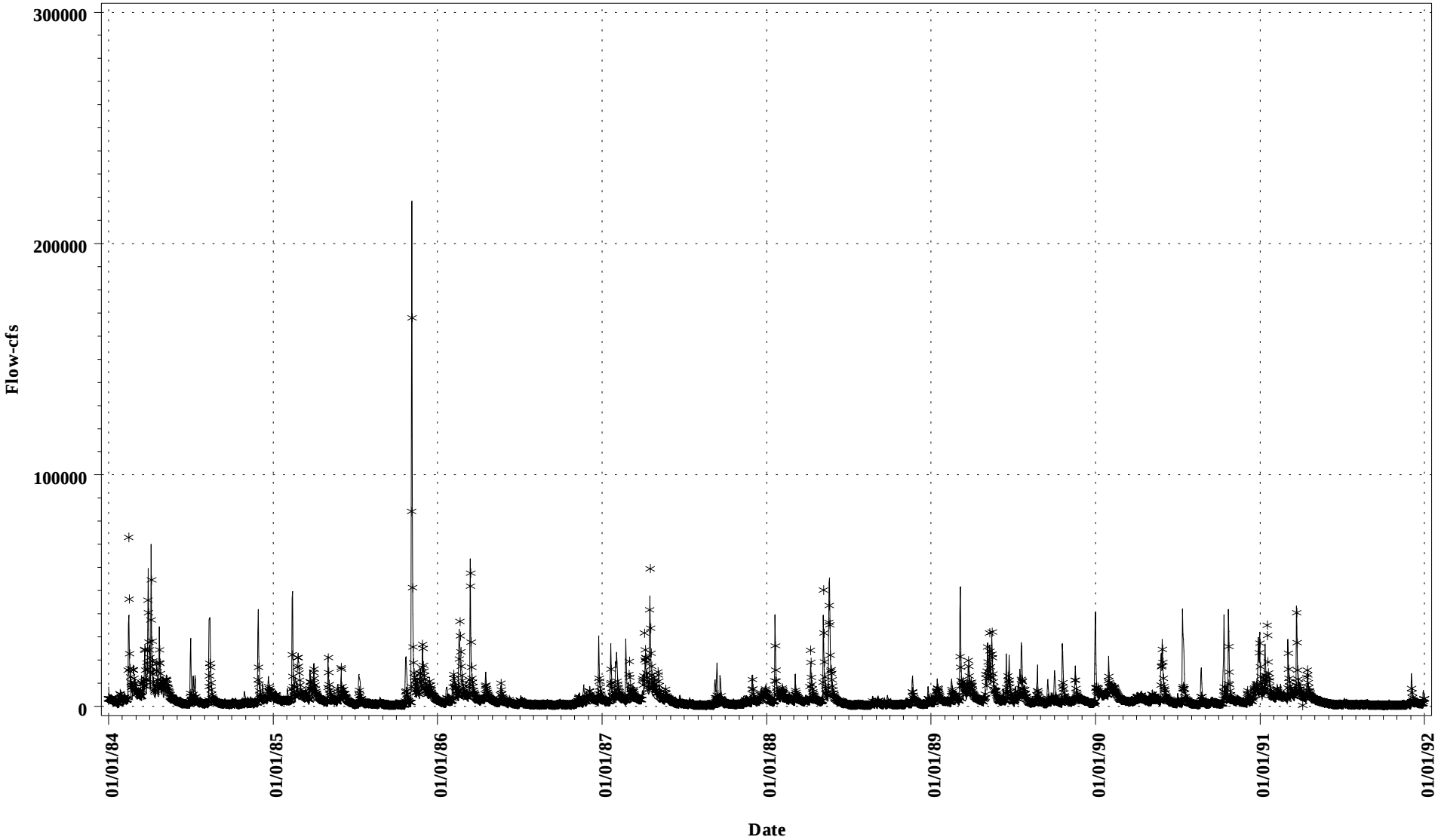
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

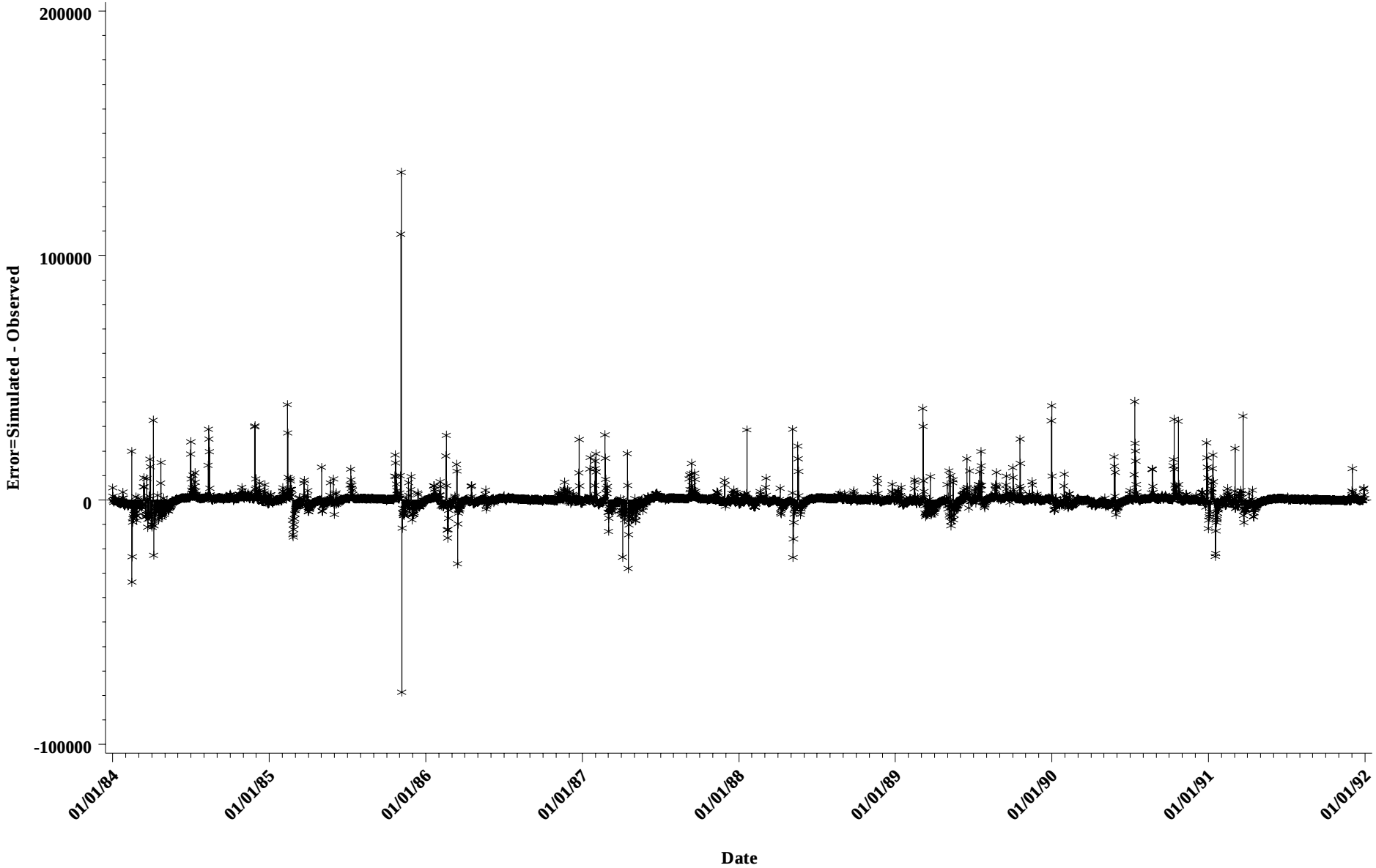
Upper Potomac River at Segment 175
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(upflo.drv 12JUN98 15:56)

Upper Potomac River at Segment 175
Actual Error versus Time
Flow-cfs



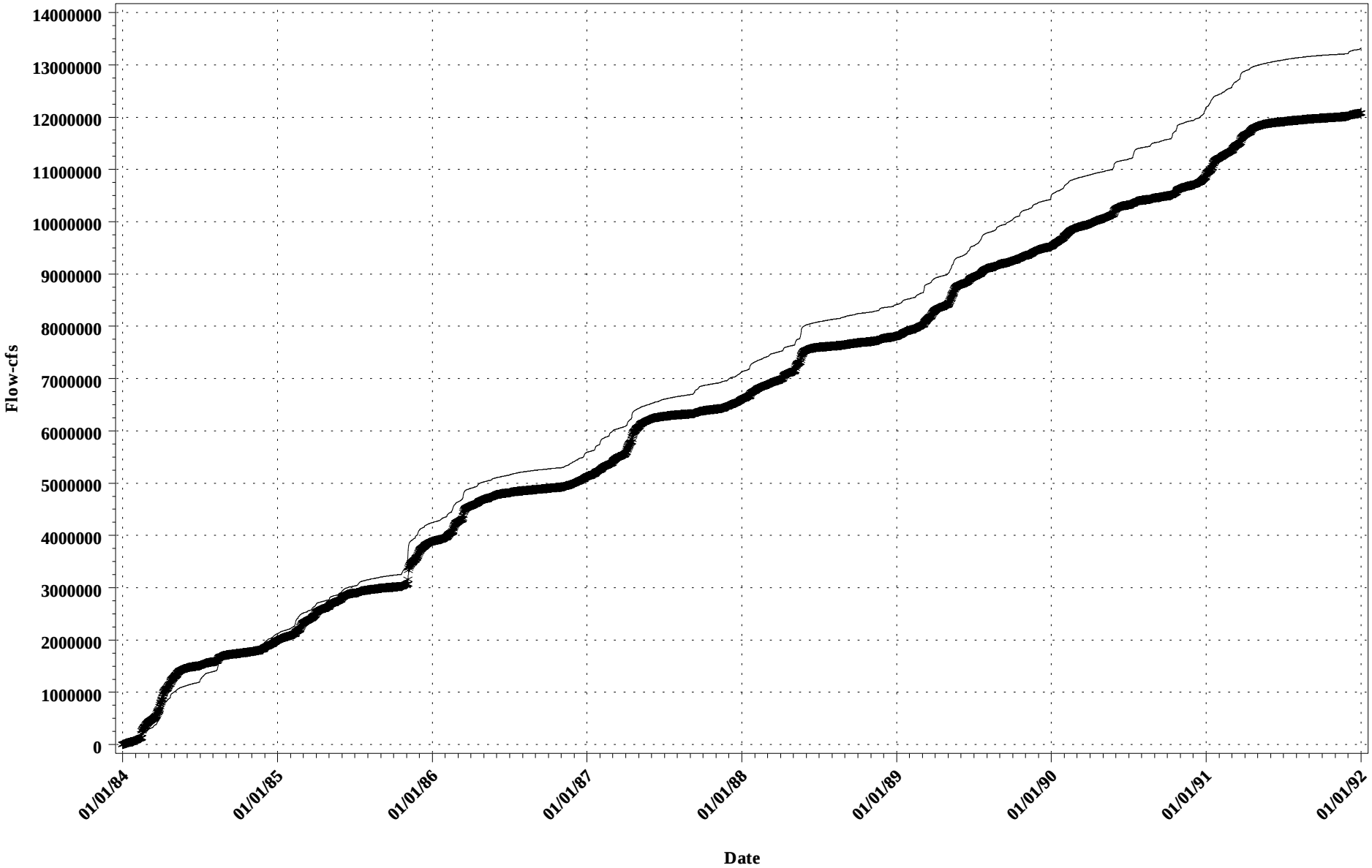
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(upflo.drv 12JUN98 15:56)

Upper Potomac River at Segment 175

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

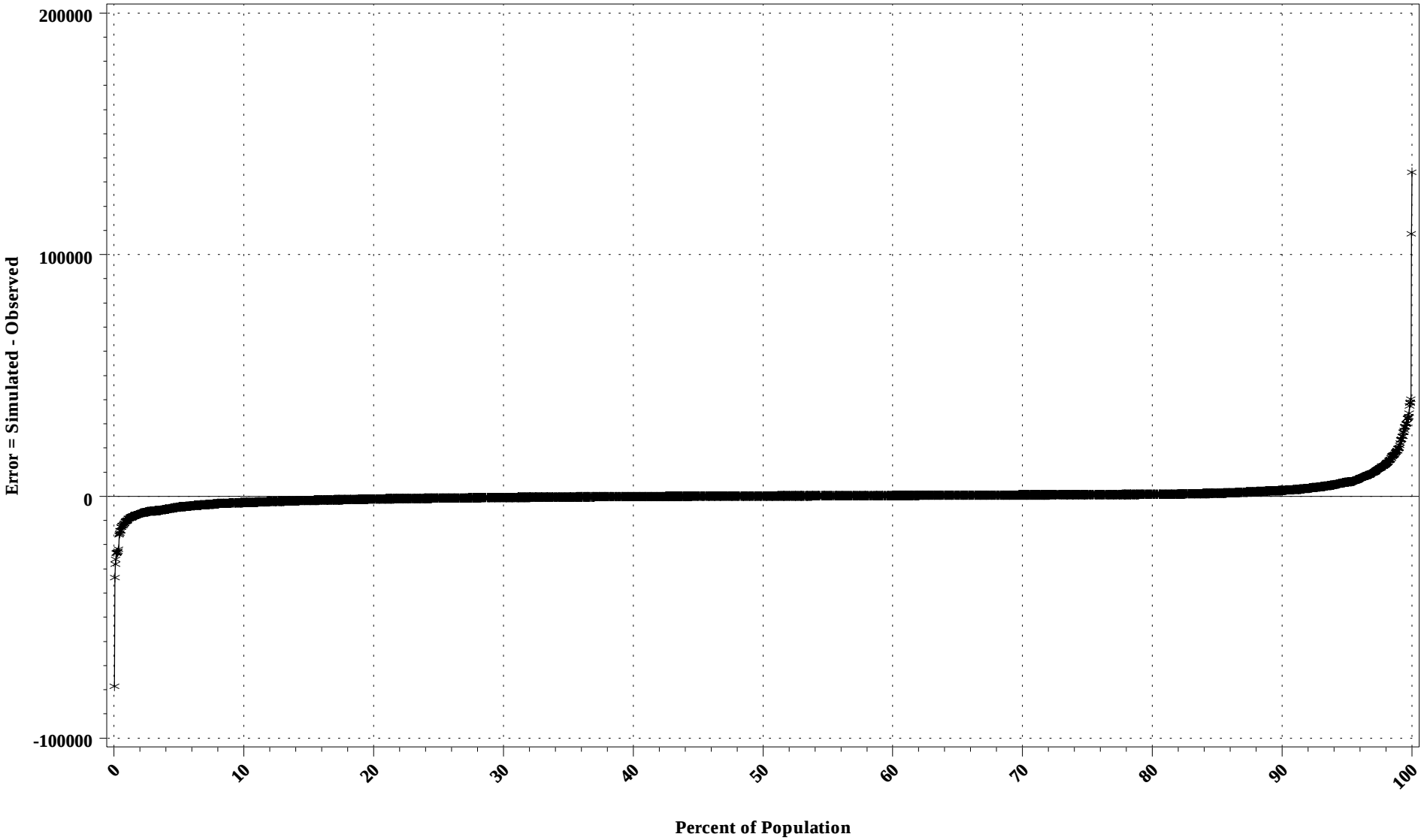
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(upflo.drv 12JUN98 15:56)

Upper Potomac River at Segment 175
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

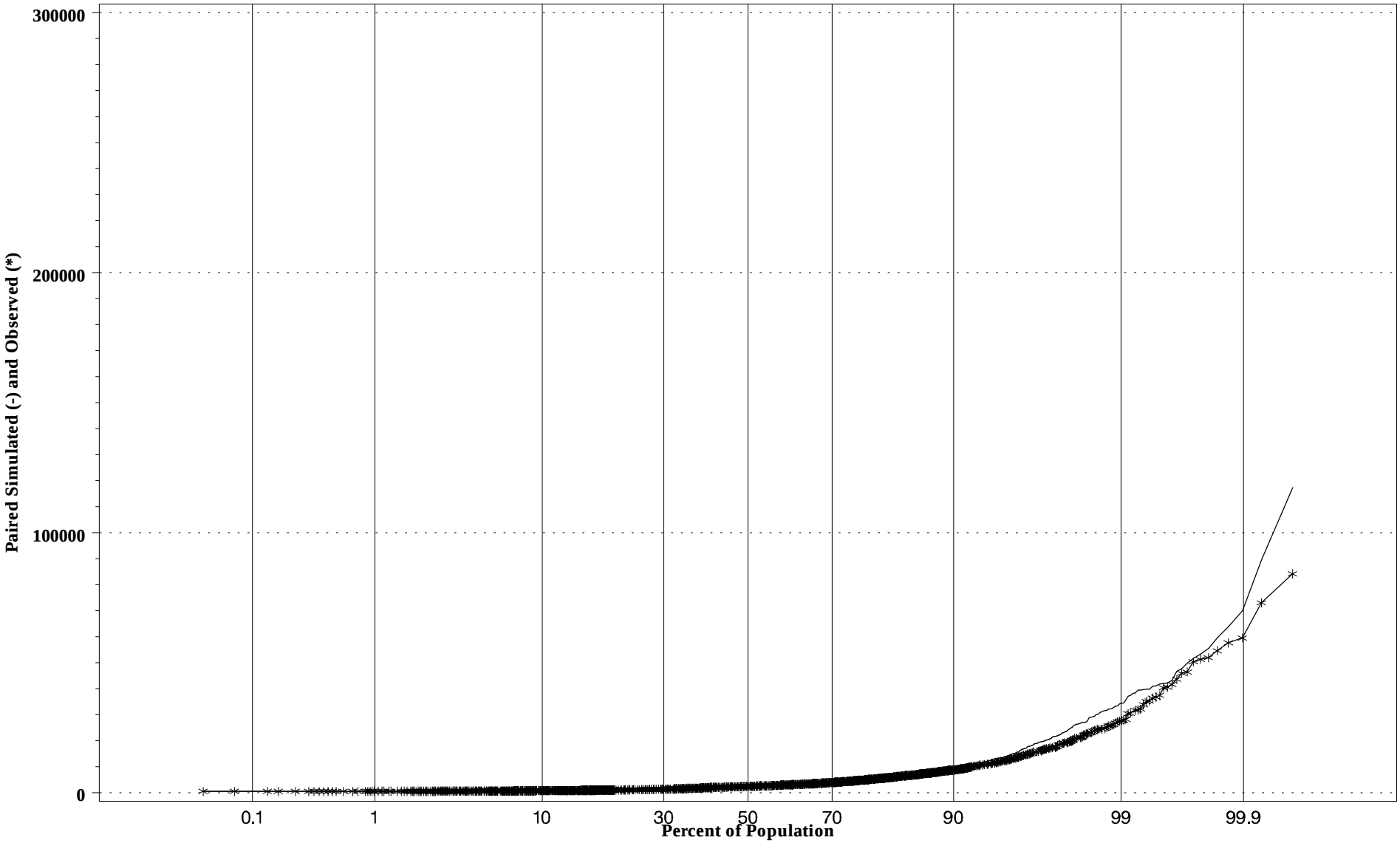


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(upflo.drv 12JUN98 15:56)

Upper Potomac River at Segment 175

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

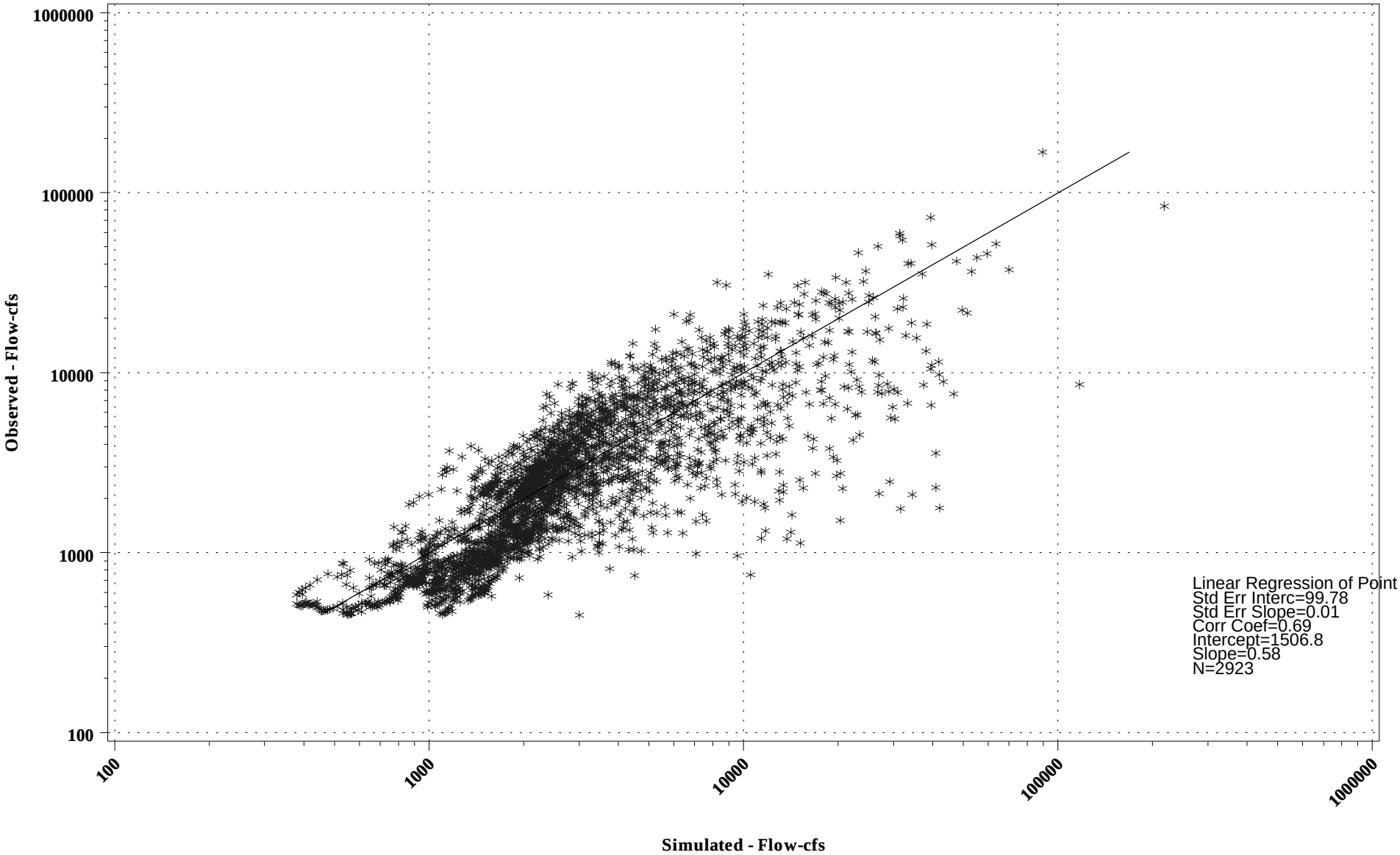


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(upflo.drv 12JUN98 15:56)

Upper Potomac River at Segment 175

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(upflo.drv 12JUN98 15:56,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
UPPER POTOMAC RIVER, MD (Segments 160, 170 and 175)

Table A.3.1.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	18.19	18.69
1985	17.3	18.67
1986	11.35	11.48
1987	13.47	13.26
1988	11.07	11.04
1989	15.59	18.5
1990	12.33	14.83
1991	11.08	9.97
Mean	13.80	14.56

*Observed flow at Upper Potomac River at Hancock, MD
**Simulated outflow from RCH 175

Table A.3.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.66	1.25	0.59	0.51	1.76	0.70
1985	0.74	0.97	0.69	0.70	1.09	0.86
1986	0.82	0.65	0.80	0.85	0.58	0.94
1987	0.56	1.59	0.57	0.54	1.63	0.78
1988	0.72	1.00	0.74	0.63	1.27	0.90
1989	0.74	0.98	0.50	0.62	1.41	0.65
1990	0.82	0.64	0.52	0.58	1.47	0.48
1991	0.82	0.59	0.82	0.84	0.53	0.94
1984-1991	0.74	0.96	0.65	0.71	1.03	0.82

Table A.3.1.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.92	0.47	0.80	0.85	0.62	0.72	0.83	0.33	0.80	0.89	0.18	0.68
1985	0.69	1.05	0.44	0.88	0.51	0.71	1.07	-0.42	0.82	0.98	0.02	0.85
1986	1.10	-0.47	0.64	1.03	-0.10	0.86	0.70	0.86	0.59	0.72	0.92	0.84
1987	0.42	2.00	0.31	1.03	0.06	0.79	0.91	0.04	0.83	1.03	-0.19	0.74
1988	0.90	0.32	0.64	0.91	0.38	0.82	1.15	-0.65	0.62	0.78	0.66	0.76
1989	0.73	0.94	0.49	0.81	0.78	0.70	0.86	0.33	0.68	0.55	1.46	0.47
1990	0.34	2.48	0.25	0.57	1.56	0.48	0.72	0.79	0.56	0.78	0.66	0.75
1991	0.72	0.09	0.39	0.89	0.43	0.75	0.53	1.32	0.59	0.61	1.24	0.79
1984-1991	0.74	0.92	0.45	0.89	0.30	0.73	0.87	0.61	0.71	0.95	0.25	0.74

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.3.2 SHENANDOAH RIVER AT MILLVILLE, WV AT SEGMENT 200 (1636500)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

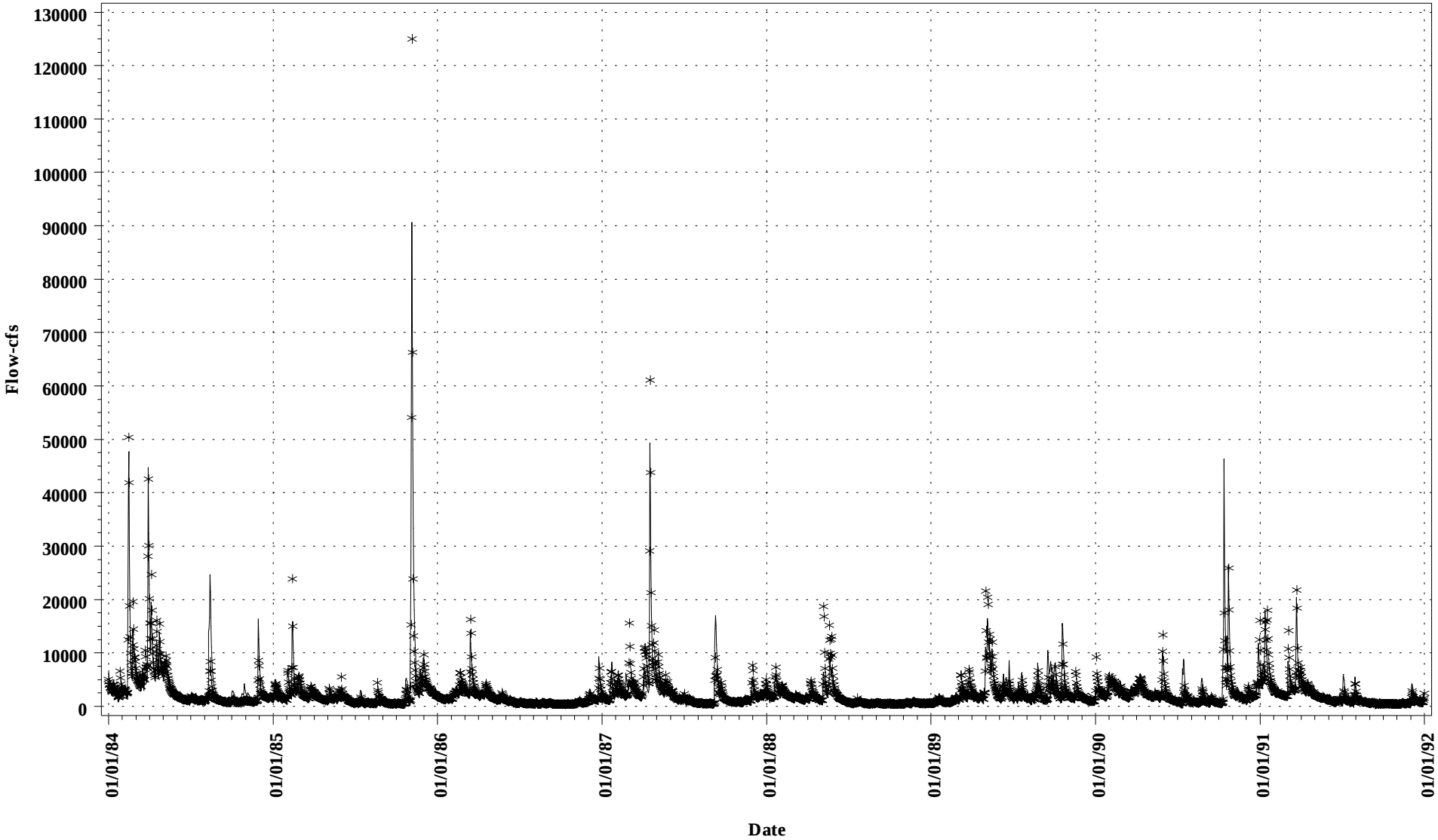
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

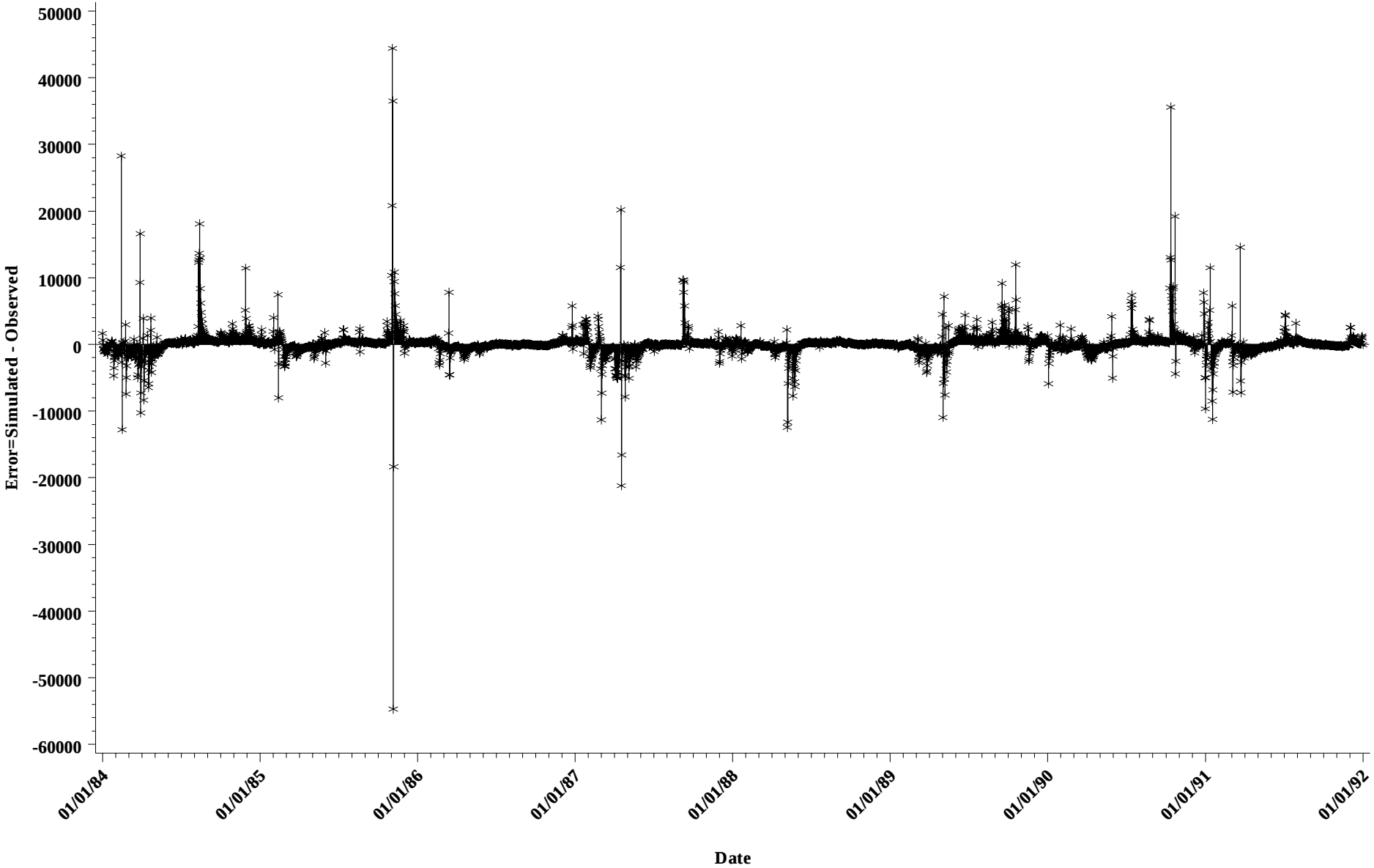
Shenandoah River at Segment 200
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(sh.drv 16JUN98 16:03)

Shenandoah River at Segment 200
Actual Error versus Time
Flow-cfs



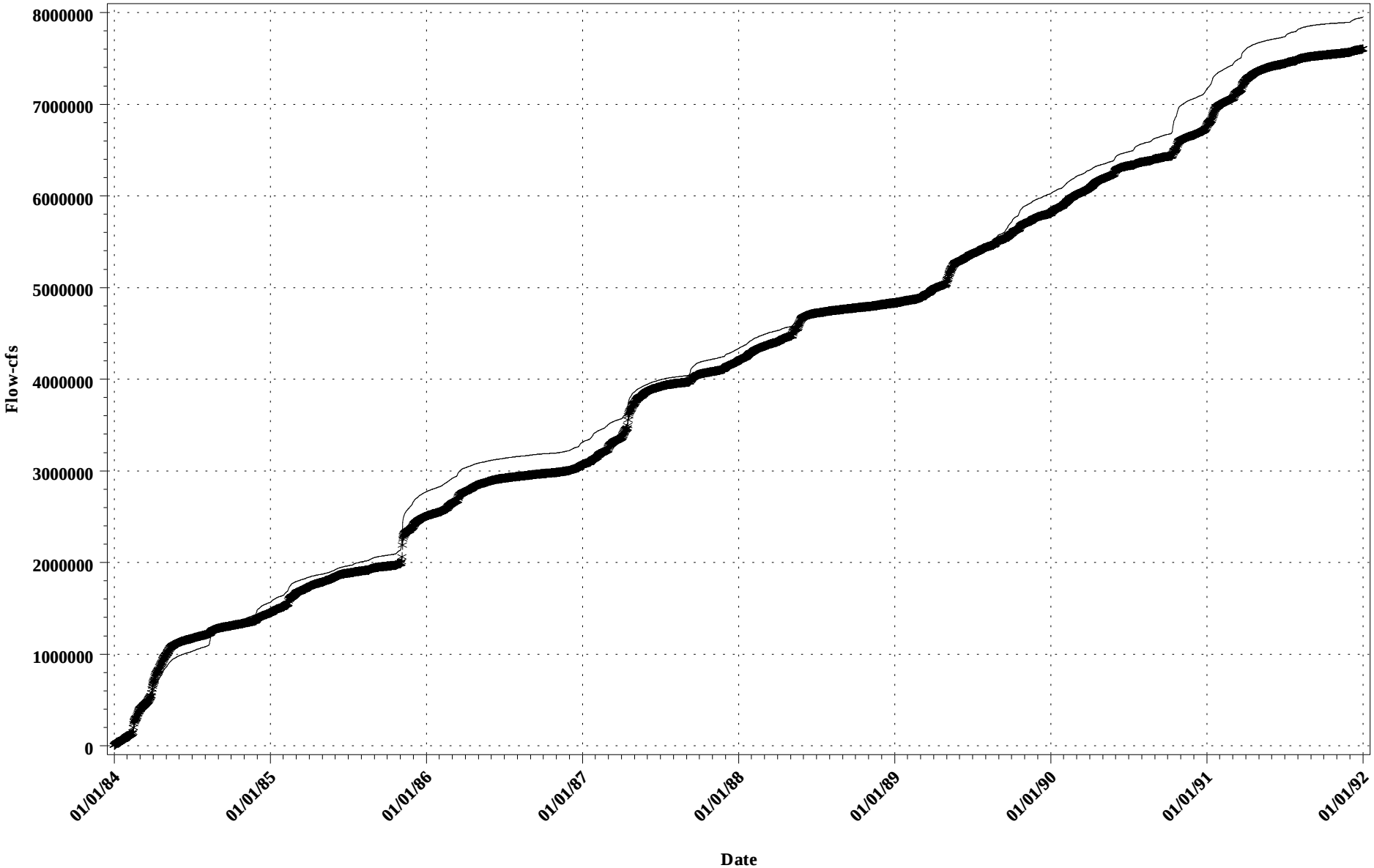
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(sh.drv 16JUN98 16:03)

Shenandoah River at Segment 200

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

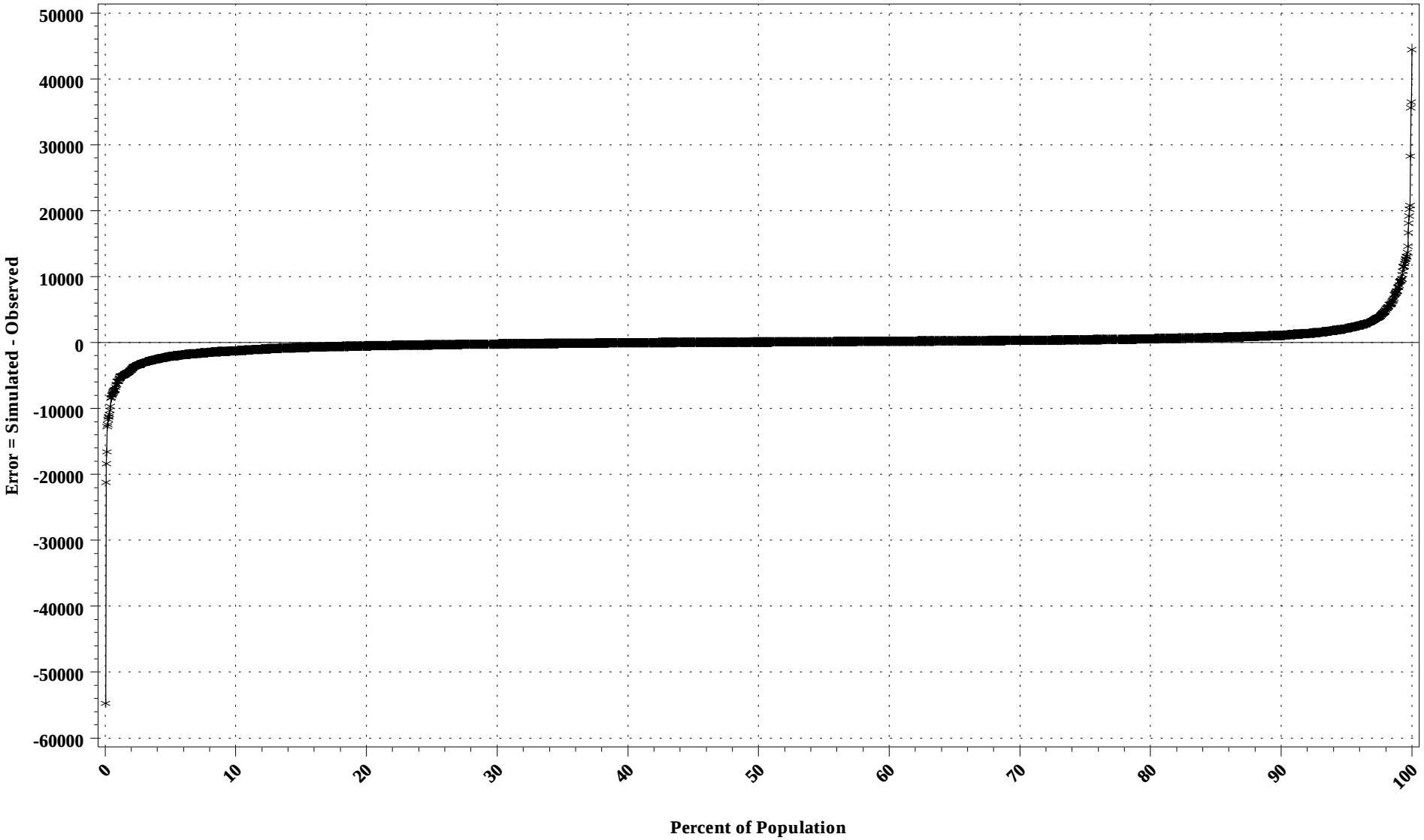
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(sh.drv 16JUN98 16:03)

Shenandoah River at Segment 200
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

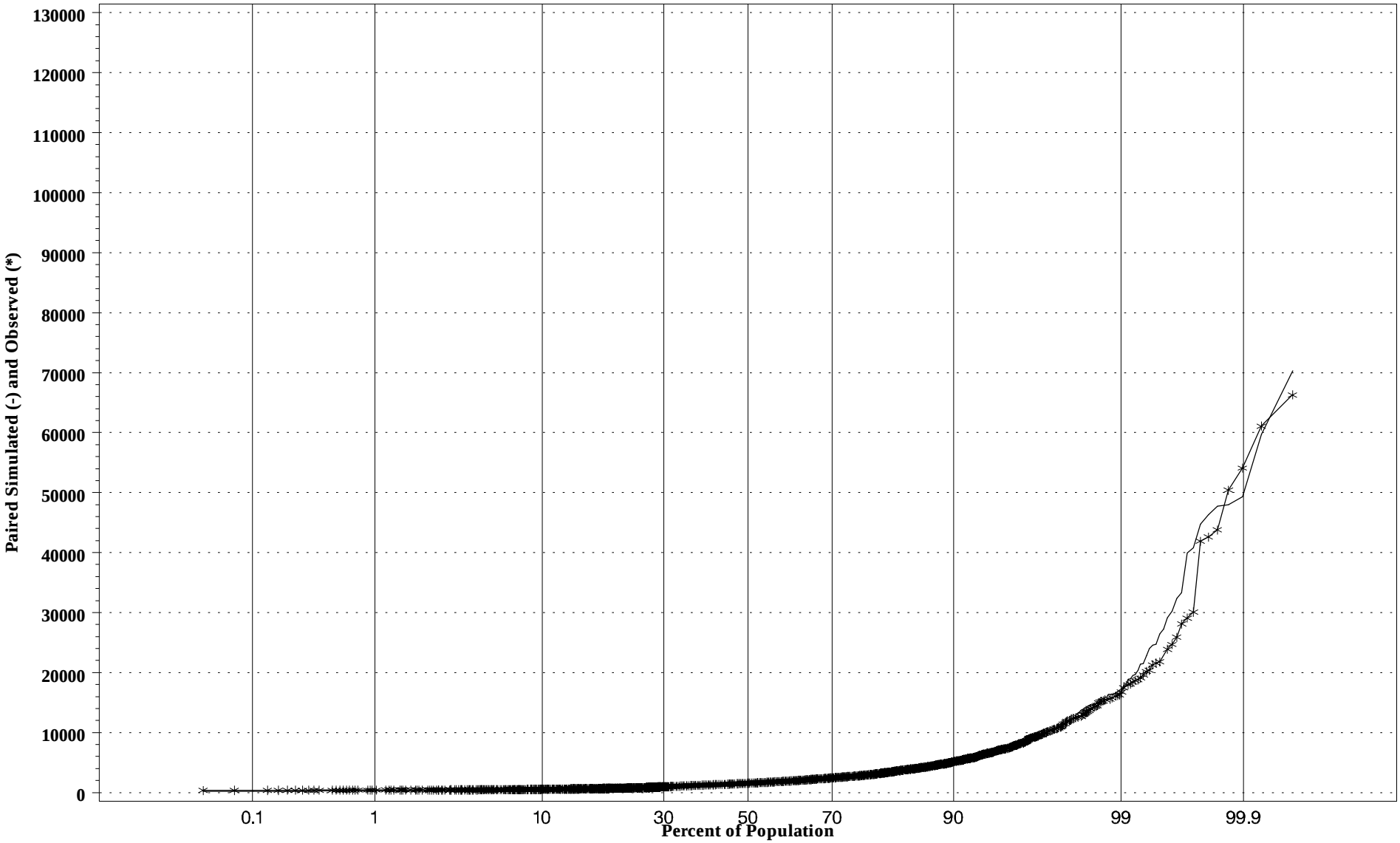


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(sh.drv 16JUN98 16:03)

Shenandoah River at Segment 200

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

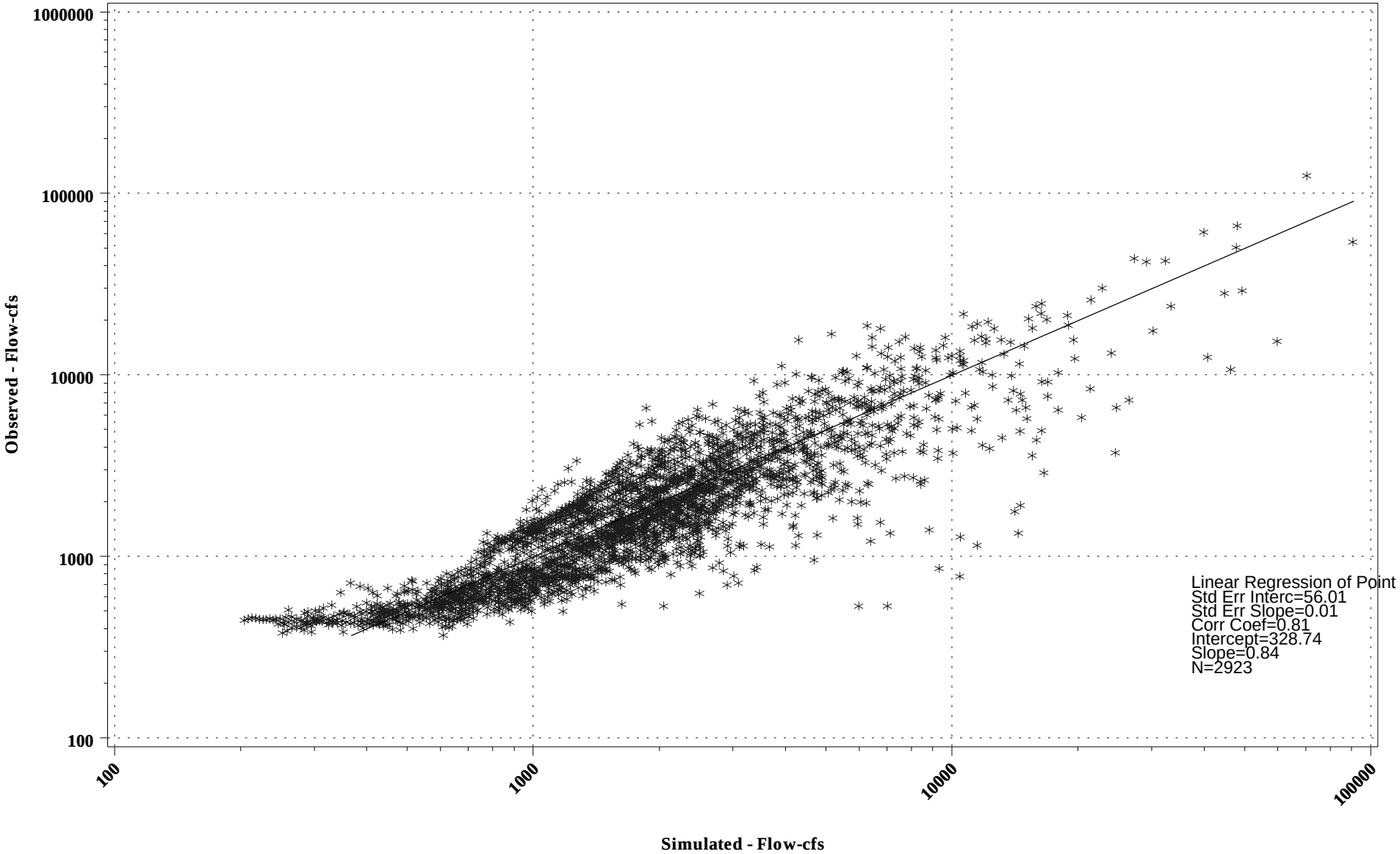


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(sh.drv 16JUN98 16:03)

Shenandoah River at Segment 200

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(sh.drv 16JUN98 16:03,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
SHENANDOAH RIVER, VA (Segments 190 and 200)

Table A.3.2.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	17.73	19.25
1985	12.93	14.55
1986	6.88	7.00
1987	13.88	12.18
1988	7.69	6.78
1989	11.96	13.20
1990	11.52	13.86
1991	10.45	10.09
Mean	11.63	12.11

* Observed flow at Shenandoah River at Millville, WV

** Simulated outflow from RCH 200

Table A.3.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.72	1.05	0.74	0.60	1.44	0.82
1985	0.84	0.58	0.76	0.88	0.44	0.80
1986	0.98	0.05	0.87	1.01	-0.05	0.91
1987	0.82	0.55	0.76	0.98	0.67	0.87
1988	0.72	0.87	0.88	0.72	0.89	0.92
1989	0.90	0.38	0.66	1.06	-0.15	0.72
1990	0.71	1.03	0.58	0.49	1.76	0.44
1991	0.94	0.17	0.83	0.95	0.12	0.87
1984-1991	0.83	0.59	0.76	0.87	0.44	0.81

Table A.3.2.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.68	1.31	0.81	0.89	0.49	0.83	0.64	0.96	0.73	0.90	0.05	0.65
1985	0.91	0.27	0.64	1.06	-0.14	0.41	1.10	-0.52	0.60	1.04	-0.29	0.88
1986	1.56	-1.98	0.78	0.97	0.18	0.84	1.00	-0.11	0.71	0.83	0.45	0.93
1987	0.44	1.87	0.20	0.88	0.63	0.78	0.95	0.04	0.80	1.25	-0.82	0.86
1988	1.06	-0.17	0.65	1.31	-0.89	0.90	1.68	-2.26	0.83	0.73	0.67	0.47
1989	1.30	-0.81	0.67	0.82	0.78	0.84	0.75	0.71	0.56	0.96	-0.02	0.65
1990	0.81	0.69	0.53	0.71	1.05	0.48	0.85	0.29	0.48	0.86	0.34	0.74
1991	1.09	0.28	0.65	0.96	0.20	0.80	0.80	0.44	0.74	0.67	0.88	0.83
1984-1991	0.84	0.54	0.76	0.95	0.05	0.86	1.02	0.04	0.76	1.10	-0.22	0.85

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.3.3 LOWER POTOMAC RIVER AT CHAIN BRIDGE NEAR WASHINGTON, DC AT SEGMENT 220 (1646500)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

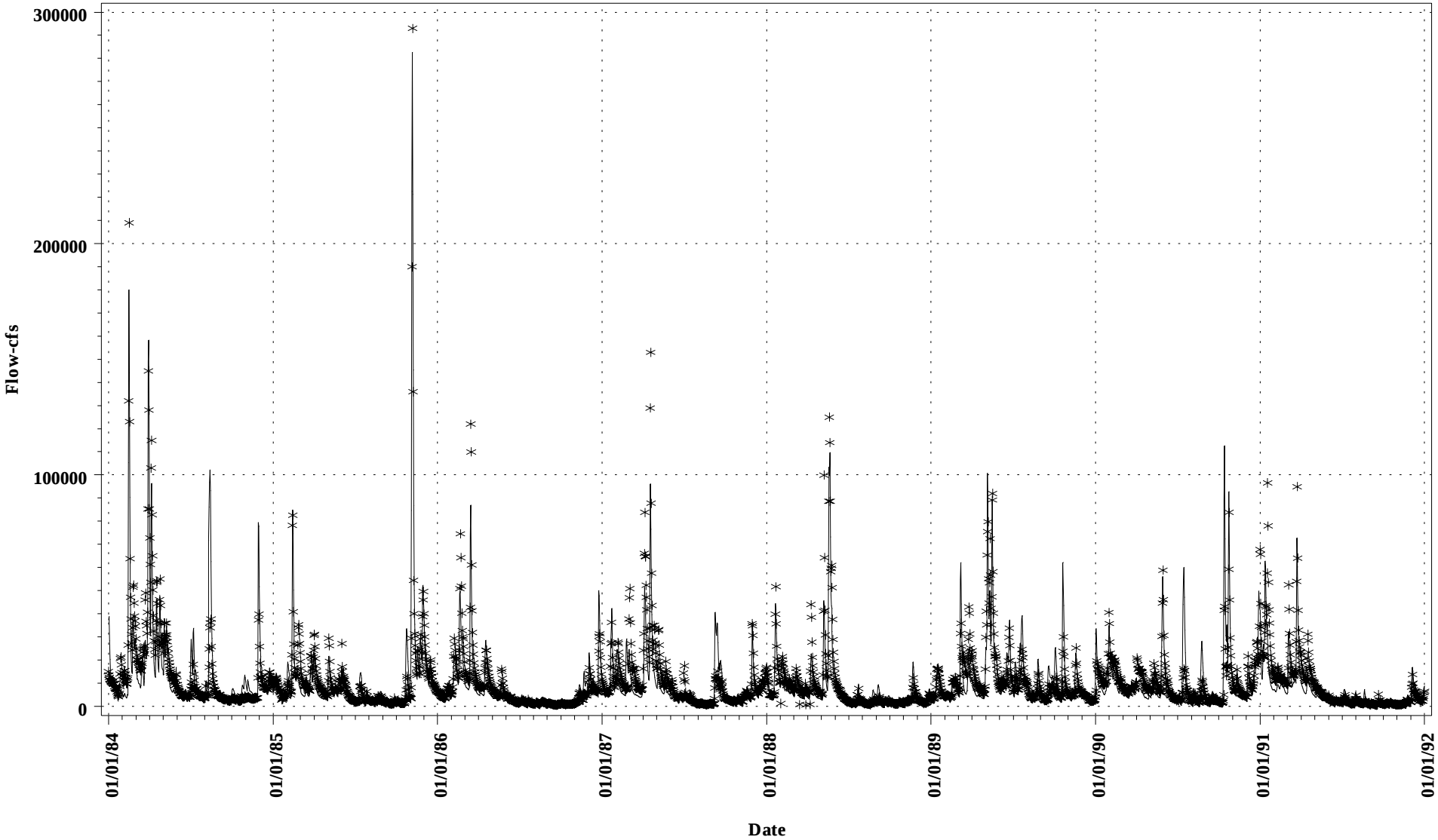
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

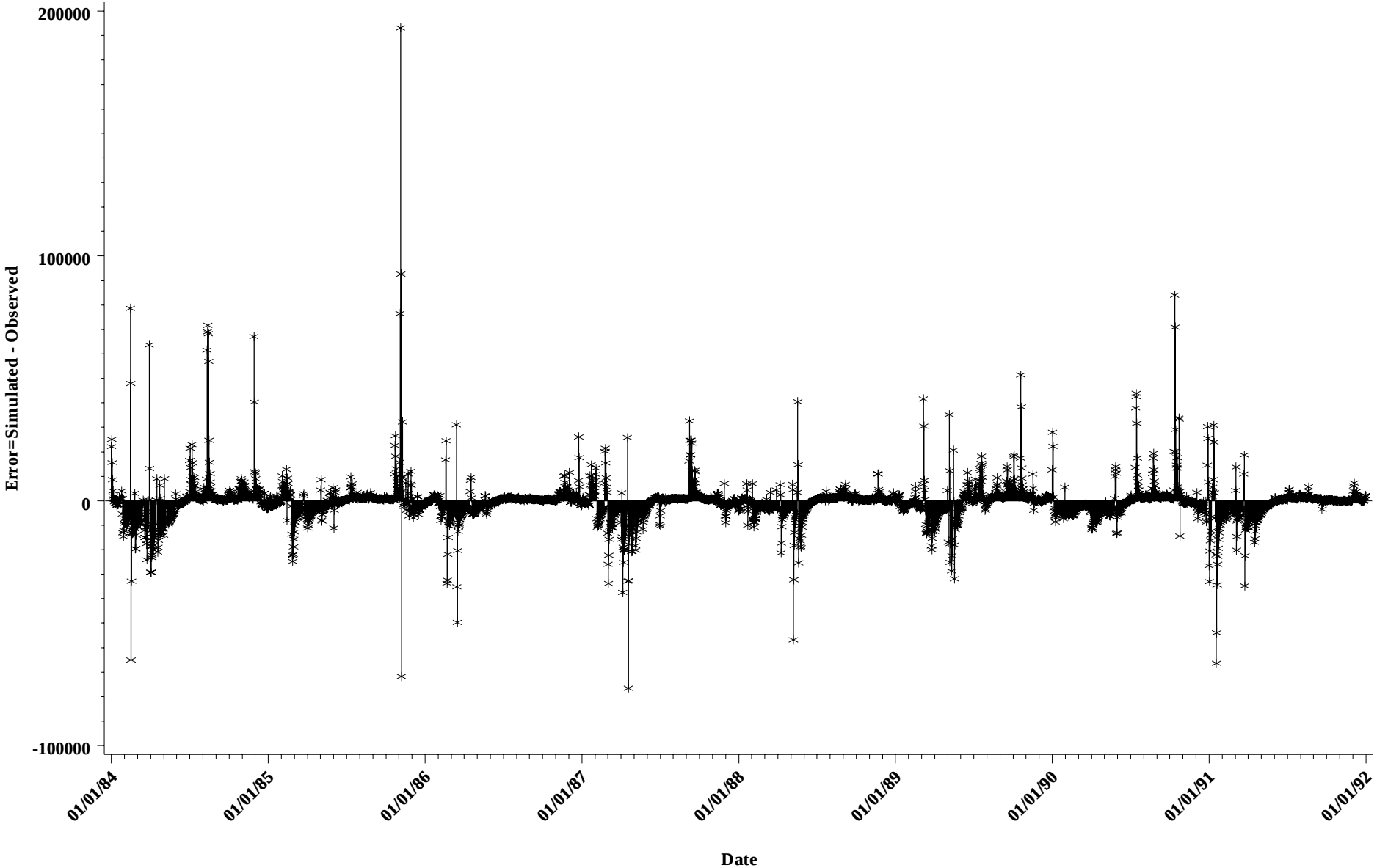
Lower Potomac River at Segment 220
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(lo.drv 15JUN98 16:45)

Lower Potomac River at Segment 220
Actual Error versus Time
Flow-cfs



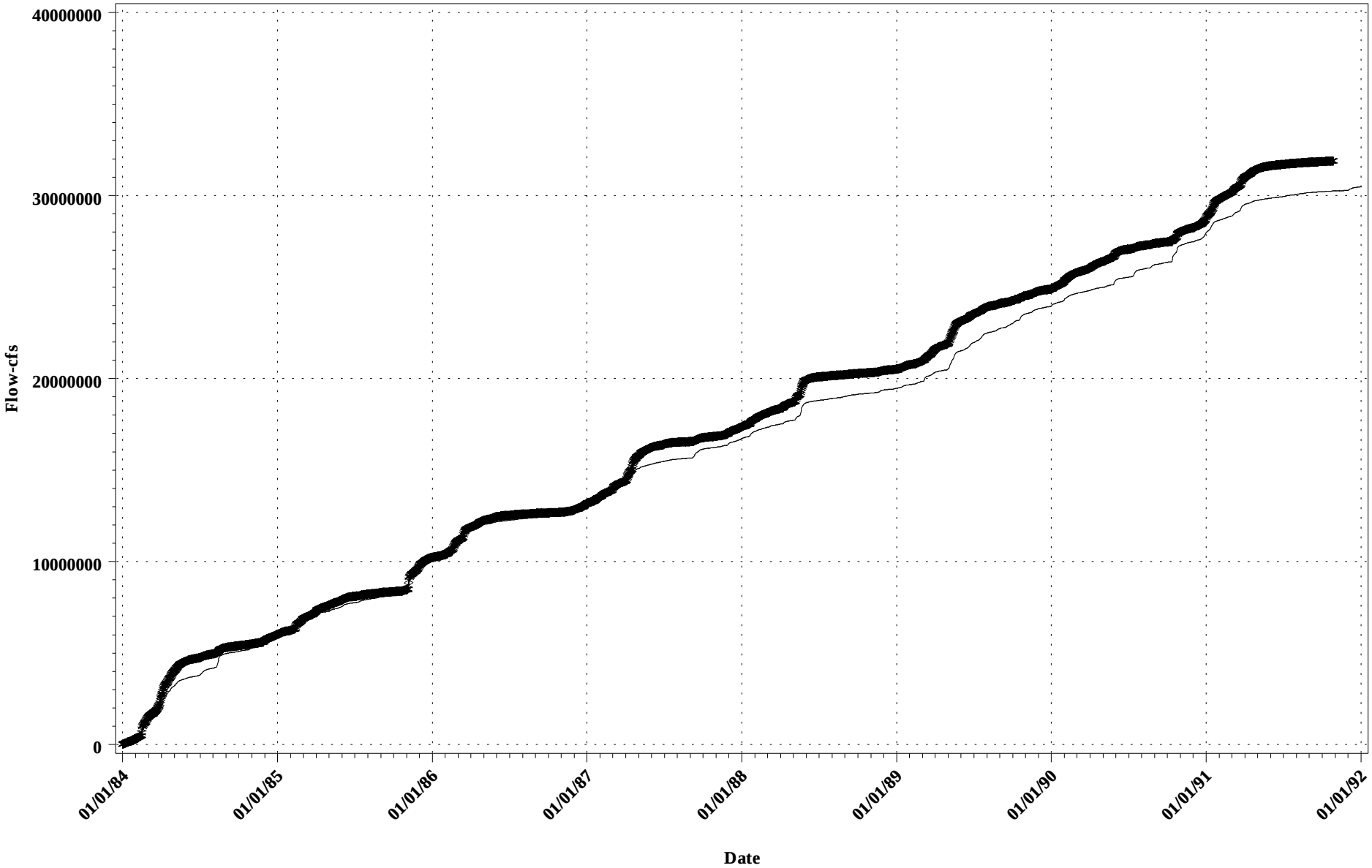
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(lo.drv 15JUN98 16:45)

Lower Potomac River at Segment 220

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

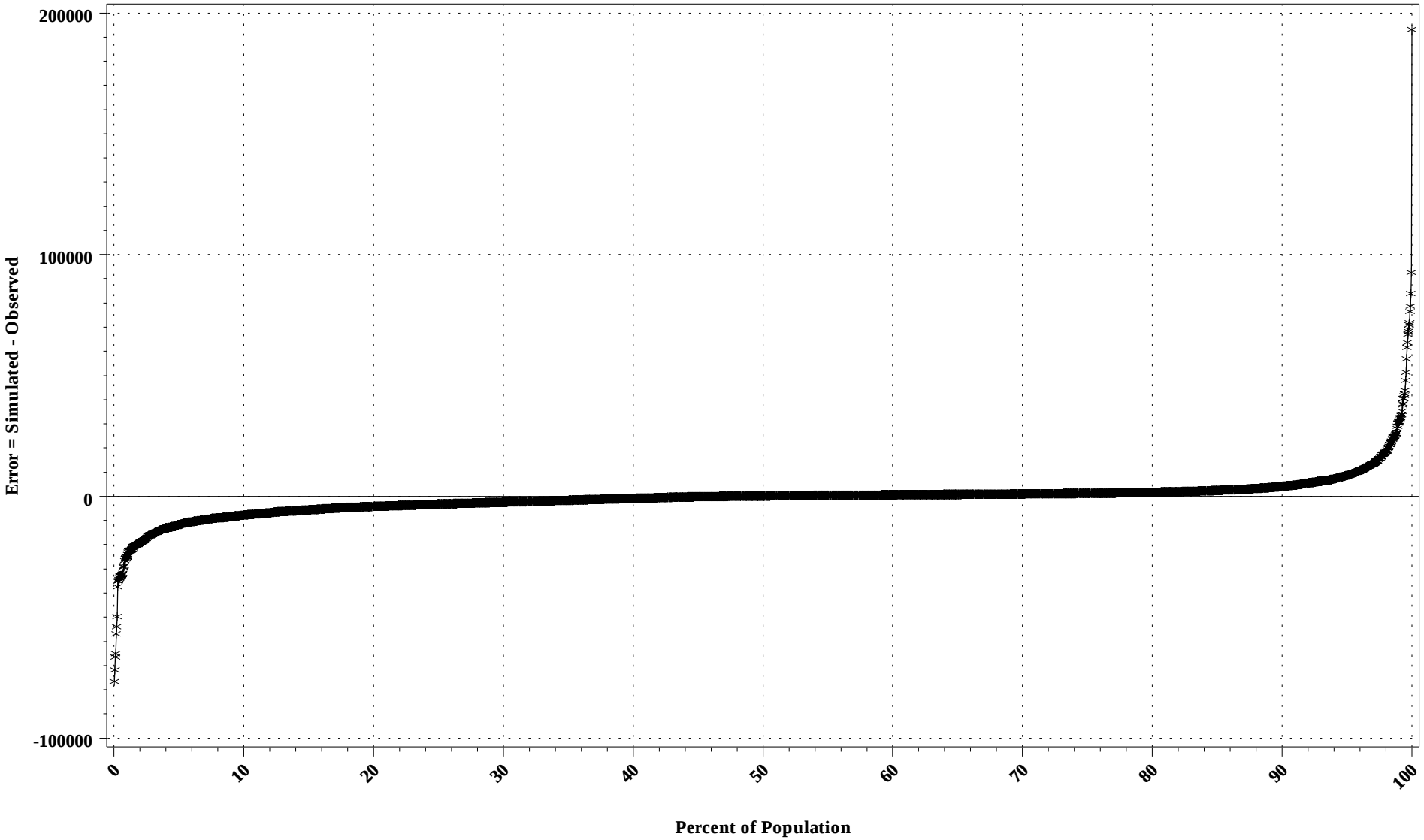
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(lo.drv 15JUN98 16:45)

Lower Potomac River at Segment 220
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

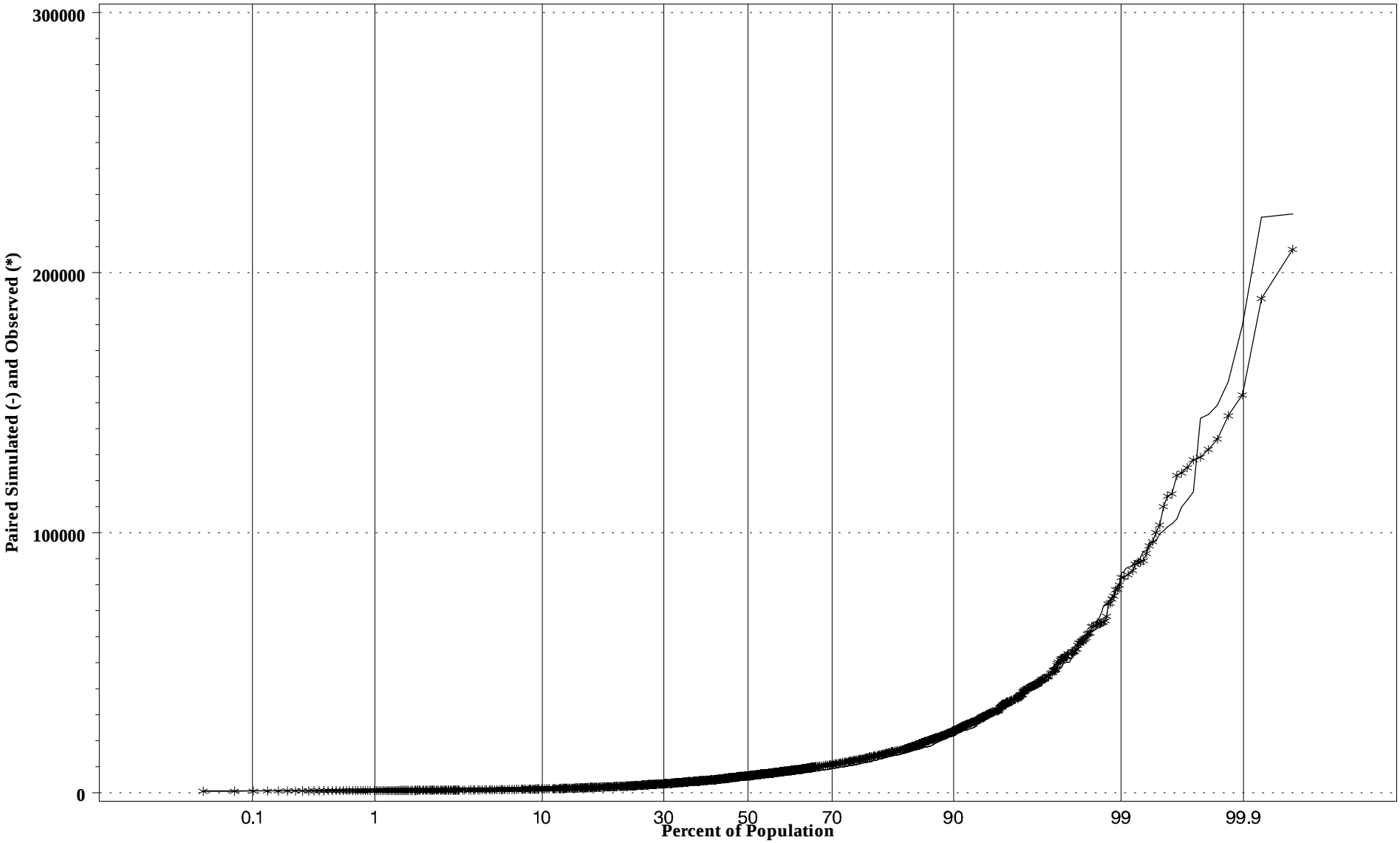


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(lo.drv 15JUN98 16:45)

Lower Potomac River at Segment 220

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

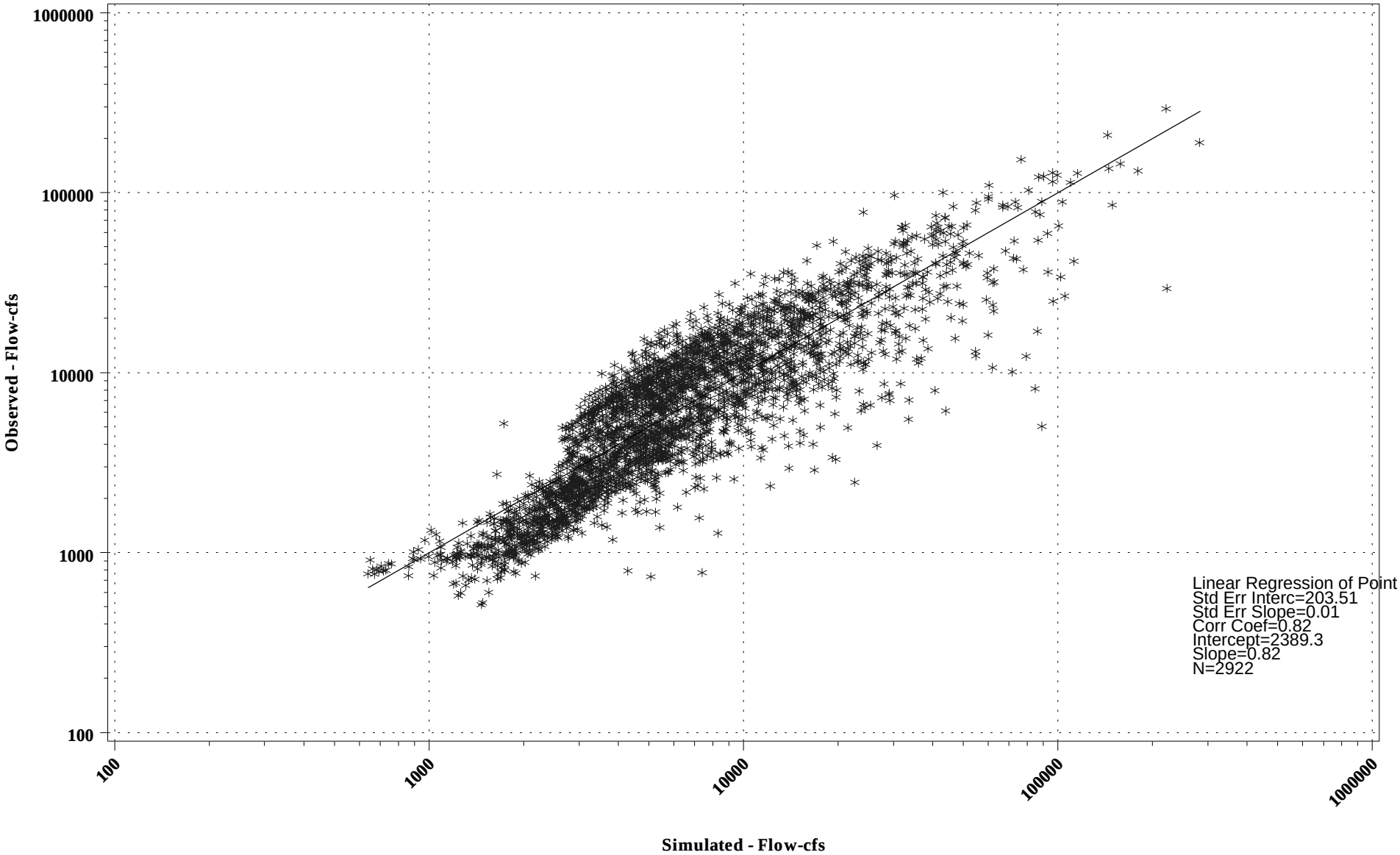


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(lo.drv 15JUN98 16:45)

Lower Potomac River at Segment 220

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(lo.drv 15JUN98 16:45,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
LOWER POTOMAC RIVER (Segments 180, 210 and 220)

Table A.3.3.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	19.38	19.41
1985	13.58	14.22
1986	9.55	8.76
1987	13.47	11.38
1988	10.26	8.85
1989	14.04	14.40
1990	12.27	12.83
1991	10.89	8.22
Mean	12.93	12.26

* Observed flow at Potomac River at Chain Bridge near Washington, D.C.
** Simulated outflow from RCH 220

Table A.3.3.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.76	0.98	0.70	0.61	1.58	0.82
1985	0.78	0.87	0.74	0.72	1.07	0.77
1986	0.77	0.86	0.87	0.74	0.96	0.92
1987	0.68	1.21	0.72	0.98	0.05	0.99
1988	0.68	1.20	0.78	0.63	1.38	0.00
1989	0.78	0.88	0.63	0.67	1.31	0.00
1990	0.74	1.01	0.56	0.39	2.35	0.00
1991	0.66	1.22	0.80	0.25	2.77	0.00
1984-1991	0.73	1.03	0.73	0.62	1.43	0.44

Table A.3.3.3 Seasonal r-sqaured.

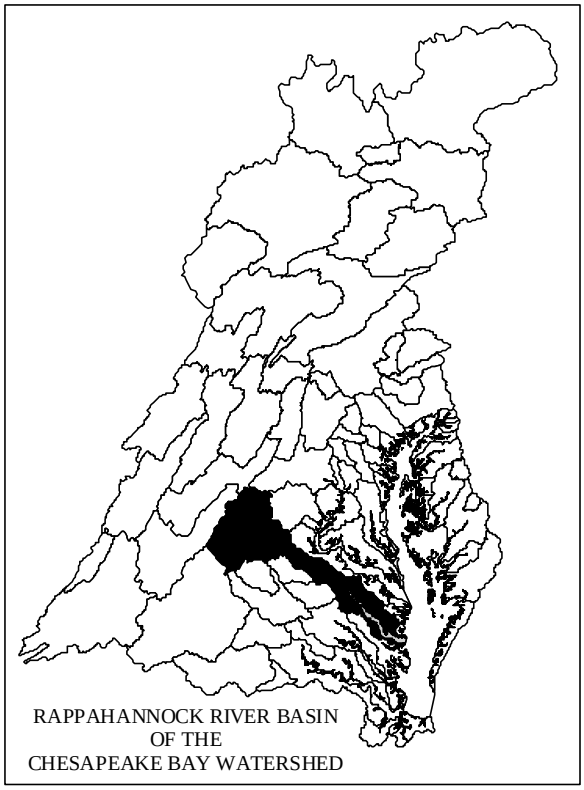
	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	1.37	-1.89	0.88	1.91	-1.03	0.89	1.32	-1.06	0.82	0.84	0.77	0.69
1985	0.79	0.82	0.69	0.93	0.07	0.65	0.78	0.90	0.83	0.86	0.66	0.81
1986	0.82	0.70	0.90	1.08	-0.50	0.90	0.54	1.63	0.72	0.99	0.18	0.93
1987	0.89	0.44	0.39	1.04	-0.47	0.89	0.82	0.78	0.77	0.83	0.79	0.99
1988	0.20	3.08	0.22	0.86	0.41	0.75	0.48	1.91	0.61	1.04	-0.02	0.84
1989	0.84	0.54	0.69	1.16	-0.86	0.83	0.81	0.84	0.68	0.98	0.23	0.74
1990	0.65	1.33	0.26	0.95	-0.04	0.58	0.86	0.64	0.66	0.90	0.47	0.72
1991	0.91	0.17	0.69	1.00	-0.19	0.87	0.54	1.68	0.46	0.60	1.35	0.56
1984-1991	0.79	0.78	0.65	1.00	-0.18	0.83	0.83	0.76	0.79	0.94	0.32	0.86

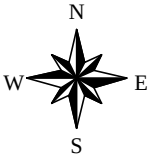
Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

Figure A.4

Monitoring Stations

Chesapeake Bay Watershed
Phase IV Model Segments:
Rappahannock River Basin





KAG Map Date: January 1998

Source: USGS and Chesapeake Bay Program Modeling Team

A.4 RAPPAHANNOCK RIVER NEAR FREDERICKSBURG, VA AT SEGMENT 230 (1668000)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

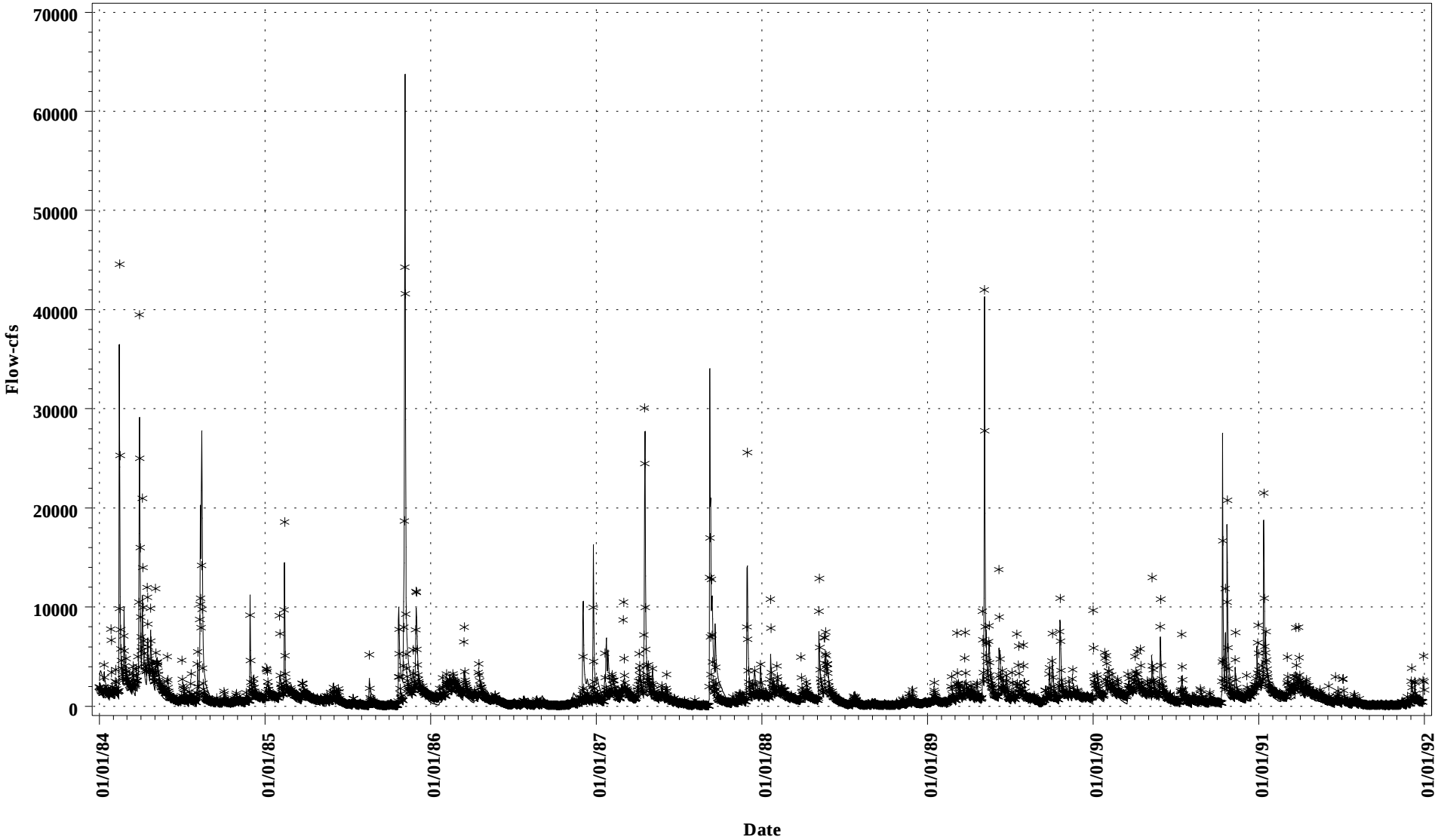
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

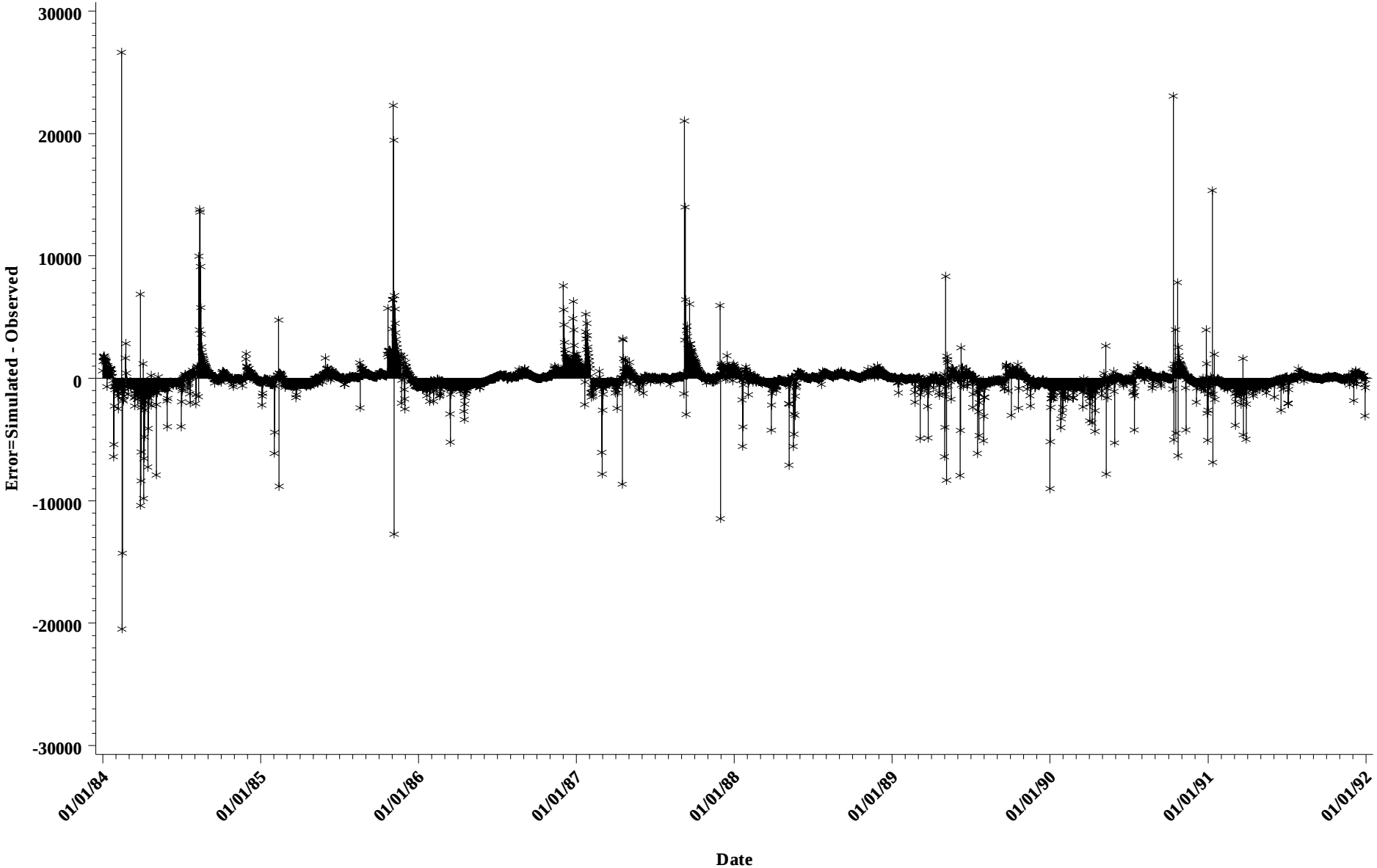
Rappahannock River at Segment 230
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(rap.drv 15JUN98 09:14)

Rappahannock River at Segment 230
Actual Error versus Time
Flow-cfs



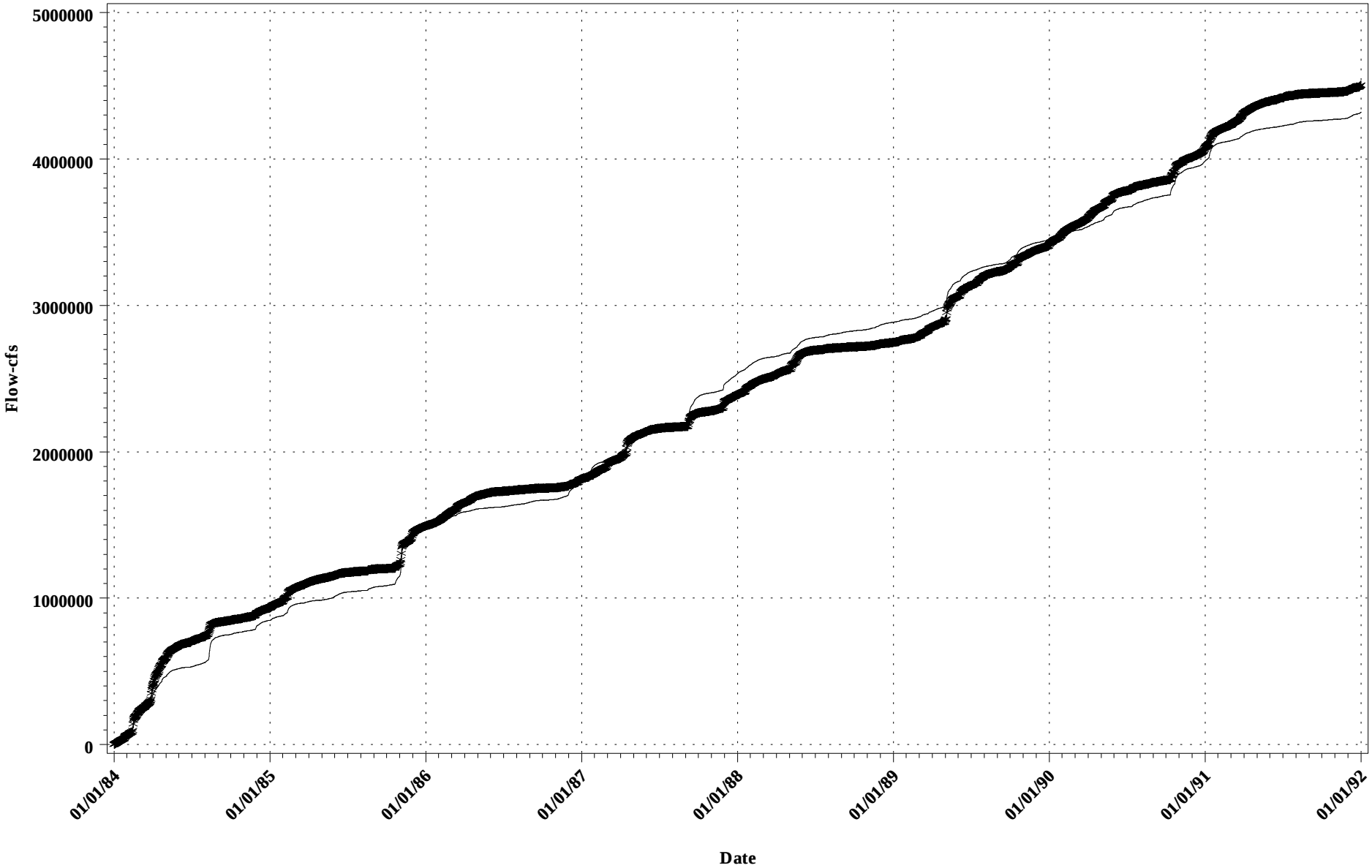
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(rap.drv 15JUN98 09:14)

Rappahannock River at Segment 230

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

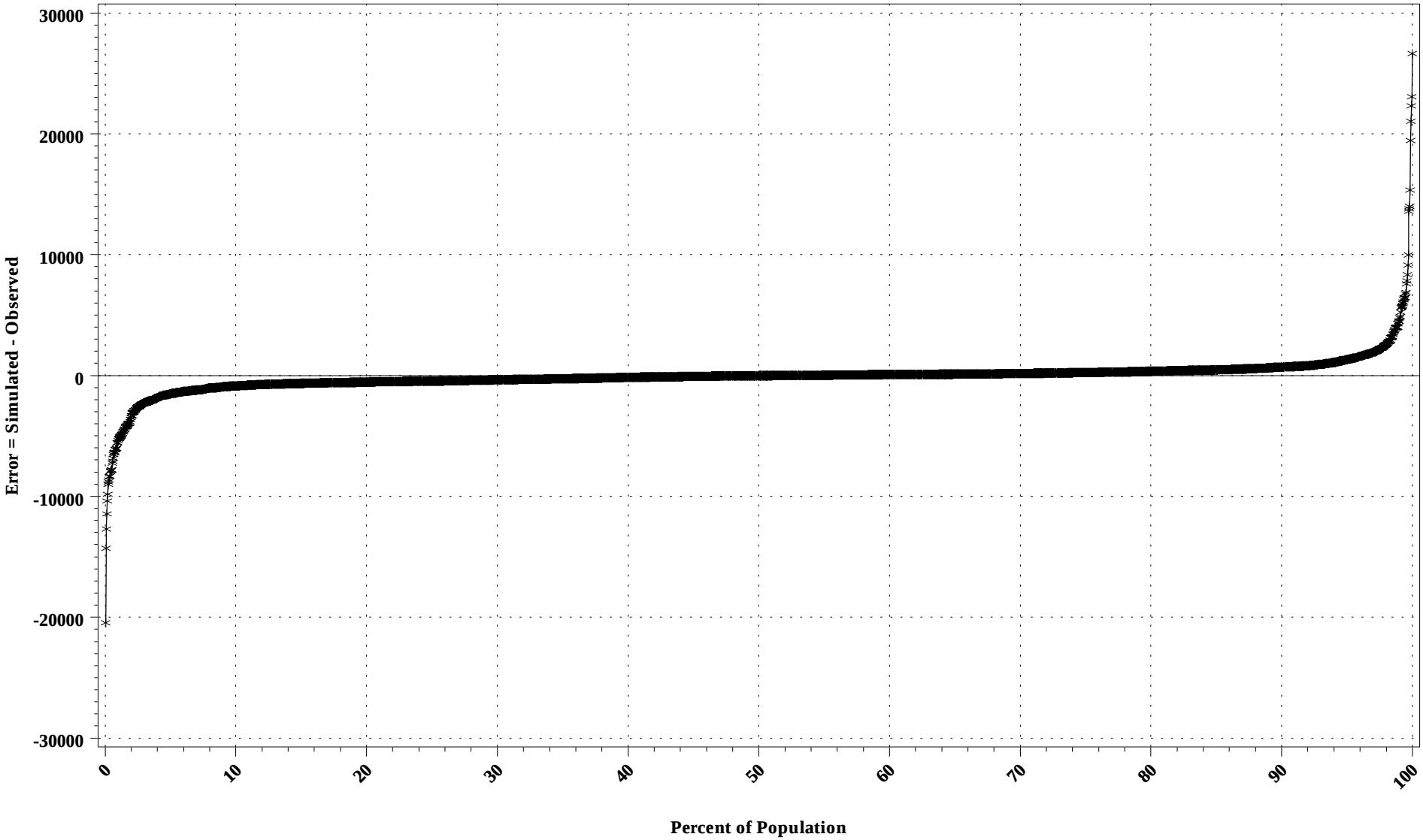
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(rap.drv 15JUN98 09:14)

Rappahannock River at Segment 230
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

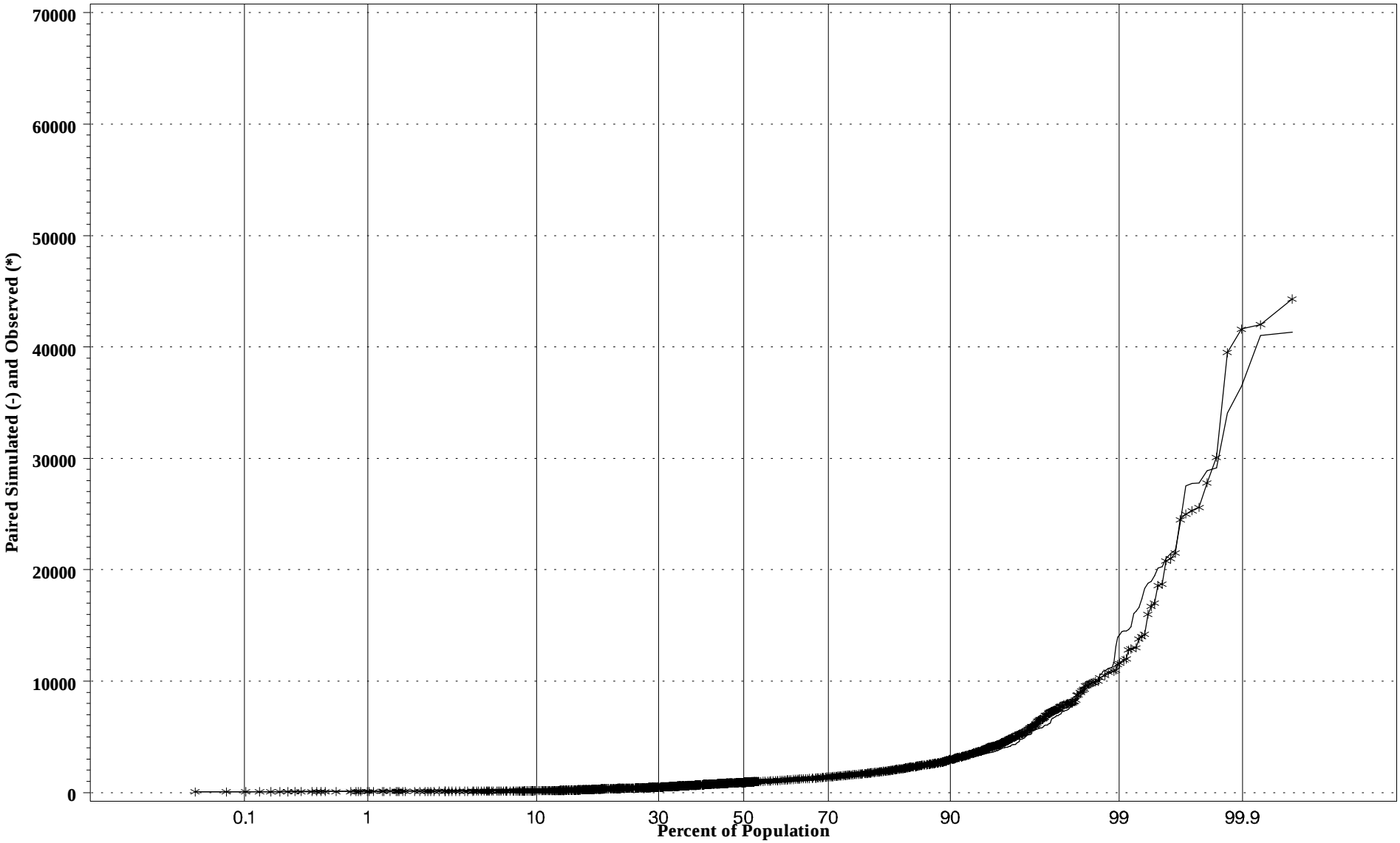


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(rap.drv 15JUN98 09:14)

Rappahannock River at Segment 230

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

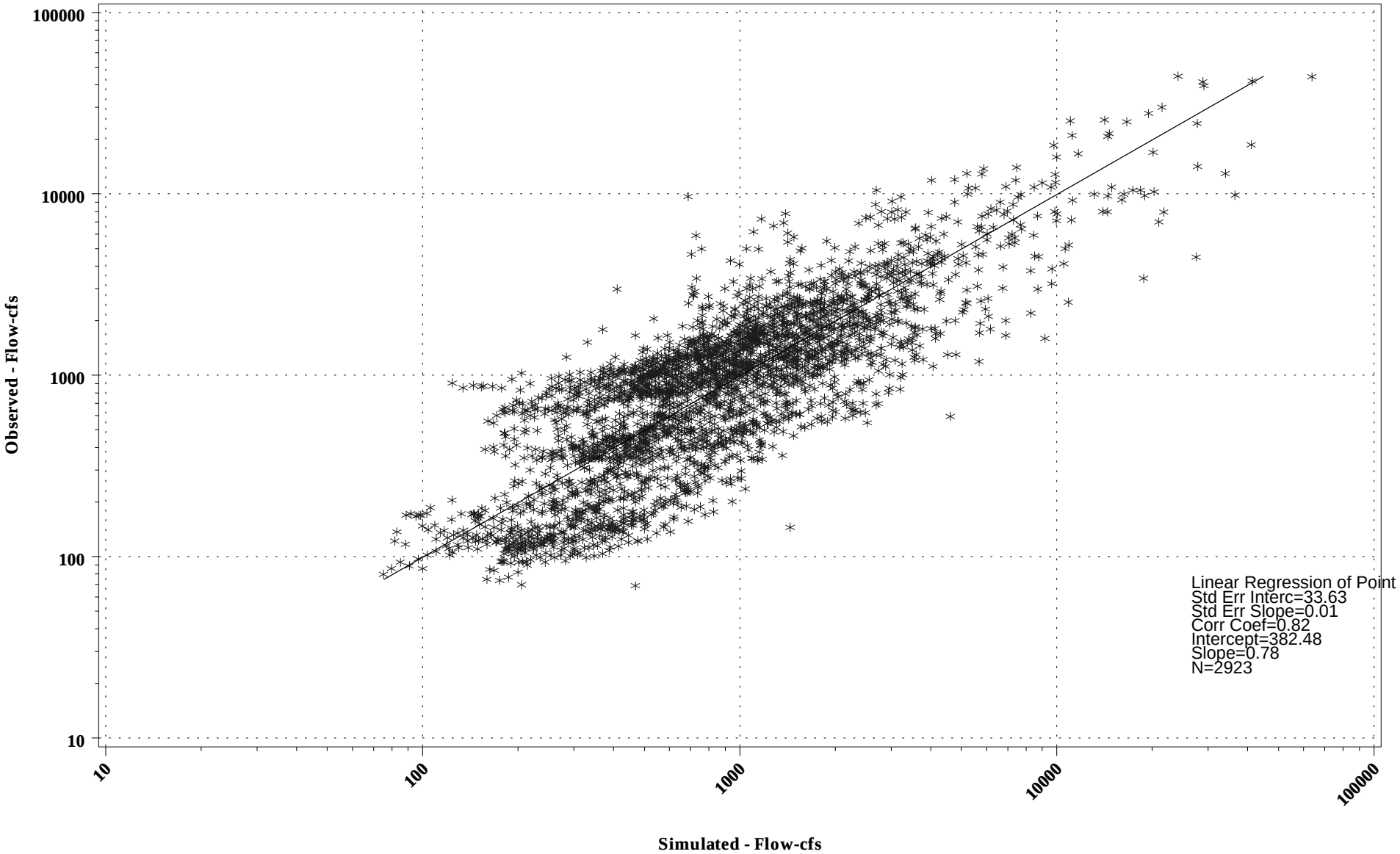


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(rap.drv 15JUN98 09:14)

Rappahannock River at Segment 230

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(rap.drv 15JUN98 09:14,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
RAPPAHANNOCK RIVER, VA (Segments 230)

Table A.4.1.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	21.77	19.77
1985	13.05	15.07
1986	7.48	7.64
1987	13.43	16.53
1988	8.31	8.21
1989	15.36	13.04
1990	15.51	12.60
1991	10.04	7.74
Mean	13.12	12.58

* Observed flow at Rappahannock River near Fredericksburg, VA
** Simulated outflow from RCH 230

Table A.4.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.85	0.44	0.72	0.85	0.43	0.79
1985	0.72	0.85	0.63	0.66	1.03	0.58
1986	0.57	1.20	0.41	0.53	1.31	0.39
1987	0.87	0.47	0.77	0.90	0.38	0.78
1988	0.59	1.24	0.65	0.54	1.37	0.70
1989	0.89	0.27	0.73	1.18	-0.62	0.86
1990	0.55	1.30	0.44	0.06	2.87	0.10
1991	0.71	0.77	0.77	0.71	0.75	0.82
1984-1991	0.72	0.82	0.64	0.68	0.94	0.63

Table A.4.1.3 Seasonal r-squared.

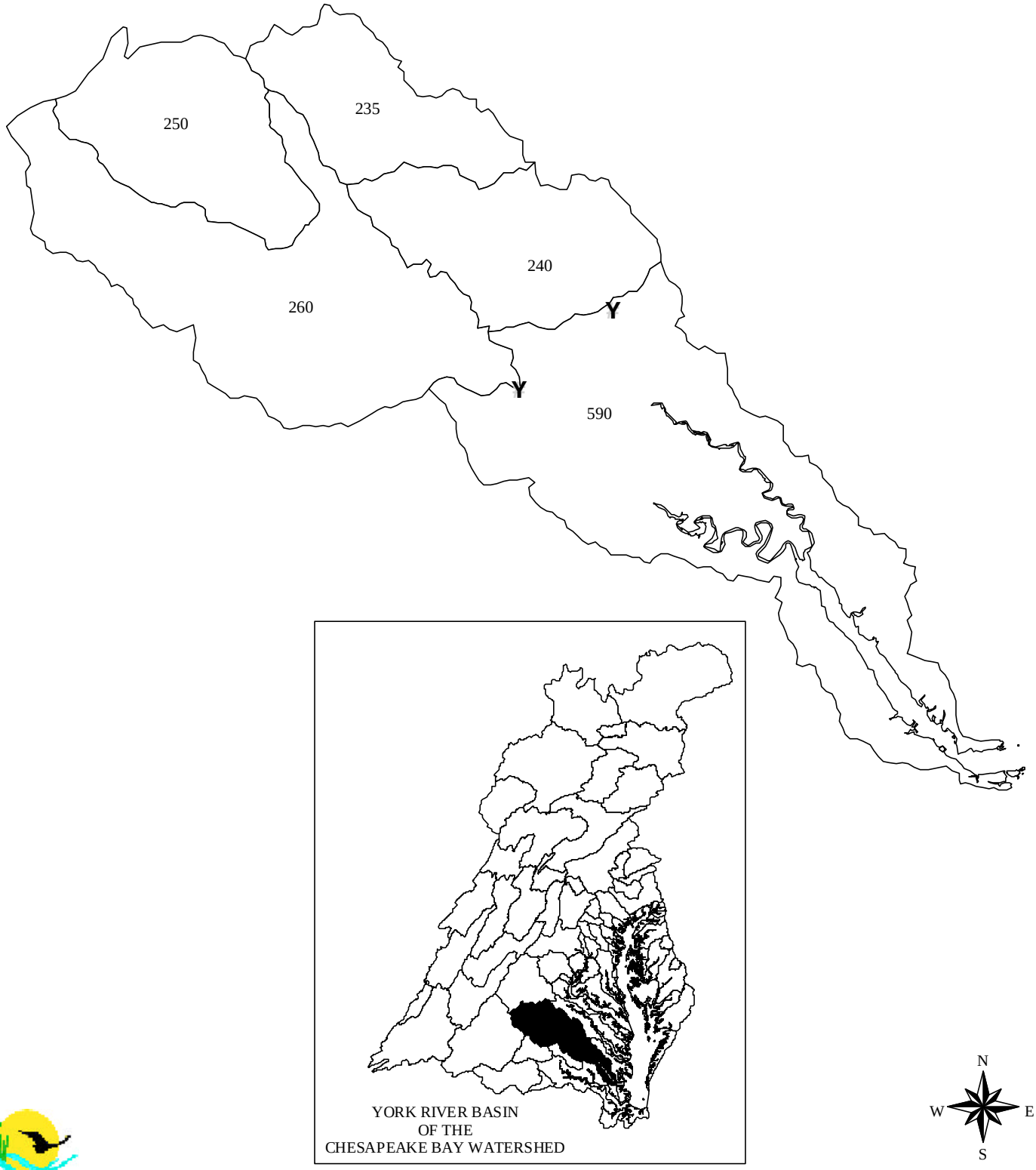
	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.71	0.93	0.46	1.05	0.36	0.89	0.92	0.22	0.55	0.97	0.10	0.76
1985	0.99	-0.06	0.80	0.65	0.76	0.18	0.78	0.77	0.71	0.73	1.05	0.78
1986	1.82	-2.92	0.77	1.06	-0.51	0.84	0.27	1.94	0.05	1.19	-0.14	0.93
1987	0.32	2.23	0.08	1.01	-0.09	0.81	0.96	0.23	0.85	0.90	0.45	0.75
1988	0.62	1.24	0.58	1.02	-0.29	0.77	0.59	1.26	0.64	0.87	0.61	0.73
1989	0.67	0.87	0.80	0.90	0.28	0.80	0.80	0.51	0.61	1.06	0.27	0.61
1990	0.49	1.39	0.34	0.89	0.15	0.59	0.39	1.81	0.35	0.87	0.42	0.60
1991	1.32	-1.20	0.86	0.95	-0.13	0.78	0.60	1.03	0.54	0.81	0.59	0.83
1984-1991	0.82	0.47	0.51	1.04	-0.32	0.77	0.72	0.85	0.64	0.82	0.63	0.76

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

Figure A.5

Monitoring Stations

Chesapeake Bay Watershed
Phase IV Model Segments:
York River Basin



KAG Map Date: January 1998

Source: USGS and Chesapeake Bay Program Modeling Team

A.5.1 MATTAPONI RIVER NEAR BEULAHVILLE, VA AT SEGMENT 240 (1674500)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

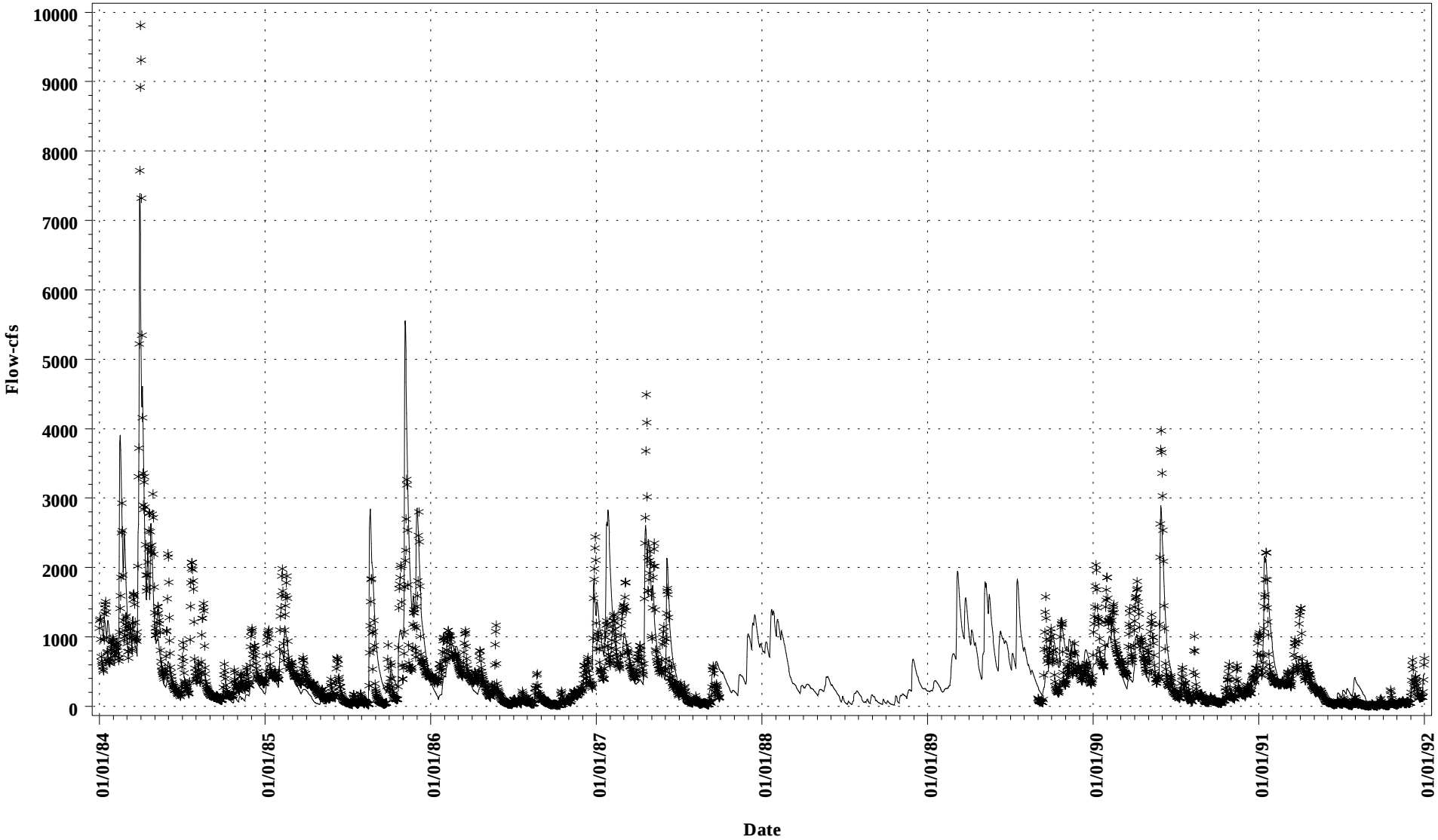
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

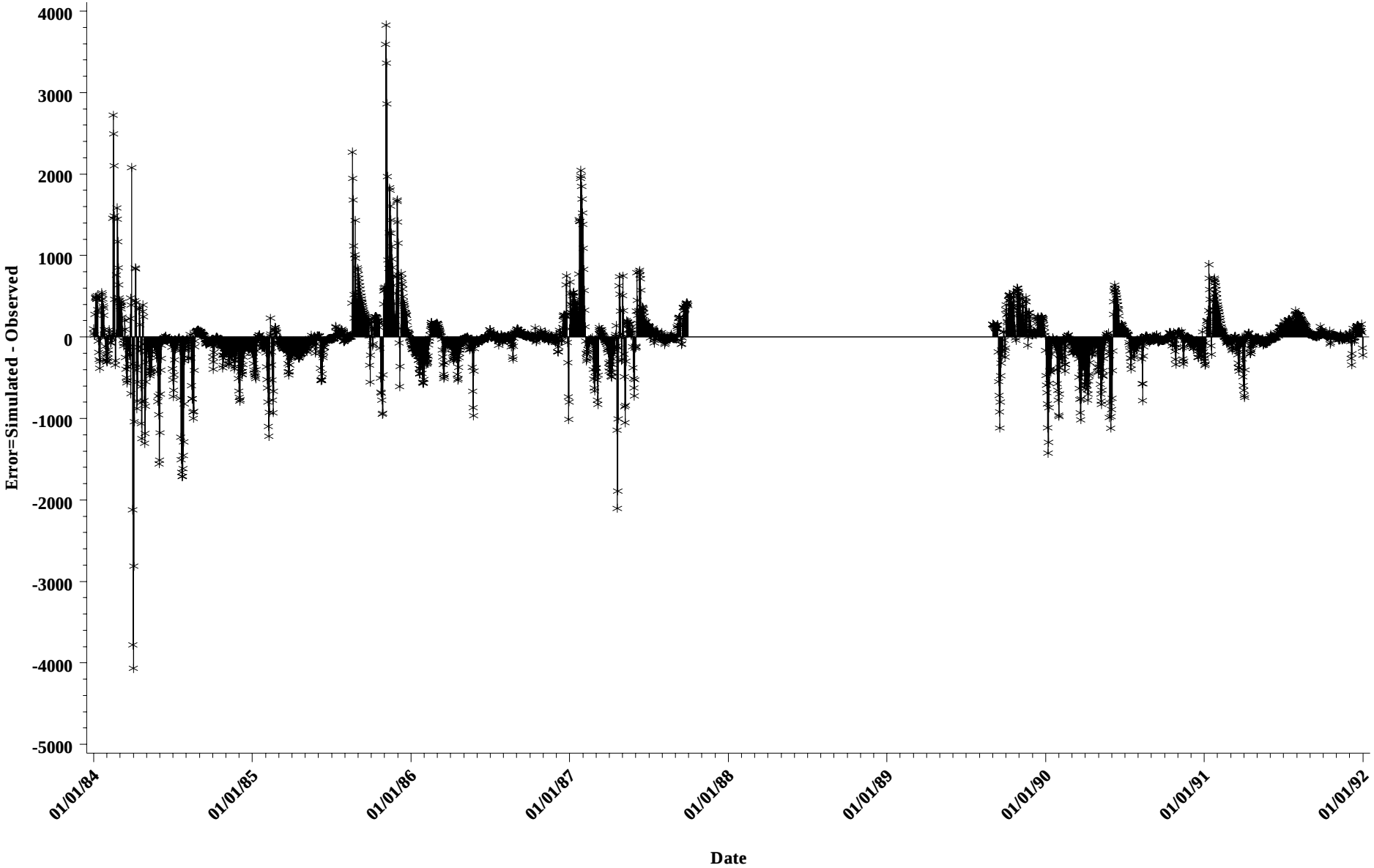
Mattaponi River at Segment 240
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(matta240.drv 15JUN98 09:46)

Mattaponi River at Segment 240
Actual Error versus Time
Flow-cfs



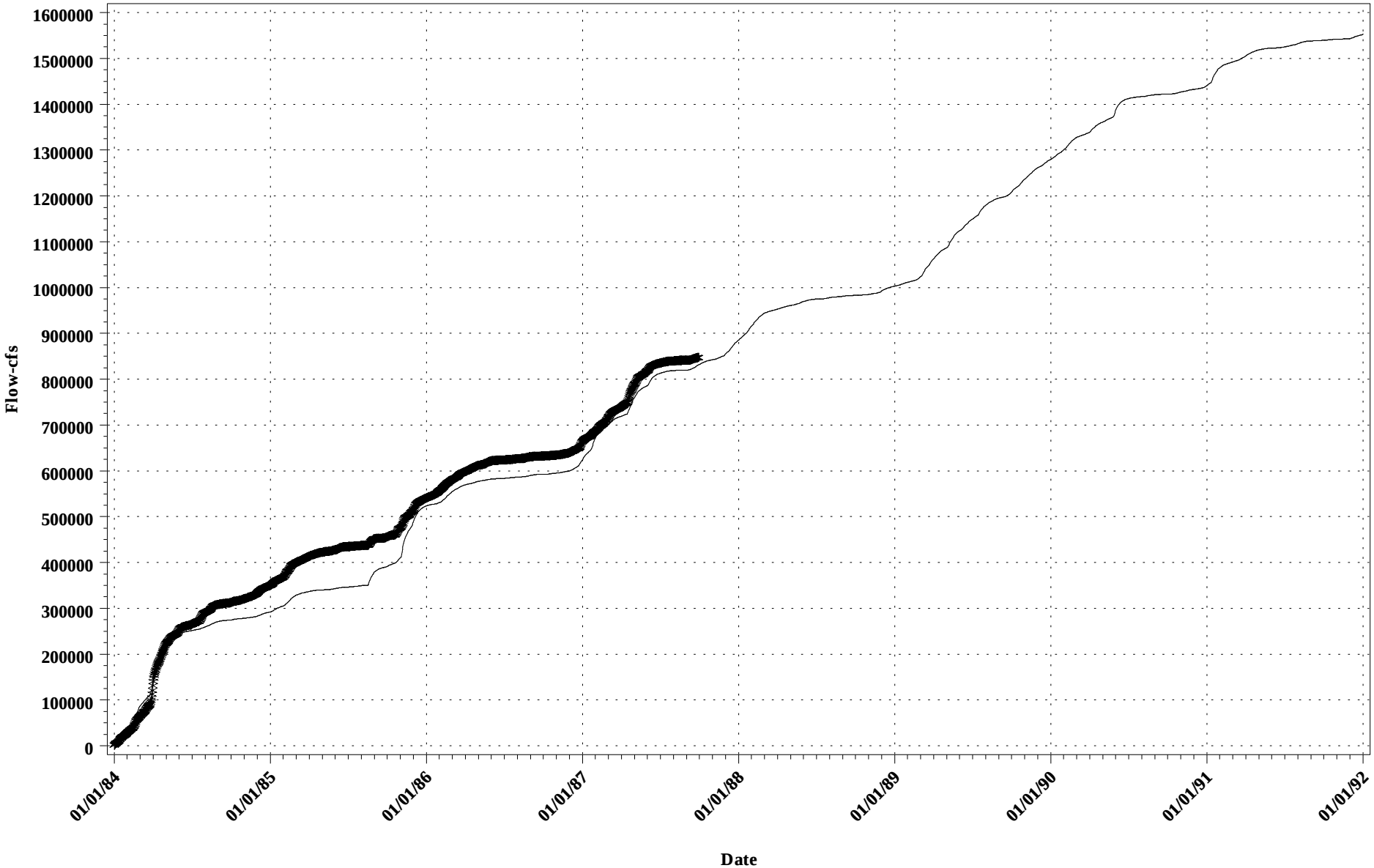
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(matta240.drv 15JUN98 09:46)

Mattaponi River at Segment 240

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

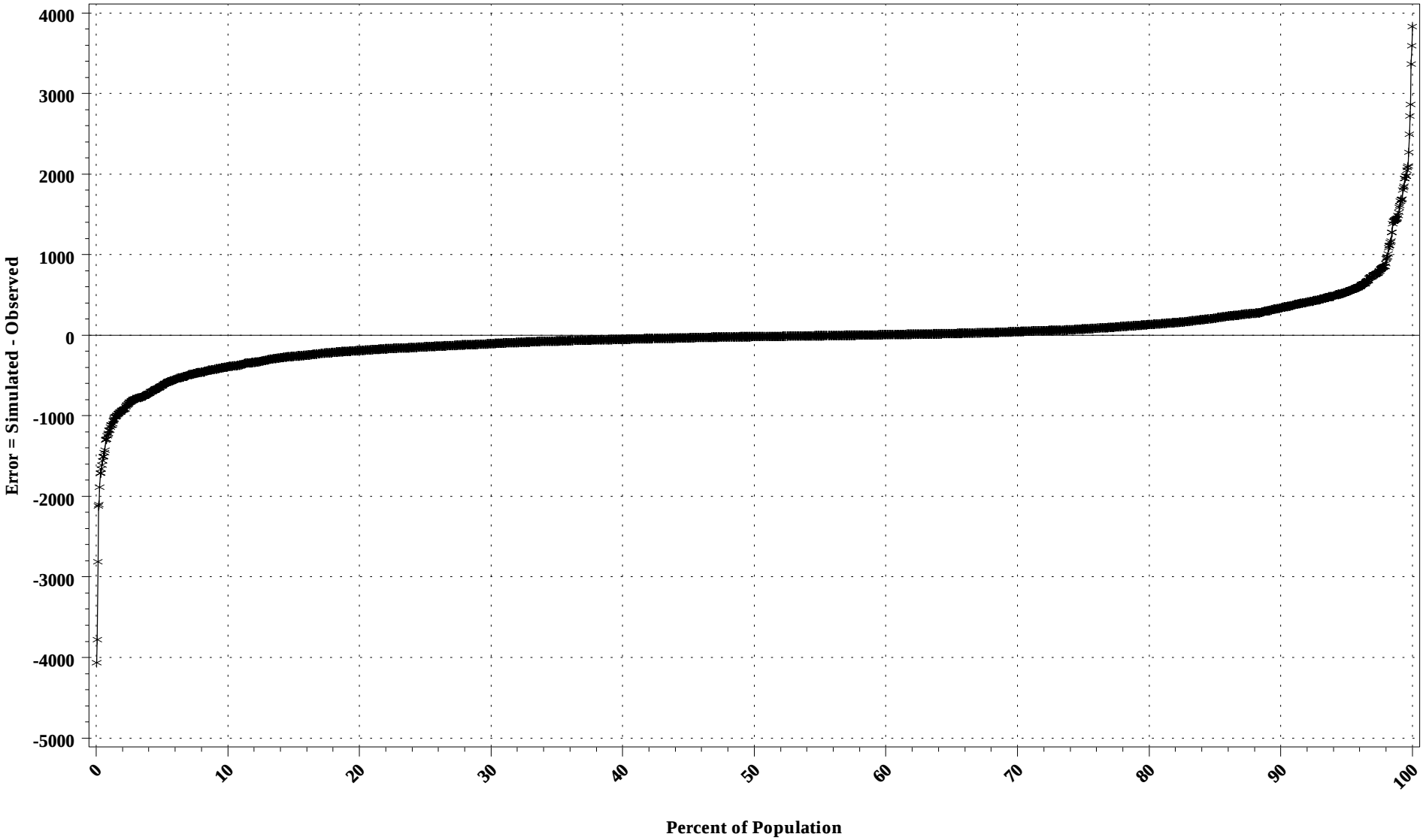
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(matta240.drv 15JUN98 09:46)

Mattaponi River at Segment 240
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

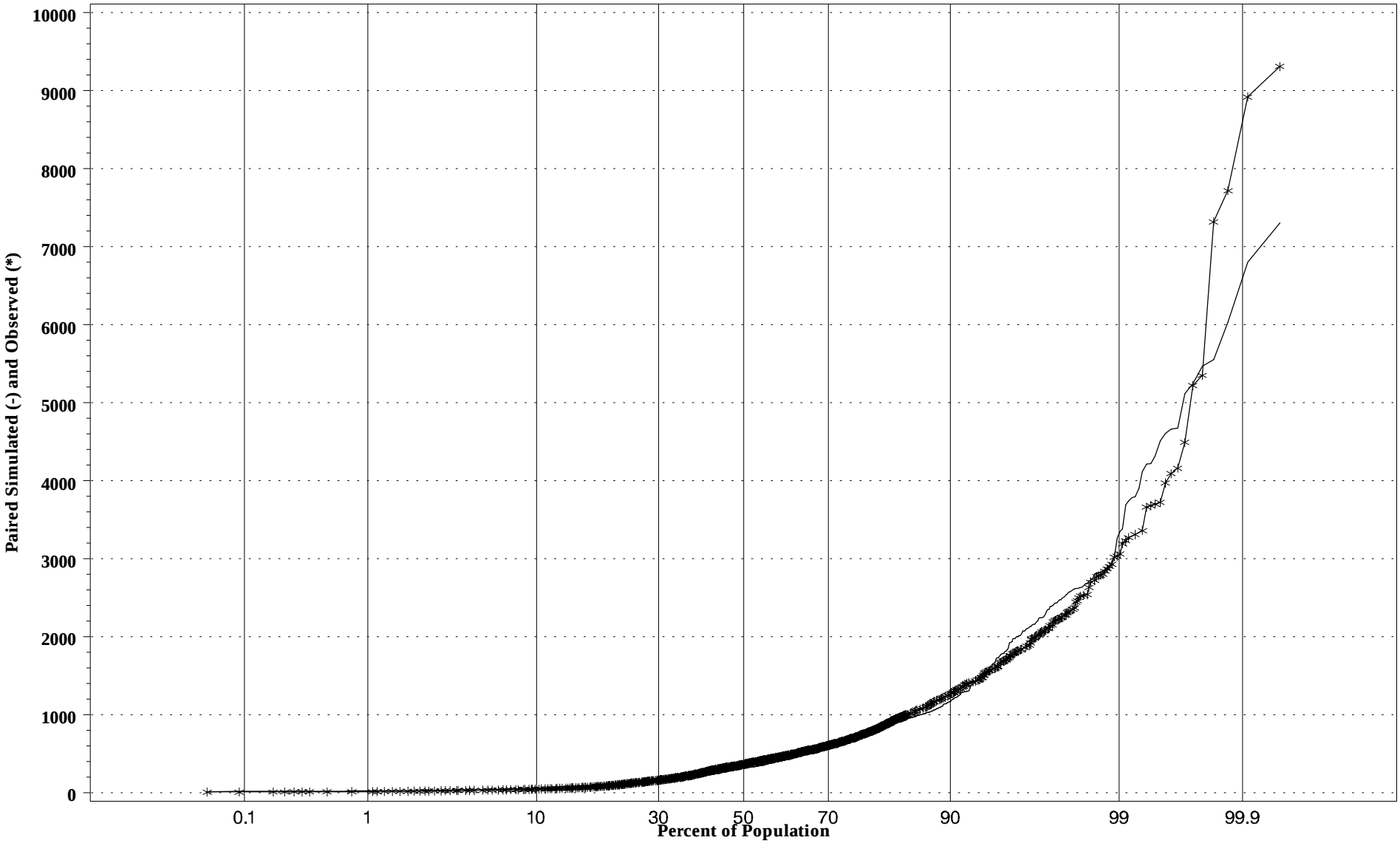


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(matta240.drv 15JUN98 09:46)

Mattaponi River at Segment 240

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

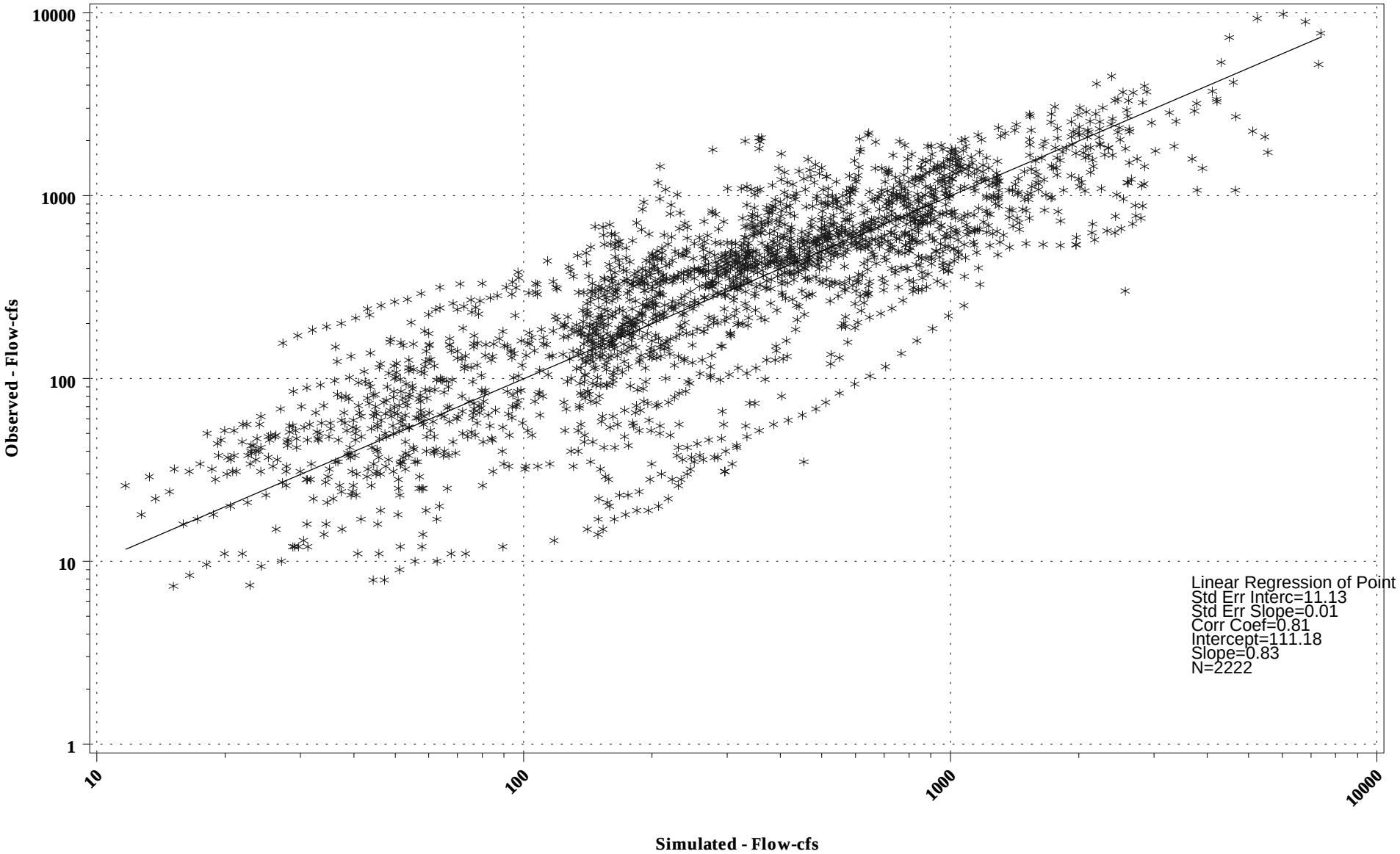


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(matta240.drv 15JUN98 09:46)

Mattaponi River at Segment 240

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(matta240.drv 15JUN98 09:46,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
MATTAPONI RIVER, VA (Segments 235 and 240)

Table A.5.1.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	21.65	18.21
1985	11.81	14.77
1986	7.57	6.52
1987	0.00	16.19
1988	0.00	7.65
1989	0.00	17.75
1990	13.59	10.76
1991	5.99	7.45
Mean	12.12	11.54+

* Observed flow at Mattaponi River at Beulahville, VA
** Simulated outflow from RCH 240
\+ Using only 1984, 1985, 1986. 1990, and 1991 years.

Table A.5.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	1.05	-0.28	0.76	1.23	-0.78	0.89
1985	0.83	0.42	0.56	0.89	0.27	0.57
1986	0.82	0.35	0.83	0.85	0.28	0.89
1987	0.94	0.22	0.80	1.01	0.02	0.99
1988	0.00	0.00	0.00	0.00	0.00	0.00
1989	1.05	0.01	0.99	1.06	0.00	1.00
1990	0.93	0.05	0.83	1.02	-0.18	0.92
1991	0.65	0.90	0.67	0.66	0.89	0.71
1984-1991	0.78	0.21	0.68	0.84	0.06	0.75

Table A.5.1.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	1.11	-0.23	0.49	0.99	-0.06	0.84	0.57	0.90	0.55	0.87	0.01	0.63
1985	0.68	0.78	0.65	1.16	-0.72	0.57	0.77	0.65	0.43	0.74	0.93	0.64
1986	1.51	1.60	0.62	0.67	0.70	0.46	0.73	0.51	0.56	0.94	0.16	0.92
1987	0.31	2.51	0.06	0.90	0.20	0.72	1.12	-0.17	0.80	0.00	0.00	0.00
1988	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1989	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.02	0.97	0.37	1.87	0.33
1990	0.39	1.72	0.34	0.72	0.63	0.62	1.03	-0.16	0.74	0.94	0.02	0.77
1991	0.94	0.27	0.71	1.01	-0.15	0.89	0.65	1.04	0.27	0.79	0.49	0.75
1984-1991	0.84	0.44	0.41	1.09	-0.40	0.83	0.64	0.83	0.51	0.90	0.26	0.74

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.5.2 PAMUNKEY RIVER NEAR HANOVER, VA AT SEGMENT 260 (1673000)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

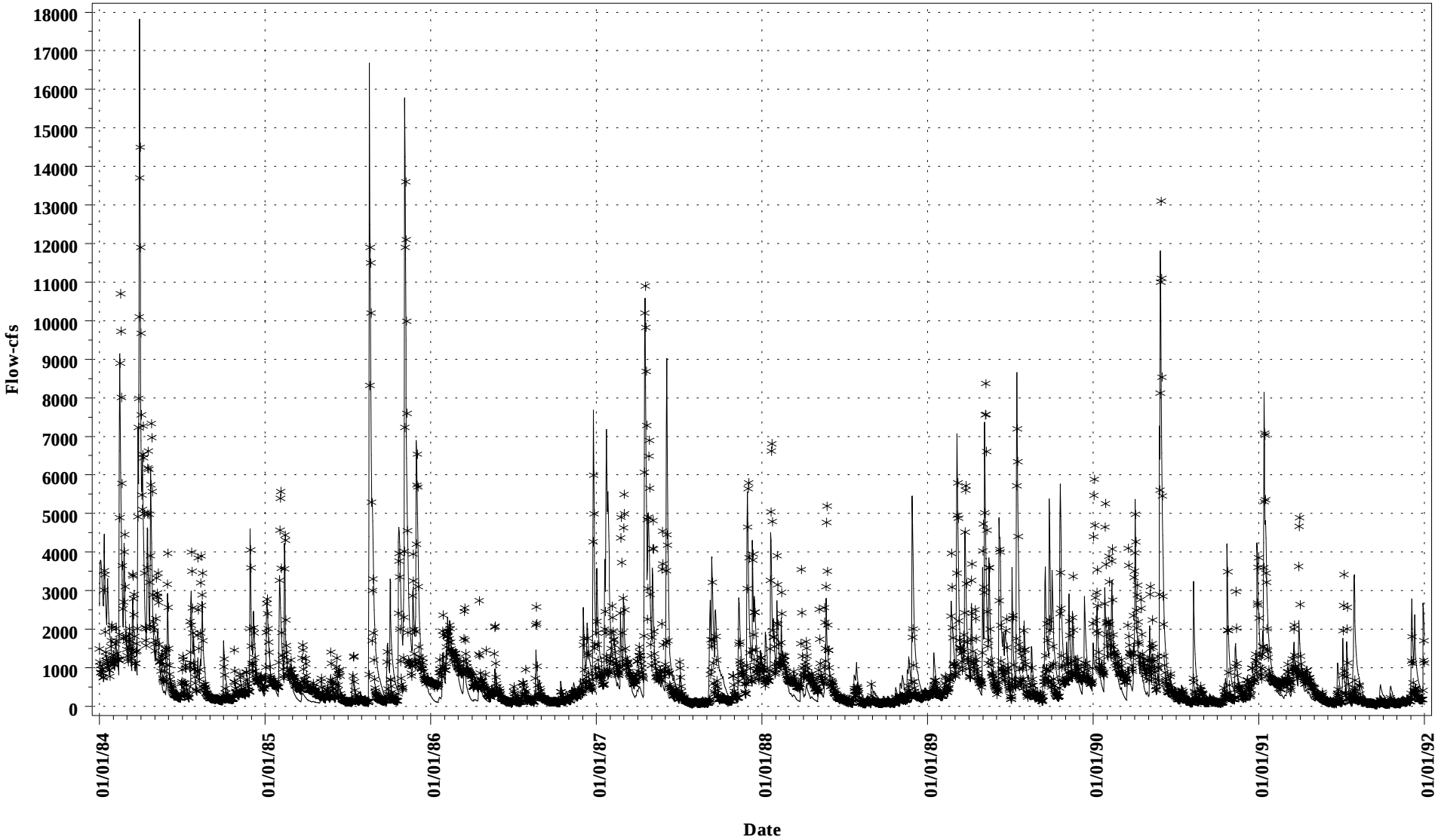
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

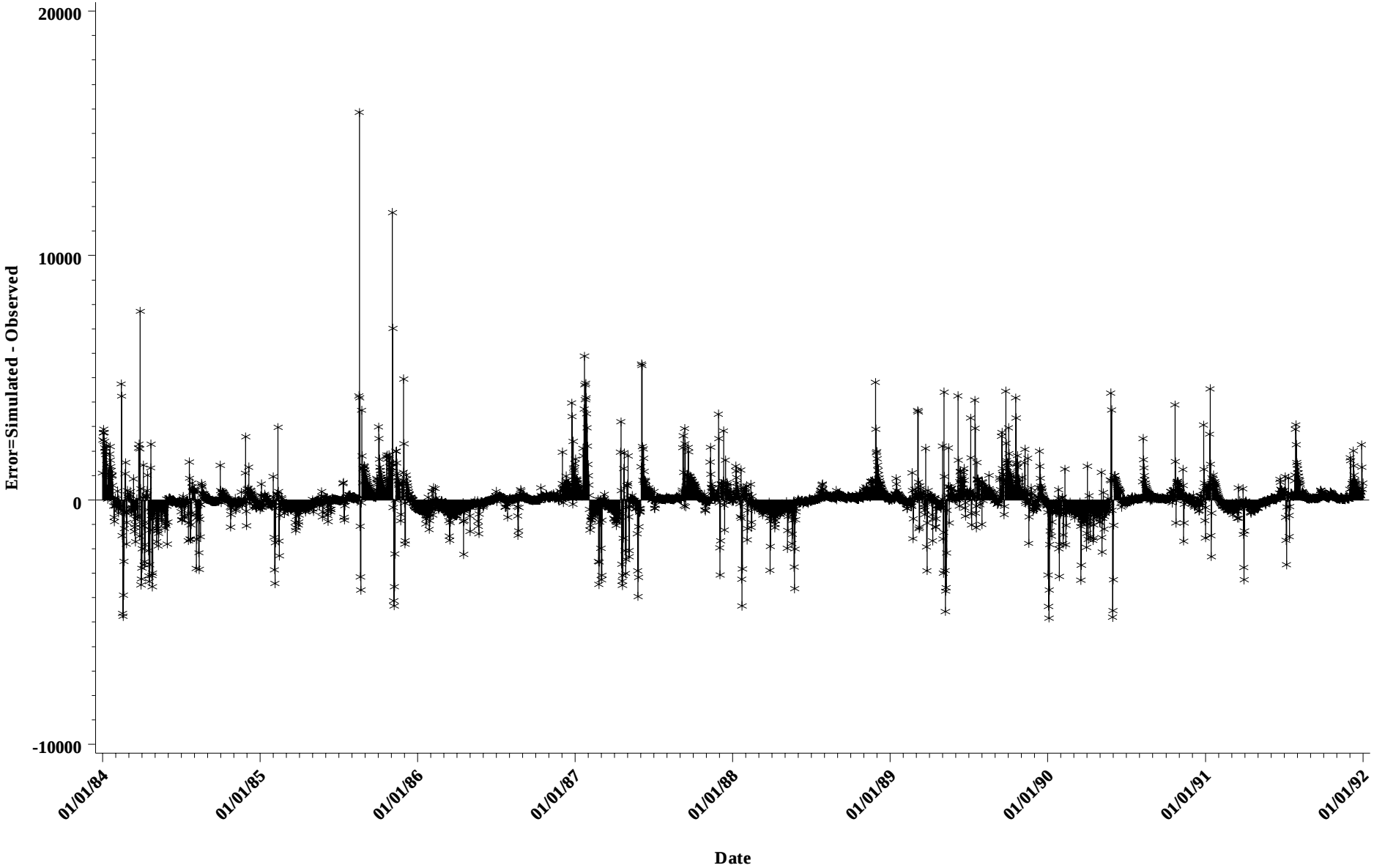
Pamunkey River at Segment 260
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(pamun260.drv 15JUN98 10:08)

Pamunkey River at Segment 260
Actual Error versus Time
Flow-cfs



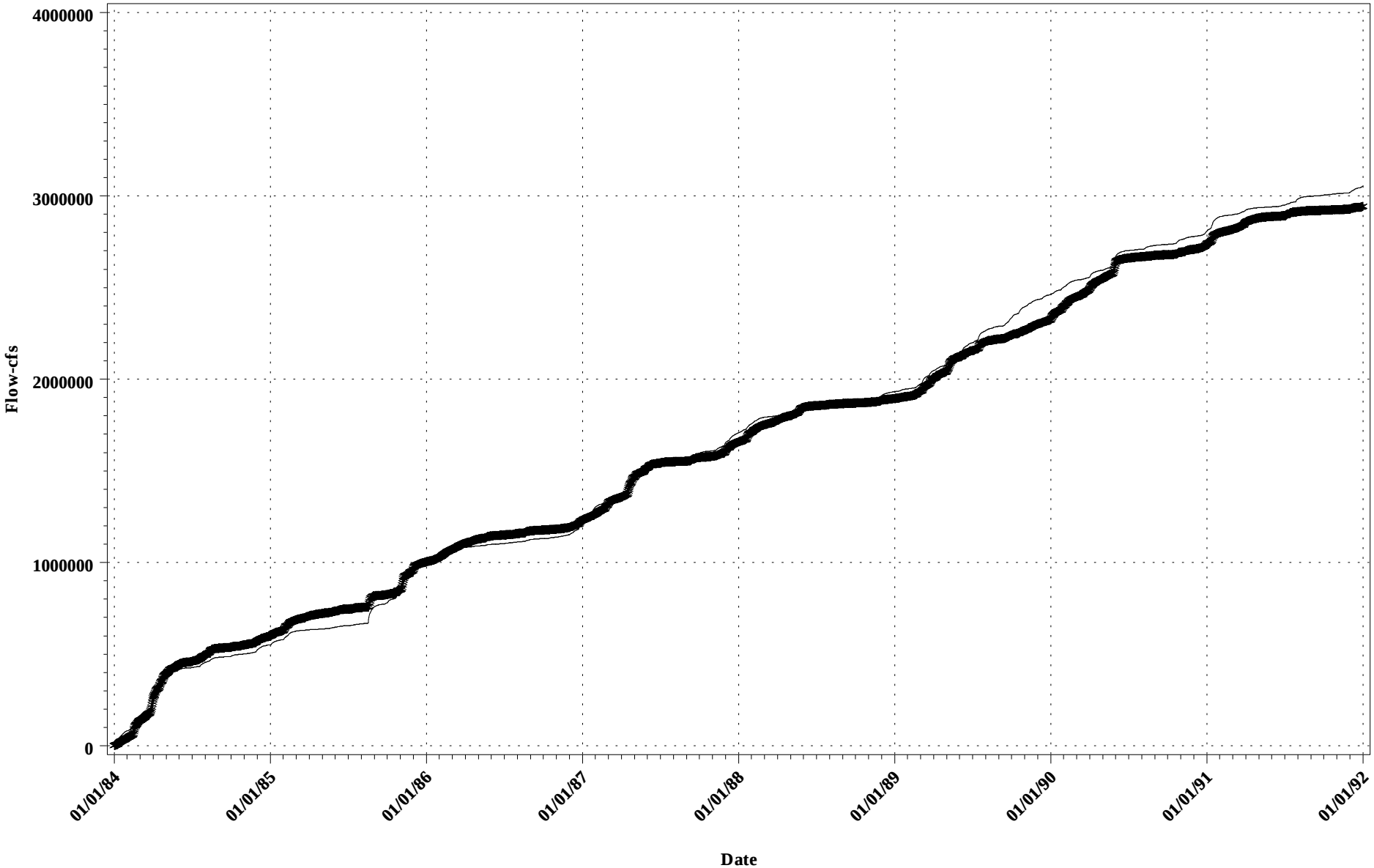
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(pamun260.drv 15JUN98 10:08)

Pamunkey River at Segment 260

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

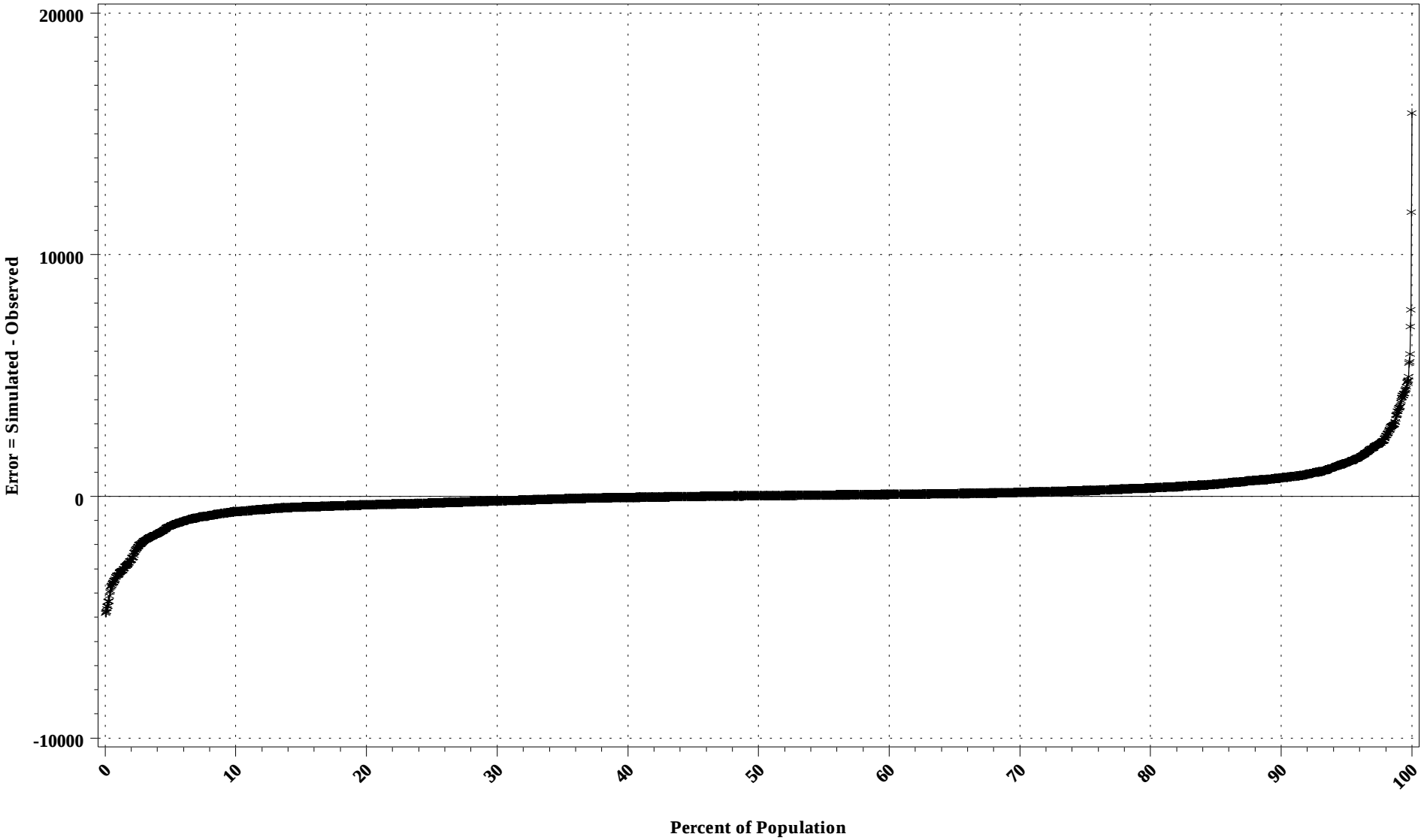
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(pamun260.drv 15JUN98 10:08)

Pamunkey River at Segment 260
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

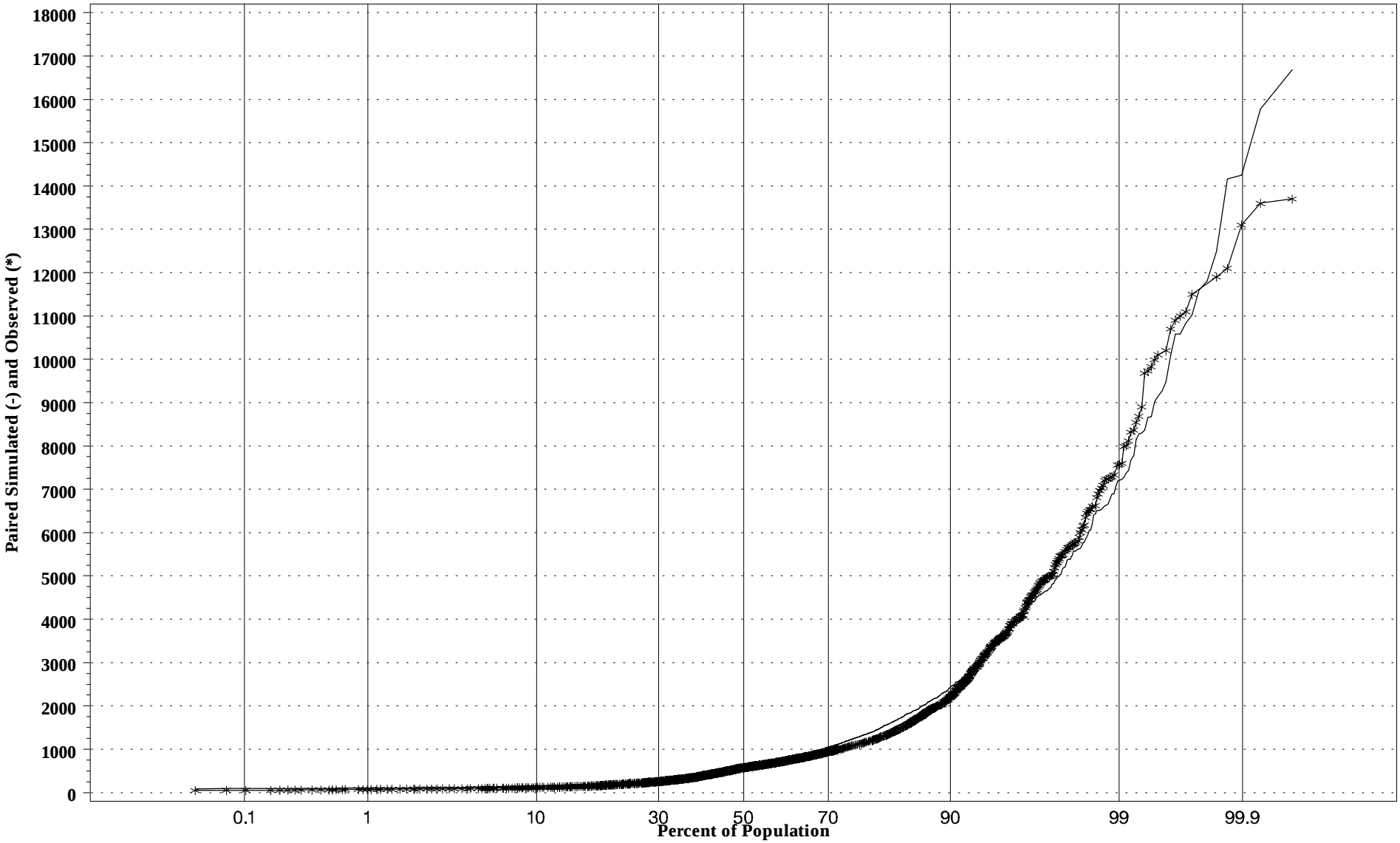


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(pamun260.drv 15JUN98 10:08)

Pamunkey River at Segment 260

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

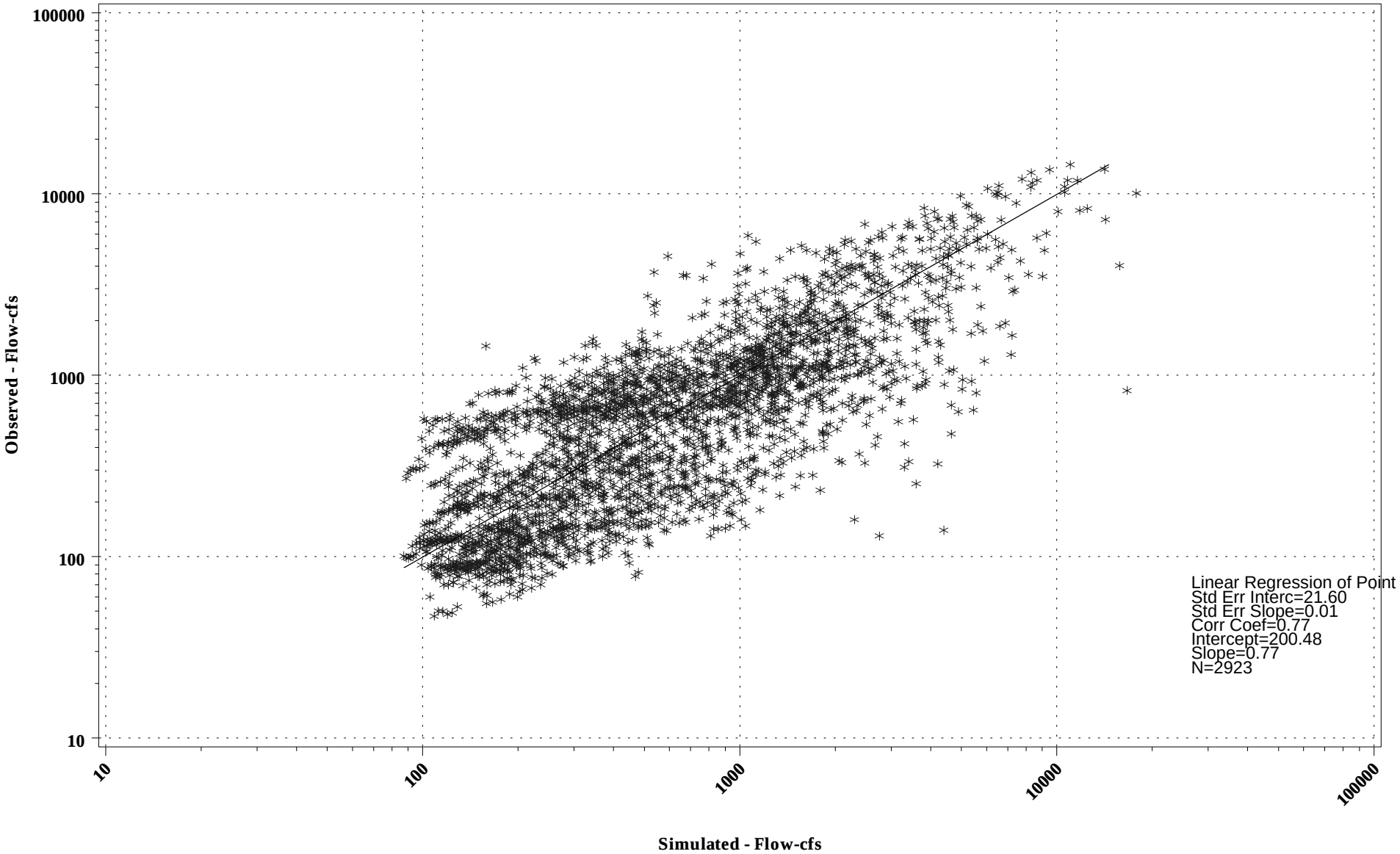


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(pamun260.drv 15JUN98 10:08)

Pamunkey River at Segment 260

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(pamun260.drv 15JUN98 10:08,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
PAMUNKEY RIVER, VA (Segments 250 and 260)

Table A.5.2.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	20.59	18.55
1985	13.95	15.66
1986	7.80	6.35
1987	14.71	16.55
1988	8.17	7.39
1989	14.76	17.92
1990	14.17	11.44
1991	7.13	8.09
Mean	12.66	12.74

* Observed flow at Pamunkey River at Hanover, VA
** Simulated outflow from RCH 260

Table A.5.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.92	0.20	0.78	0.98	0.01	0.91
1985	0.81	0.53	0.54	0.83	0.47	0.44
1986	0.68	0.76	0.50	0.66	0.81	0.49
1987	0.73	0.81	0.63	0.99	0.07	0.97
1988	0.55	1.21	0.45	0.44	1.48	0.39
1989	0.78	0.75	0.61	0.71	0.94	0.59
1990	0.65	0.96	0.65	0.54	1.28	0.75
1991	0.64	1.04	0.55	0.59	1.13	0.57
1984-1991	0.72	0.78	0.59	0.72	0.77	0.64

Table A.5.2.3 Seasonal r-squared.

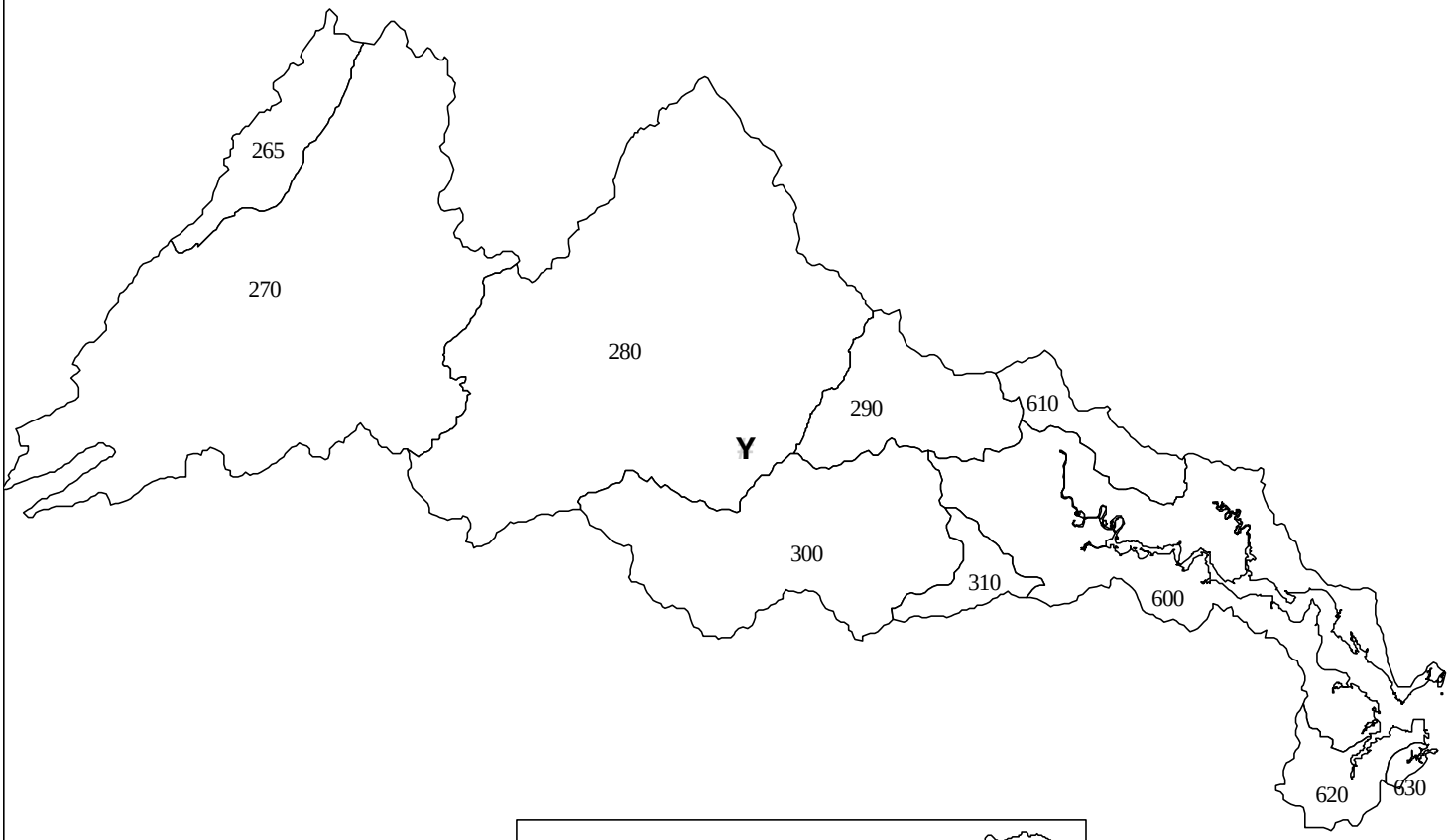
	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.81	0.58	0.69	1.07	-0.37	0.79	0.86	0.30	0.76	0.89	0.29	0.64
1985	0.92	0.18	0.74	0.53	0.89	0.22	0.83	0.61	0.63	0.63	1.35	0.61
1986	2.11	-3.63	0.86	0.83	0.11	0.59	0.62	0.92	0.53	1.08	0.01	0.88
1987	0.32	2.19	0.05	1.00	0.19	0.69	0.98	0.29	0.79	0.67	1.47	0.88
1988	0.90	0.23	0.77	1.05	-0.56	0.78	0.56	1.17	0.41	1.17	-0.04	0.81
1989	0.91	0.28	0.75	0.82	0.56	0.69	0.85	0.63	0.65	0.57	1.41	0.23
1990	0.69	0.82	0.51	1.46	-0.73	0.69	0.84	0.57	0.73	0.72	0.85	0.62
1991	1.24	-0.76	0.75	0.95	-0.10	0.82	0.78	0.81	0.60	1.00	0.37	0.79
1984-1991	0.89	0.28	0.53	1.11	-0.60	0.77	0.81	0.62	0.66	0.80	0.71	0.70

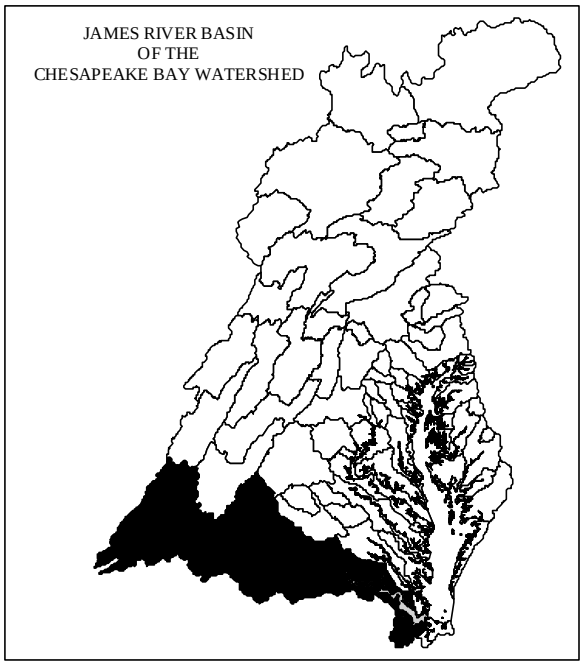
Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

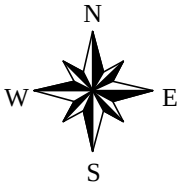
Figure A.6

Monitoring Stations

Chesapeake Bay Watershed
Phase IV Model Segments:
James River Basin







KAG Map Date: January 1998

Source: USGS and Chesapeake Bay Program Modeling Team

A.6.1 JAMES RIVER AT CARTERSVILLE, VA AT SEGMENT 280 (2035000)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

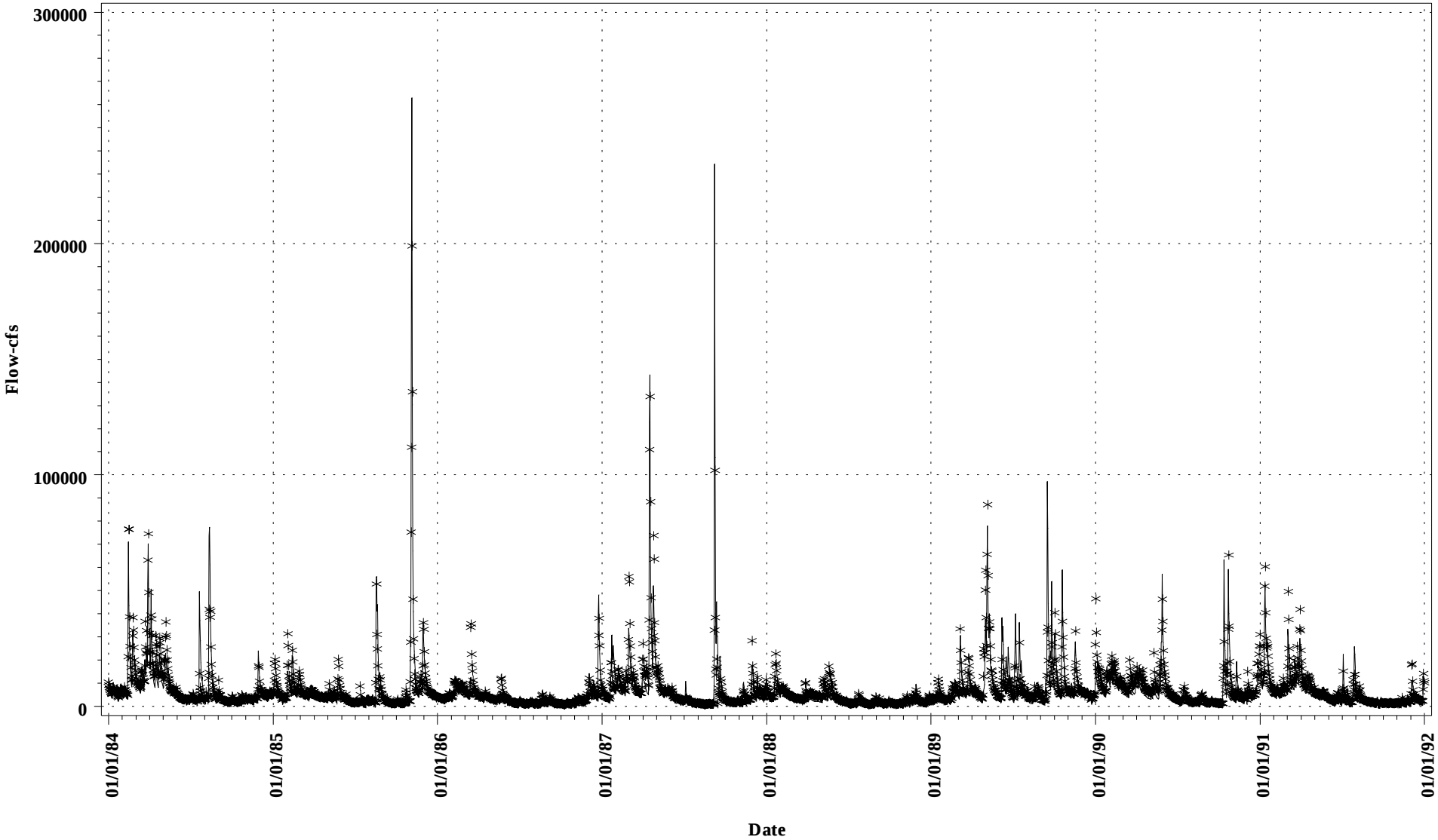
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

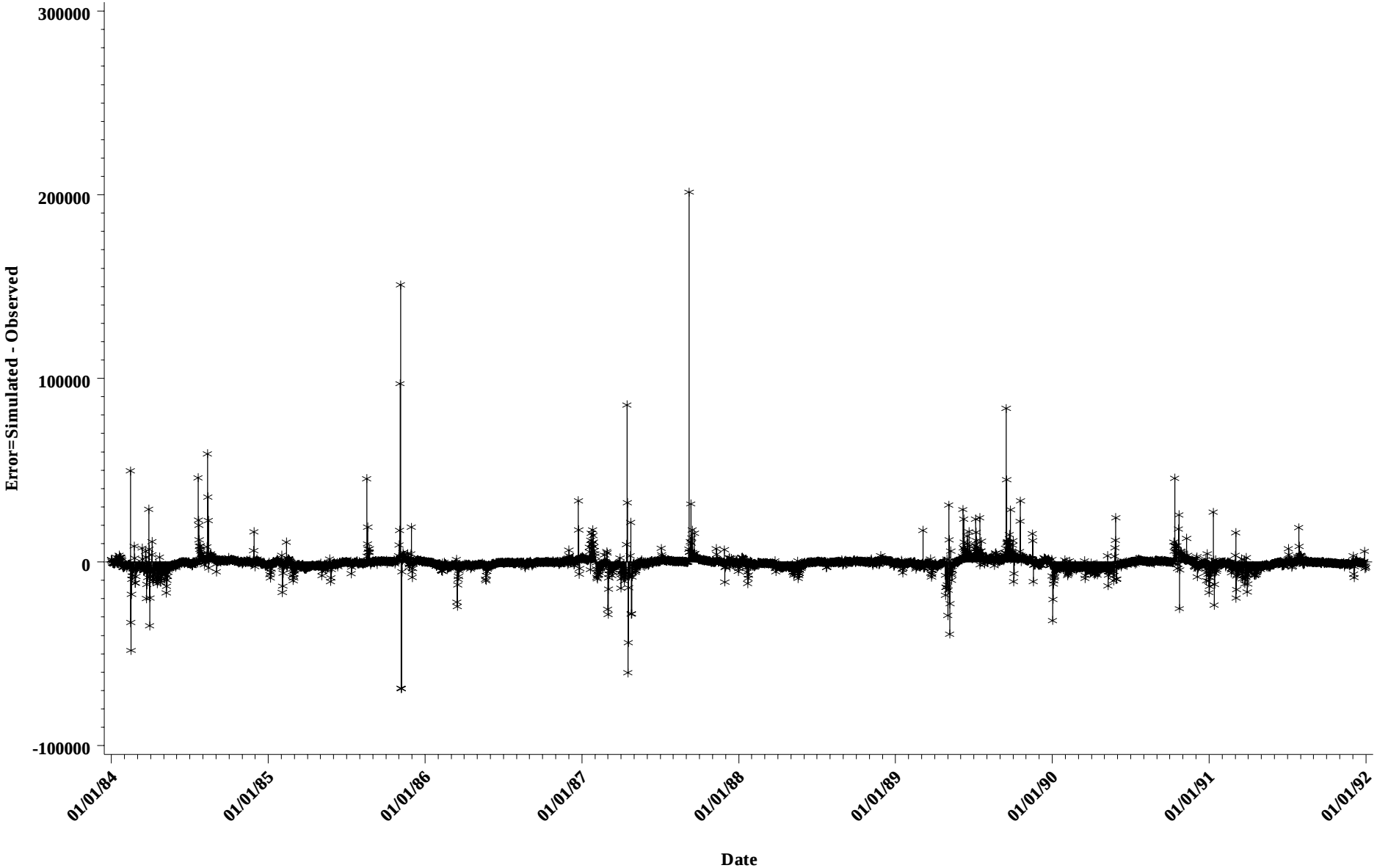
James River at Segment 280
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(j2.drv 12JUN98 15:06)

James River at Segment 280
Actual Error versus Time
Flow-cfs



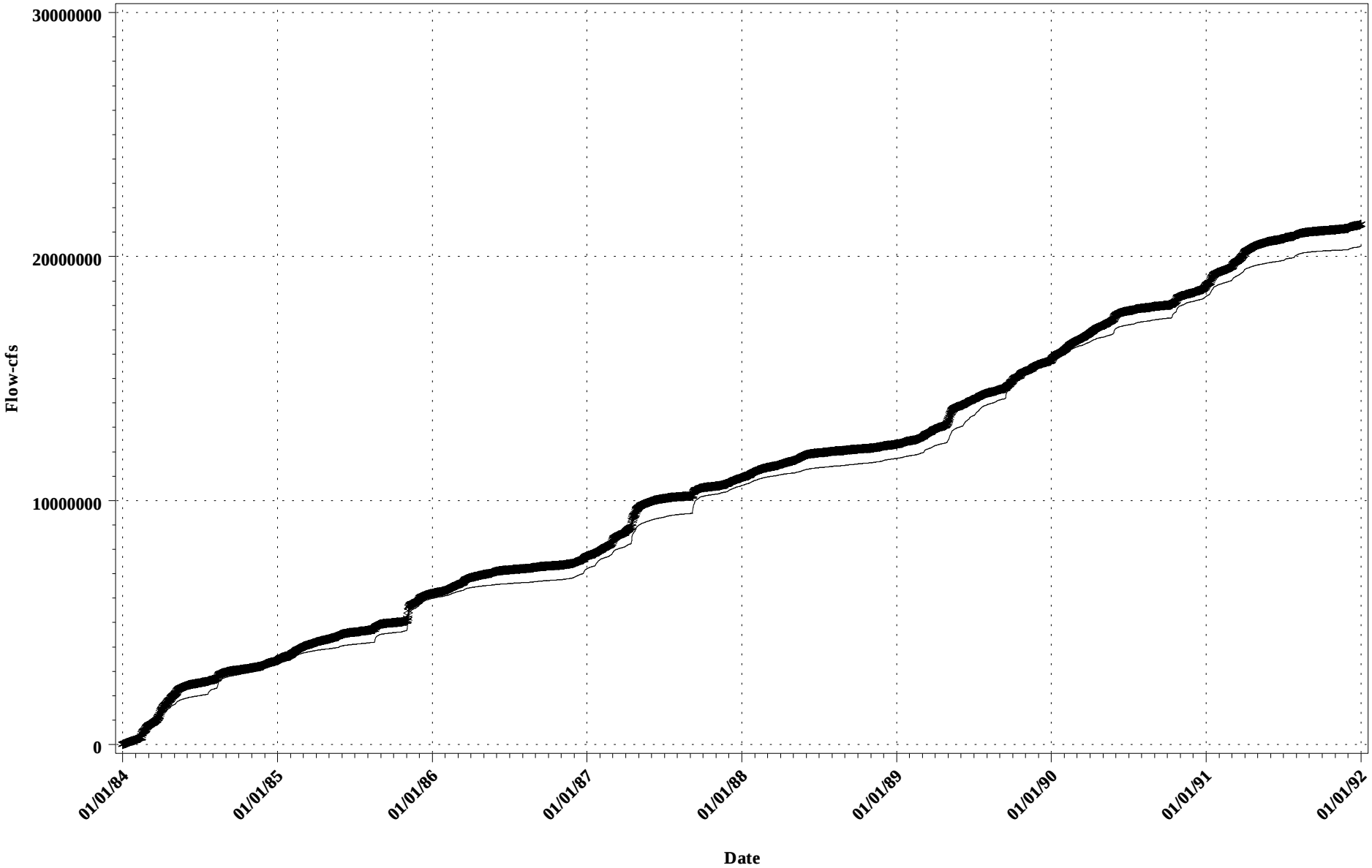
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(j2.drv 12JUN98 15:06)

James River at Segment 280

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

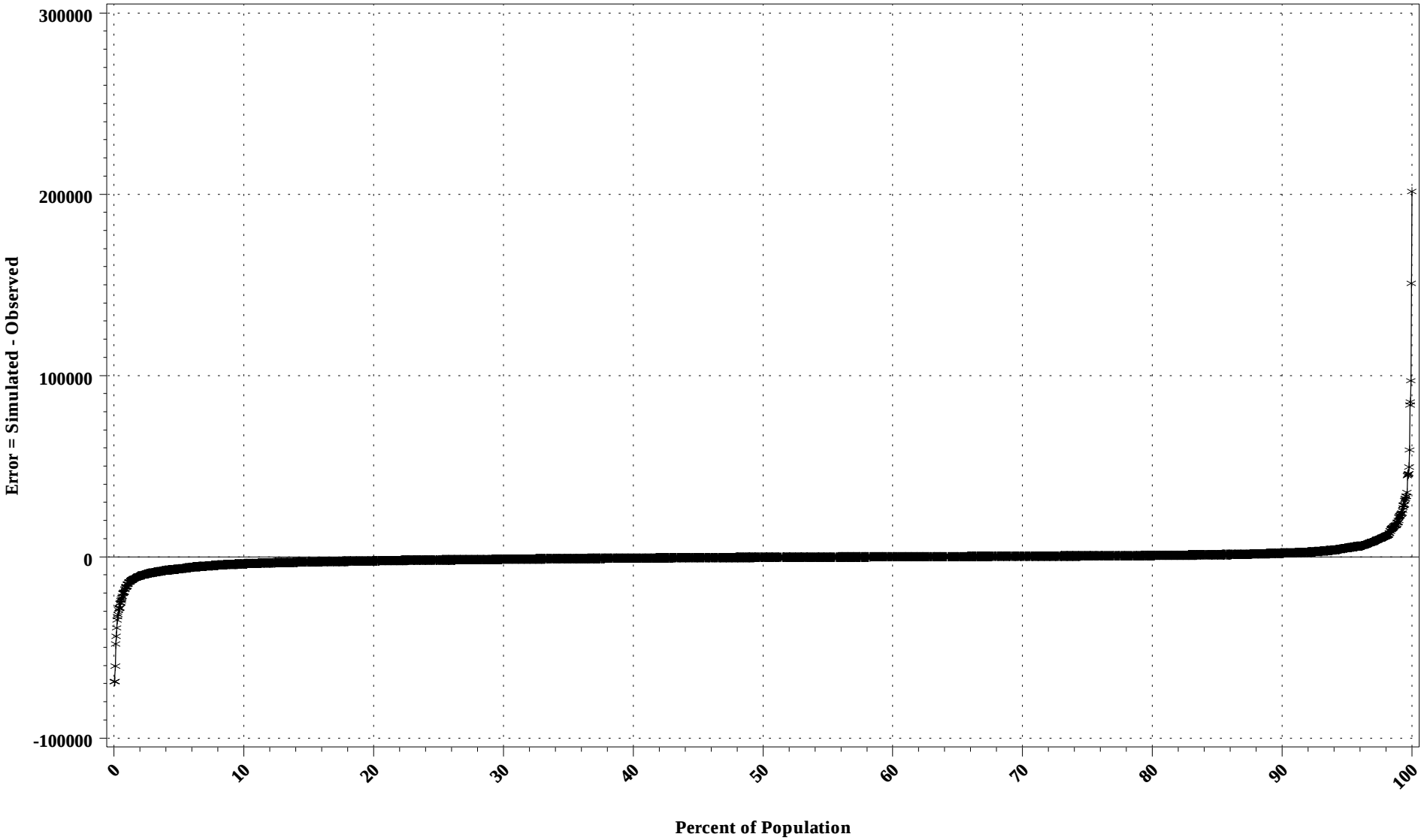
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(j2.drv 12JUN98 15:06)

James River at Segment 280
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

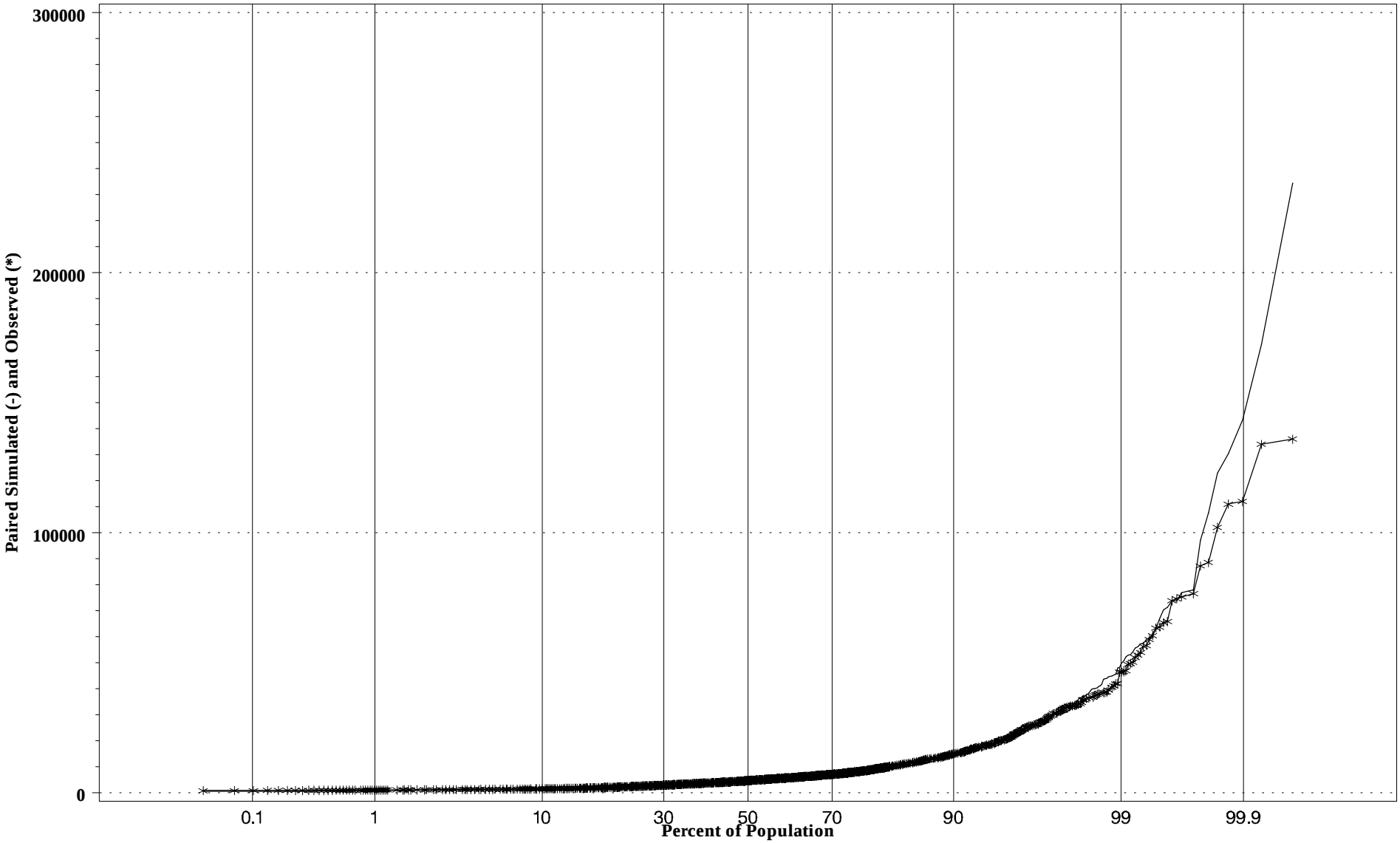


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(j2.drv 12JUN98 15:06)

James River at Segment 280

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

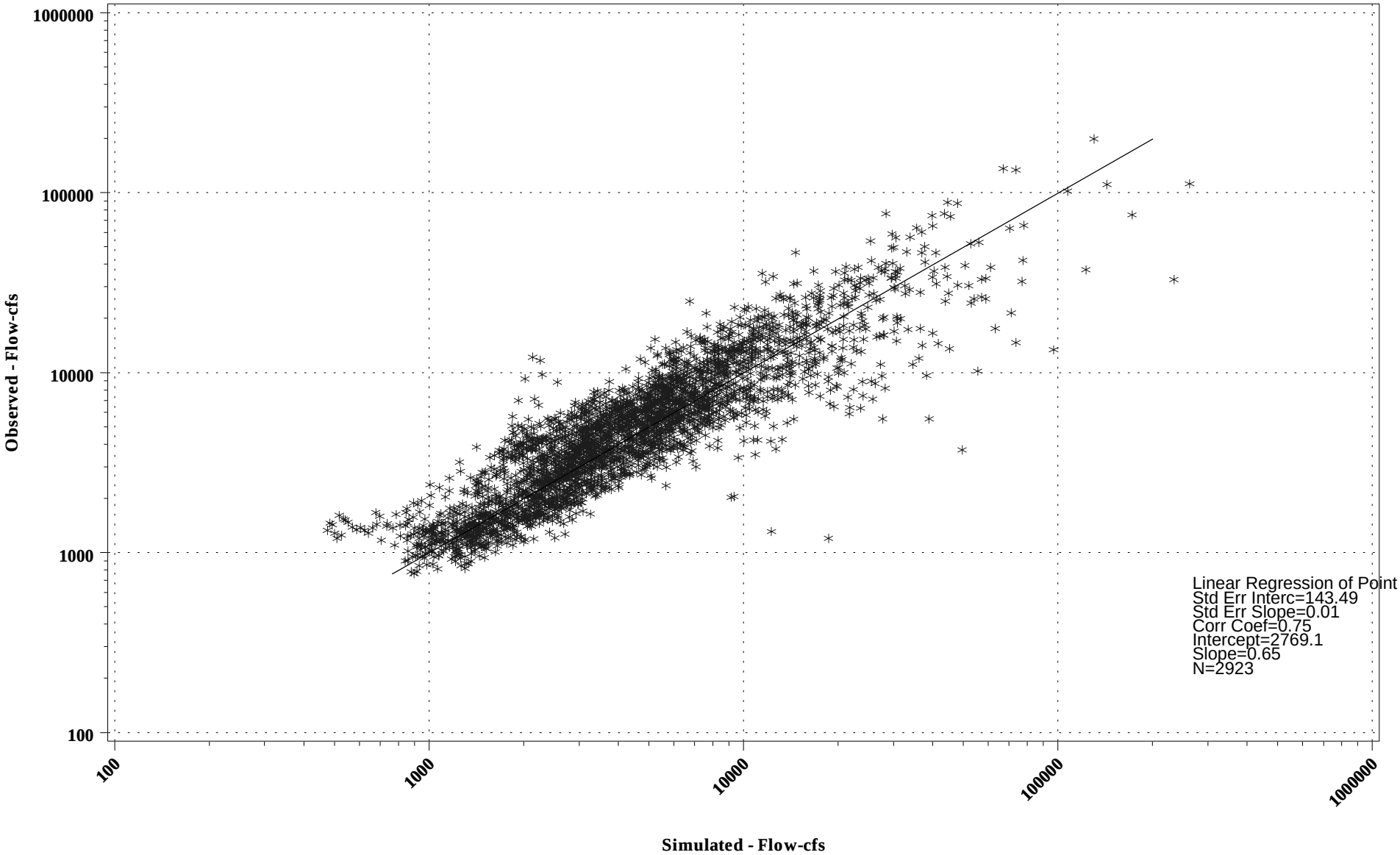


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(j2.drv 12JUN98 15:06)

James River at Segment 280

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(j2.drv 12JUN98 15:06,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
JAMES RIVER, VA (Segments 265, 270, 280 and 290)

Table A.6.1.1 Comparison of Annual Total Observed and Simulated flows..

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	20.52	19.50
1985	16.33	16.10
1986	9.10	7.22
1987	19.16	20.26
1988	8.18	6.63
1989	20.27	23.76
1990	18.18	15.66
1991	15.09	12.28
Mean	15.85	15.18

* Observed flow at James River at Cartersville, VA
** Simulated outflow from RCH 280

Table A.6.1.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.79	0.78	0.77	0.72	1.06	0.90
1985	0.92	0.23	0.80	0.96	0.09	0.80
1986	0.86	0.37	0.80	0.94	0.10	0.85
1987	0.82	0.73	0.81	1.00	0.03	0.99
1988	0.66	1.13	0.76	0.68	1.06	0.82
1989	0.94	0.30	0.72	1.15	-0.52	0.71
1990	0.77	0.83	0.78	0.63	1.34	0.85
1991	1.01	-0.12	0.87	1.04	-0.24	0.91
1984-1991	0.85	0.53	0.79	0.89	0.37	0.86

Table A.6.1.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.93	0.16	0.82	0.94	0.13	0.81	1.05	-0.10	0.68	0.71	1.08	0.63
1985	0.68	1.20	0.71	0.88	0.20	0.67	0.99	0.02	0.81	0.95	0.26	0.95
1986	0.73	0.91	0.83	0.80	0.49	0.71	0.58	1.23	0.70	1.04	-0.10	0.92
1987	0.67	1.37	0.34	0.91	0.27	0.83	1.02	0.07	0.84	-0.62	5.89	0.10
1988	0.75	0.86	0.88	0.78	0.60	0.66	0.64	1.19	0.76	0.71	1.02	0.67
1989	0.78	0.72	0.88	0.88	0.42	0.84	1.06	-0.01	0.80	0.96	0.23	0.75
1990	0.83	0.56	0.72	1.22	-1.09	0.77	0.79	0.78	0.93	0.93	0.31	0.76
1991	0.88	0.42	0.83	0.99	-0.14	0.87	1.04	-0.13	0.84	1.26	-1.05	0.84
1984-1991	0.81	0.68	0.74	1.04	-0.36	0.85	1.09	-0.25	0.83	1.02	-0.04	0.85

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.6.2 APPAMATTOX RIVER AT MATOACA, VA AT SEGMENT 310 (2041650)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

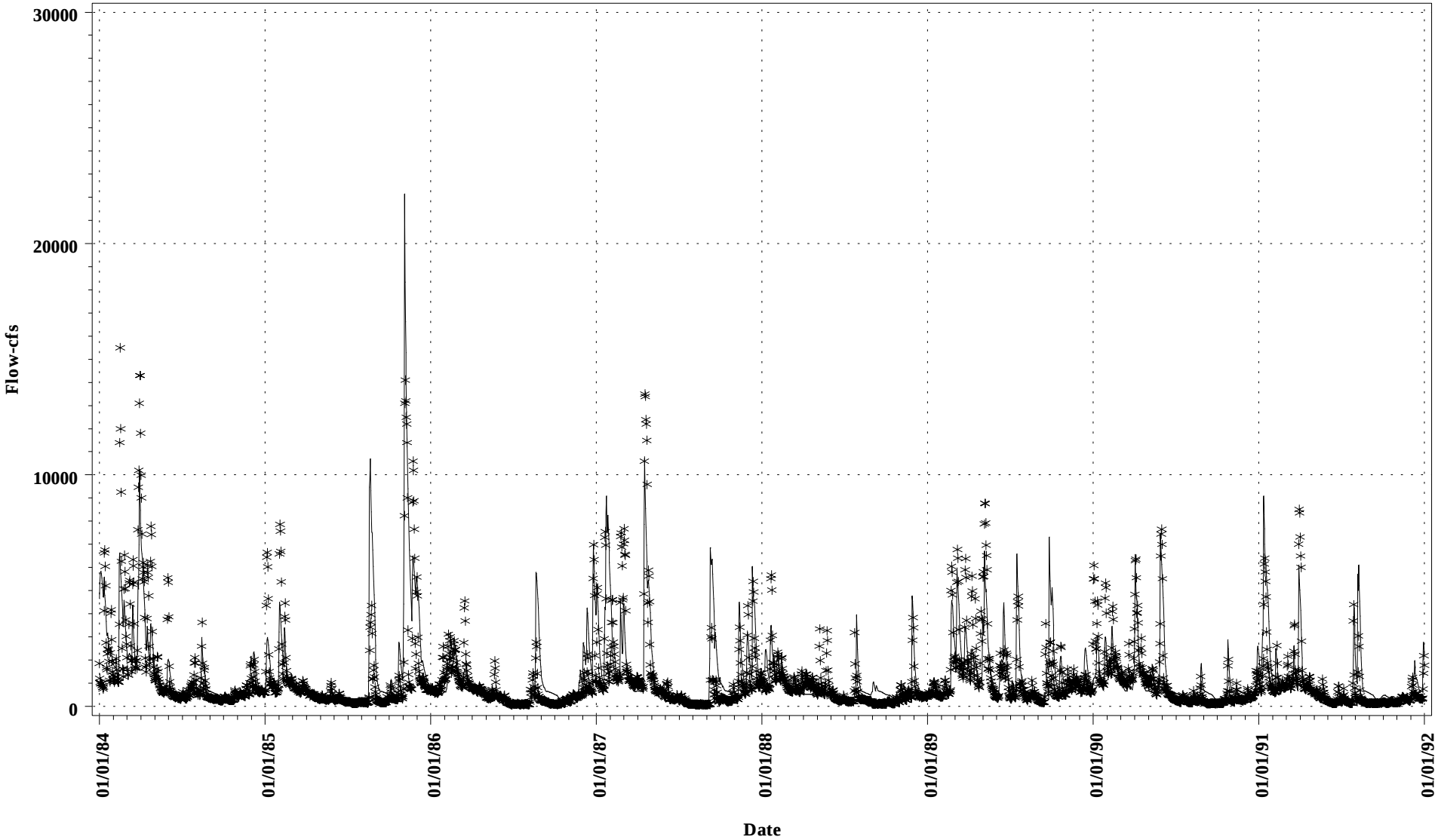
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

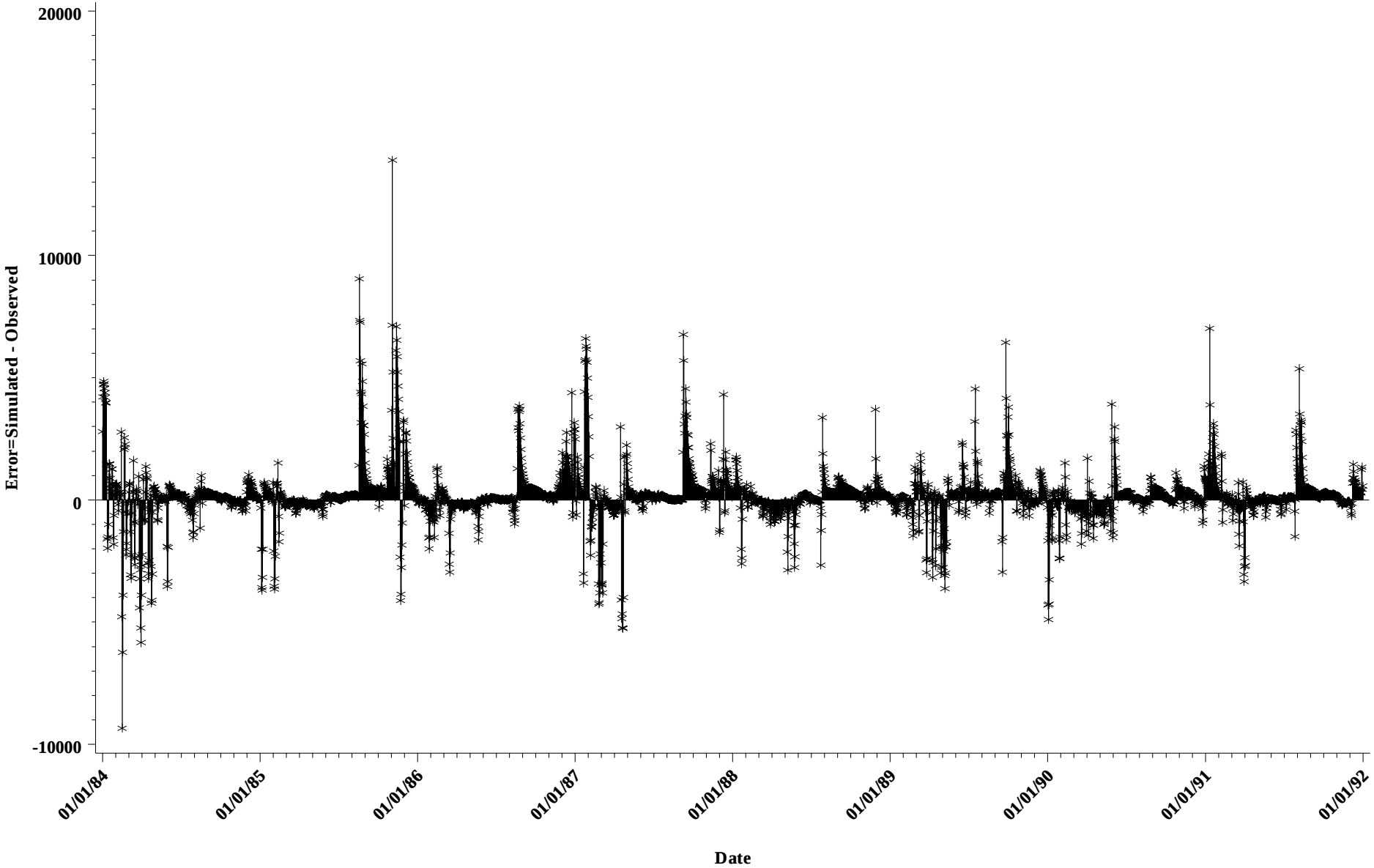
Appomattox River at Segment 310
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(appom.drv 12JUN98 15:19)

Appomattox River at Segment 310
Actual Error versus Time
Flow-cfs



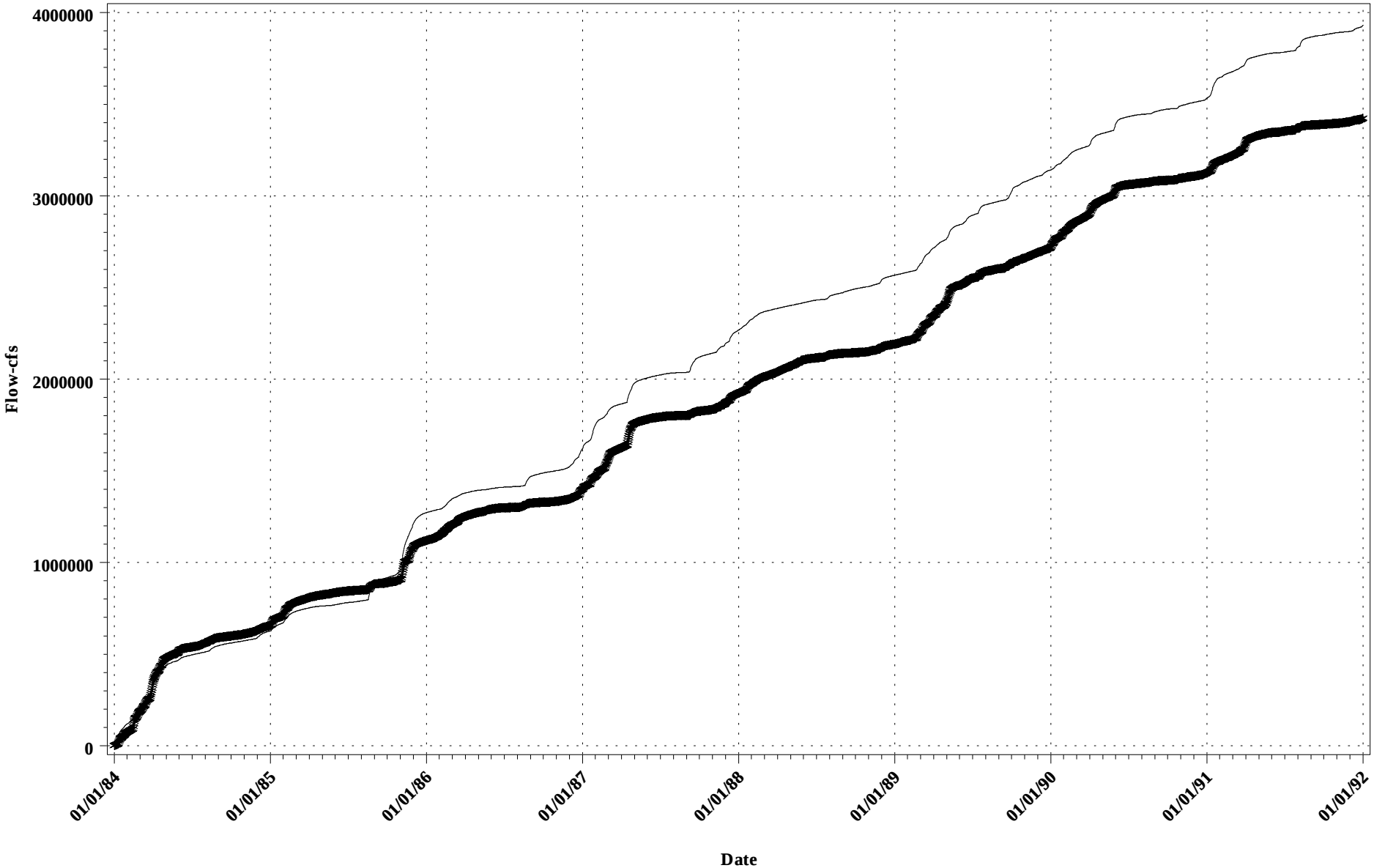
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(appom.drv 12JUN98 15:19)

Appomattox River at Segment 310

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

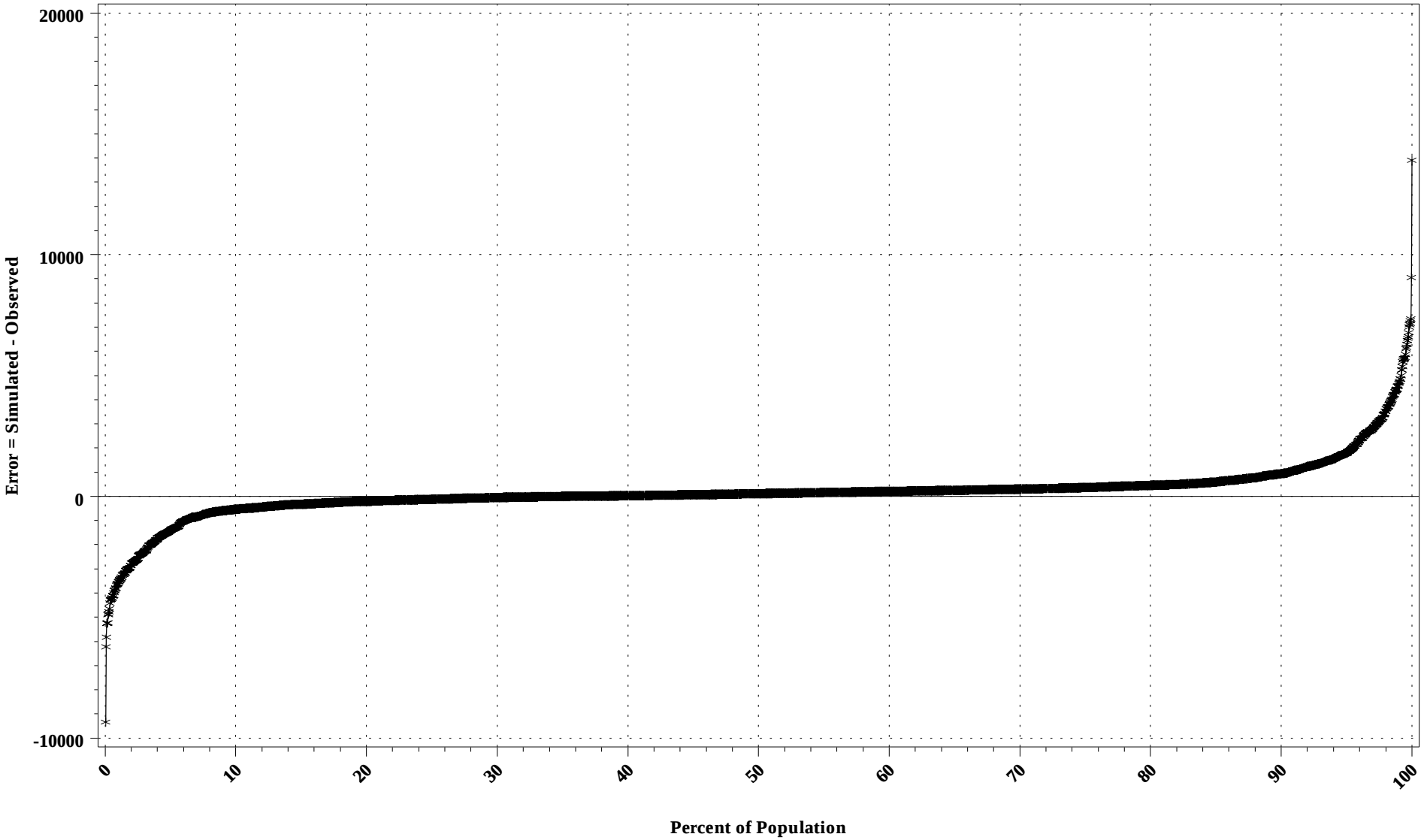
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(appom.drv 12JUN98 15:19)

Appomattox River at Segment 310
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

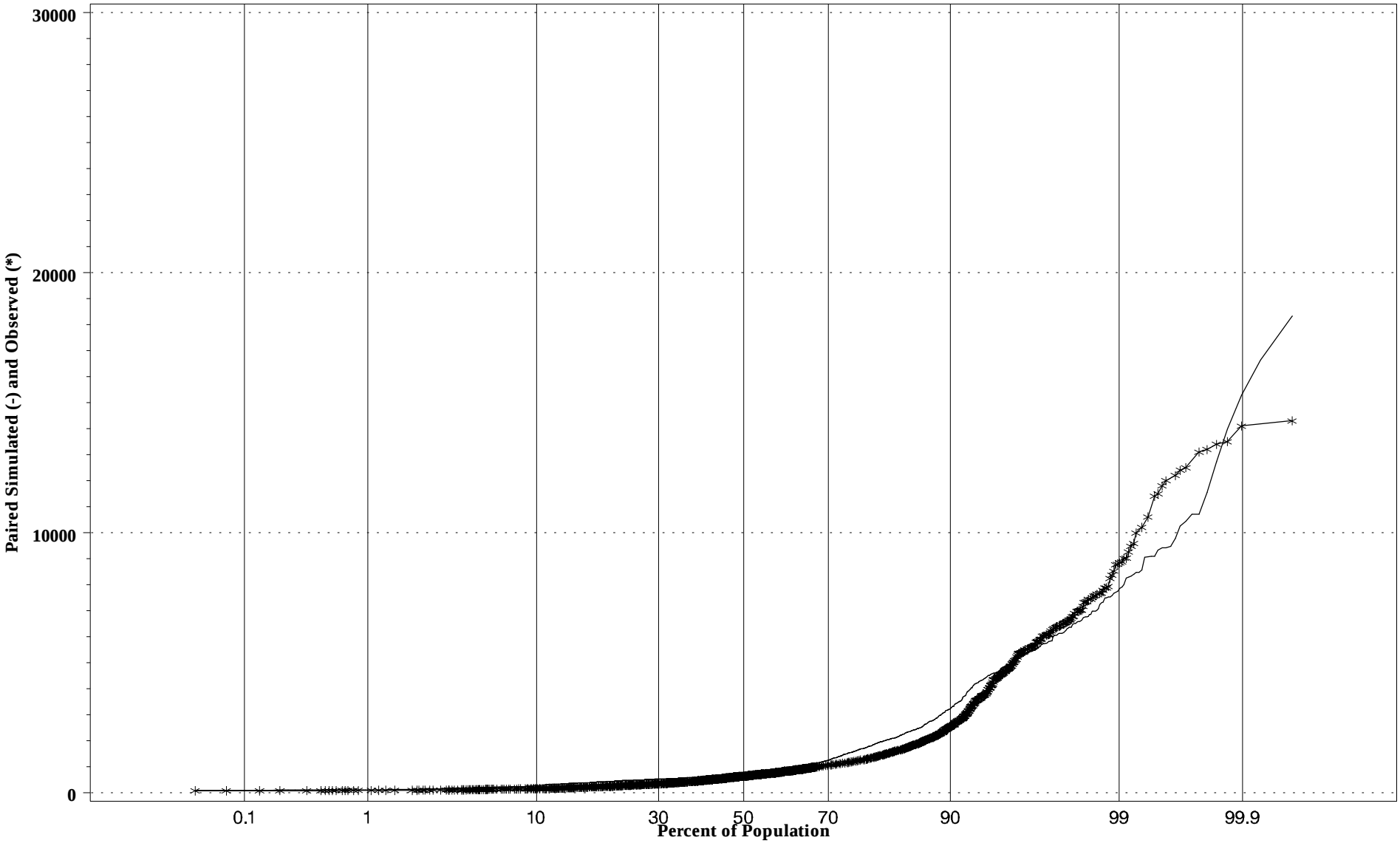


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(appom.drv 12JUN98 15:19)

Appomattox River at Segment 310

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

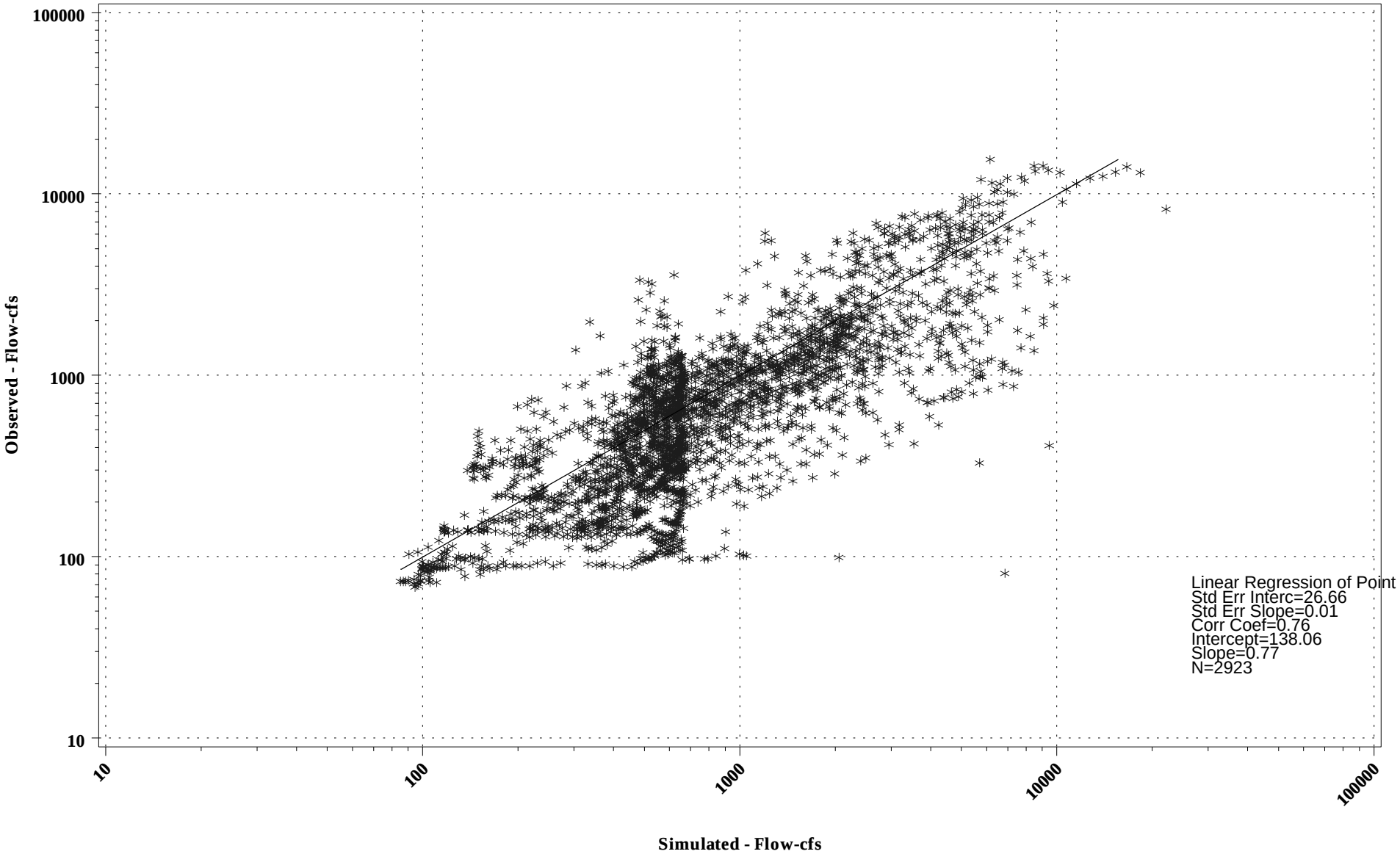


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(appom.drv 12JUN98 15:19)

Appomattox River at Segment 310

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(appom.drv 12JUN98 15:19,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
APPOMATTOX RIVER, VA (Segments 300 and 310)

Table A.6.2.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	18.16	18.03
1985	12.83	12.75
1986	7.68	7.63
1987	14.55	14.46
1988	7.42	7.36
1989	14.52	14.43
1990	11.37	11.29
1991	8.19	8.14
Mean	11.84	11.76

* Observed flow at Appomattox River at Matoaca, VA
** Simulated outflow from RCH 310

Table A.6.2.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.77	0.75	0.76	0.90	0.35	0.89
1985	0.85	0.52	0.65	0.92	0.36	0.67
1986	0.65	1.03	0.52	0.67	0.99	0.58
1987	0.82	0.65	0.76	1.02	0.06	0.98
1988	0.35	1.89	0.27	0.29	2.04	0.24
1989	0.70	0.98	0.67	0.72	0.93	0.70
1990	0.64	1.09	0.67	0.58	1.25	0.77
1991	0.74	0.84	0.62	0.75	0.83	0.61
1984-1991	0.69	0.97	0.61	0.73	0.85	0.68

Table A.6.2.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.55	1.57	0.71	0.73	0.88	0.86	0.46	1.57	0.49	0.95	0.17	0.70
1985	0.62	1.21	0.81	1.31	-1.03	0.78	1.08	0.14	0.75	0.77	0.99	0.75
1986	0.84	0.40	0.54	0.90	0.10	0.64	0.89	0.50	0.52	0.78	0.94	0.78
1987	0.44	1.98	0.21	0.87	0.38	0.82	1.08	0.07	0.72	1.12	0.45	0.99
1988	1.04	-0.11	0.87	-0.02	2.79	0.01	0.12	2.42	0.02	0.57	1.34	0.64
1989	0.86	0.37	0.79	0.62	1.26	0.69	0.68	1.08	0.62	0.86	0.55	0.48
1990	0.44	1.76	0.34	1.07	0.38	0.80	0.70	0.98	0.55	0.74	0.80	0.54
1991	0.98	0.26	0.69	0.80	0.53	0.86	0.84	0.65	0.46	0.60	1.16	0.29
1984-1991	0.72	0.94	0.51	0.95	0.02	0.80	0.77	0.82	0.56	0.81	0.73	0.69

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

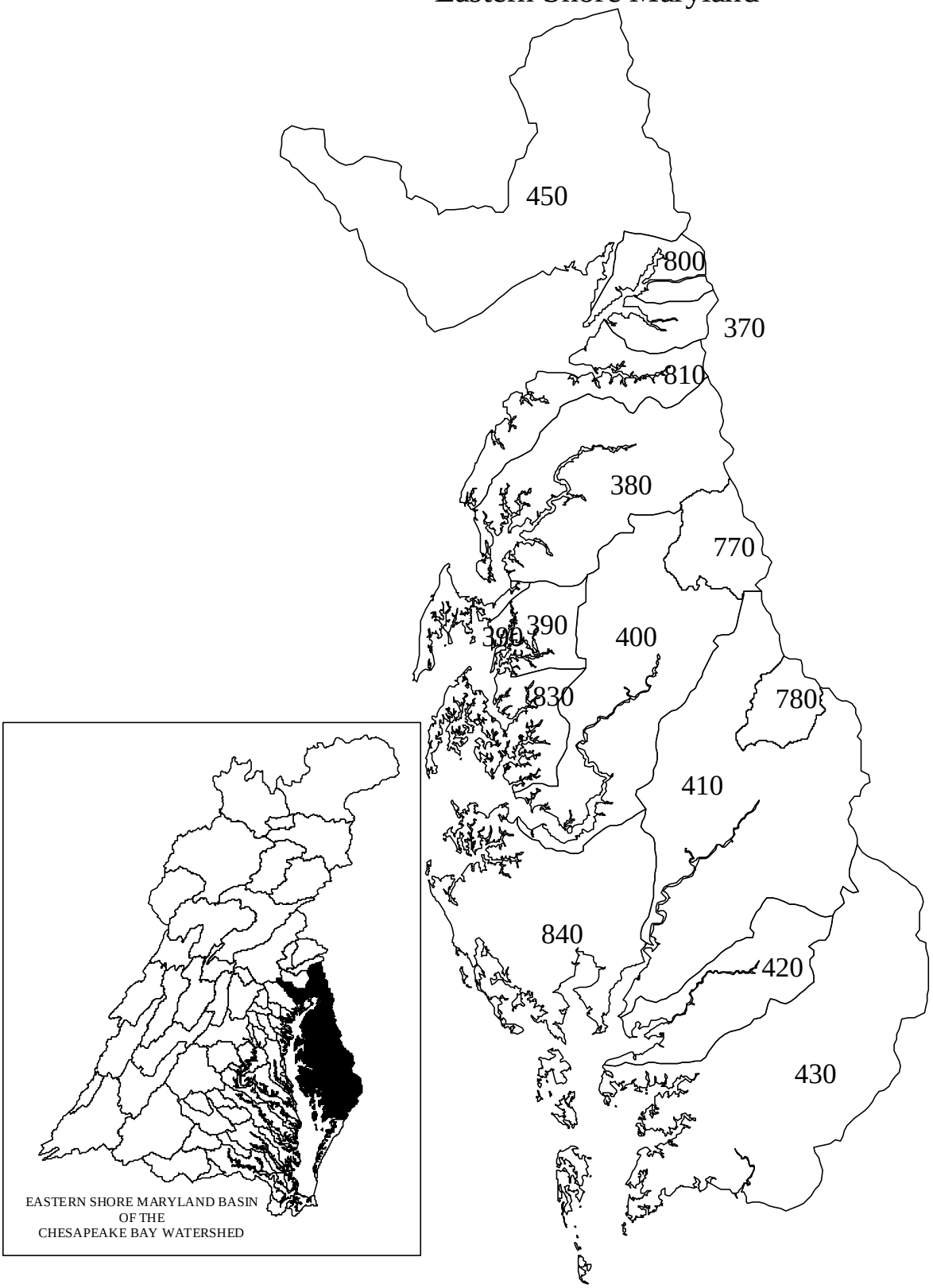
Figure A.7

Monitoring Stations

Chesapeake Bay Watershed

Phase IV Model Segments:

Eastern Shore Maryland



N
W
E
S

KAG Map Date: January 1998

Source: USGS and Chesapeake Bay Program Modeling Team

A.7.0 NANTICOKE RIVER AT BRIDGEVILLE, DE AT SEGMENT 780 (1487000)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

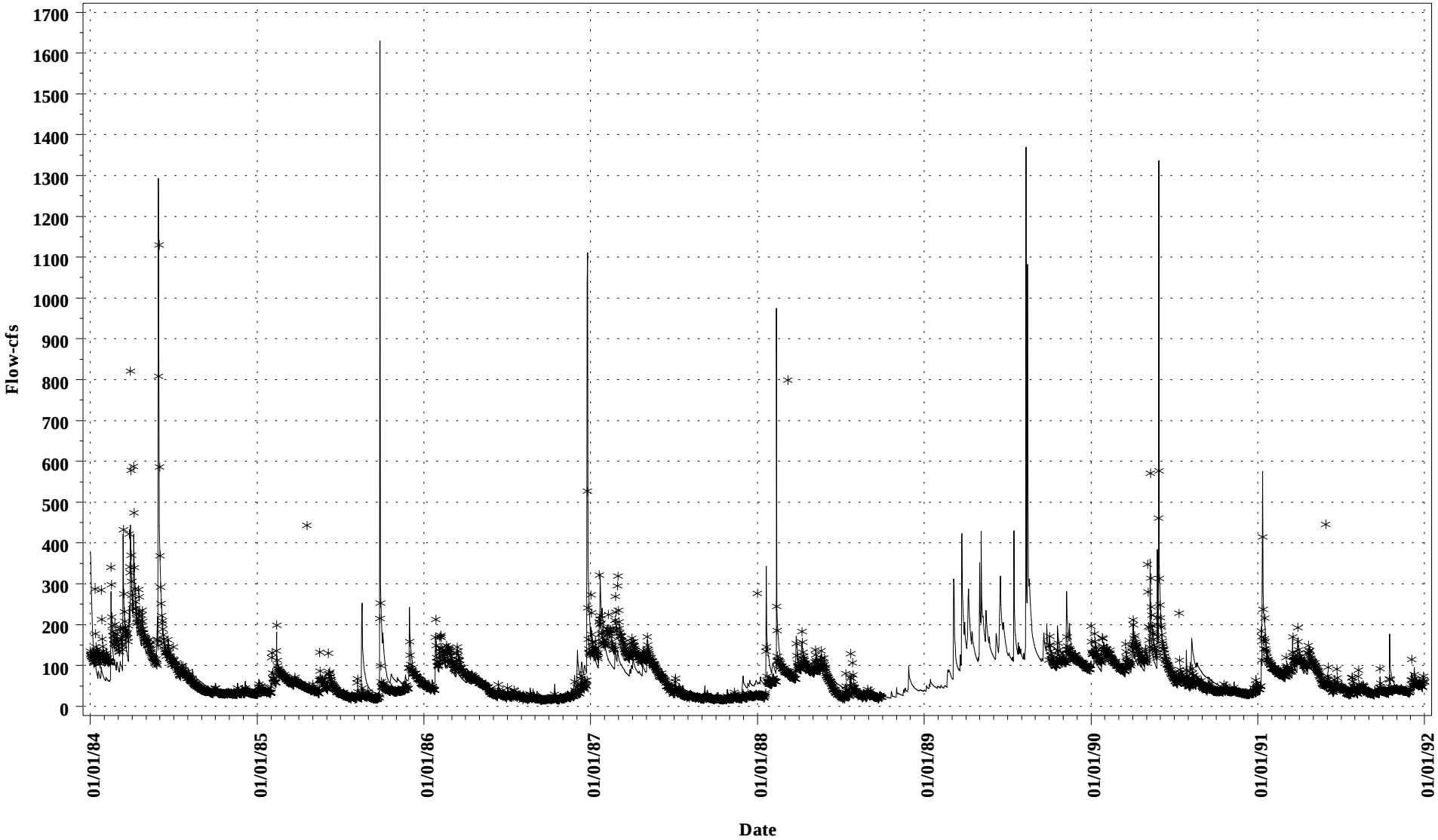
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

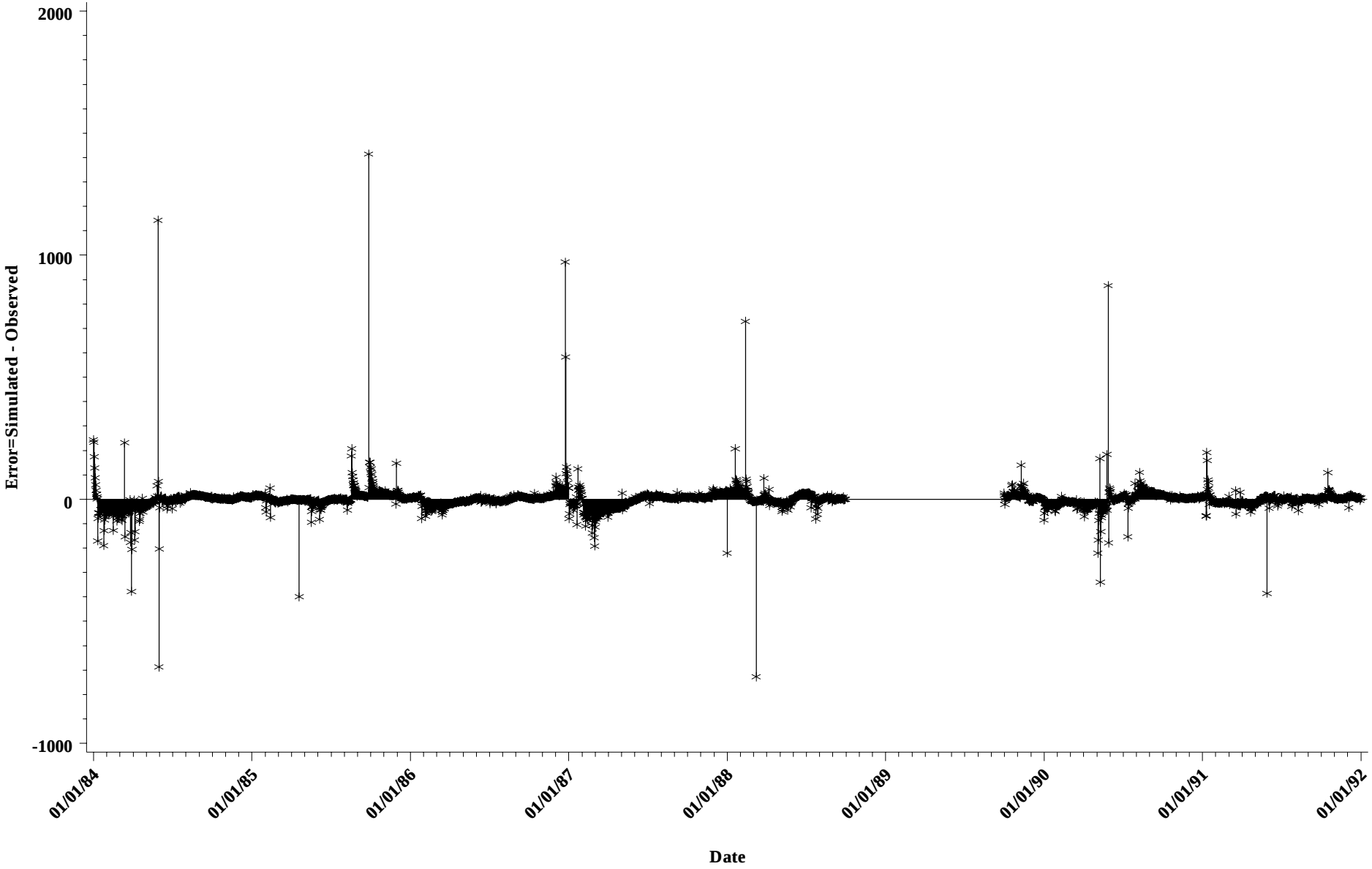
Nanticoke River at Segment 780
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(nanload.drv 15JUN98 10:58)

Nanticoke River at Segment 780
Actual Error versus Time
Flow-cfs



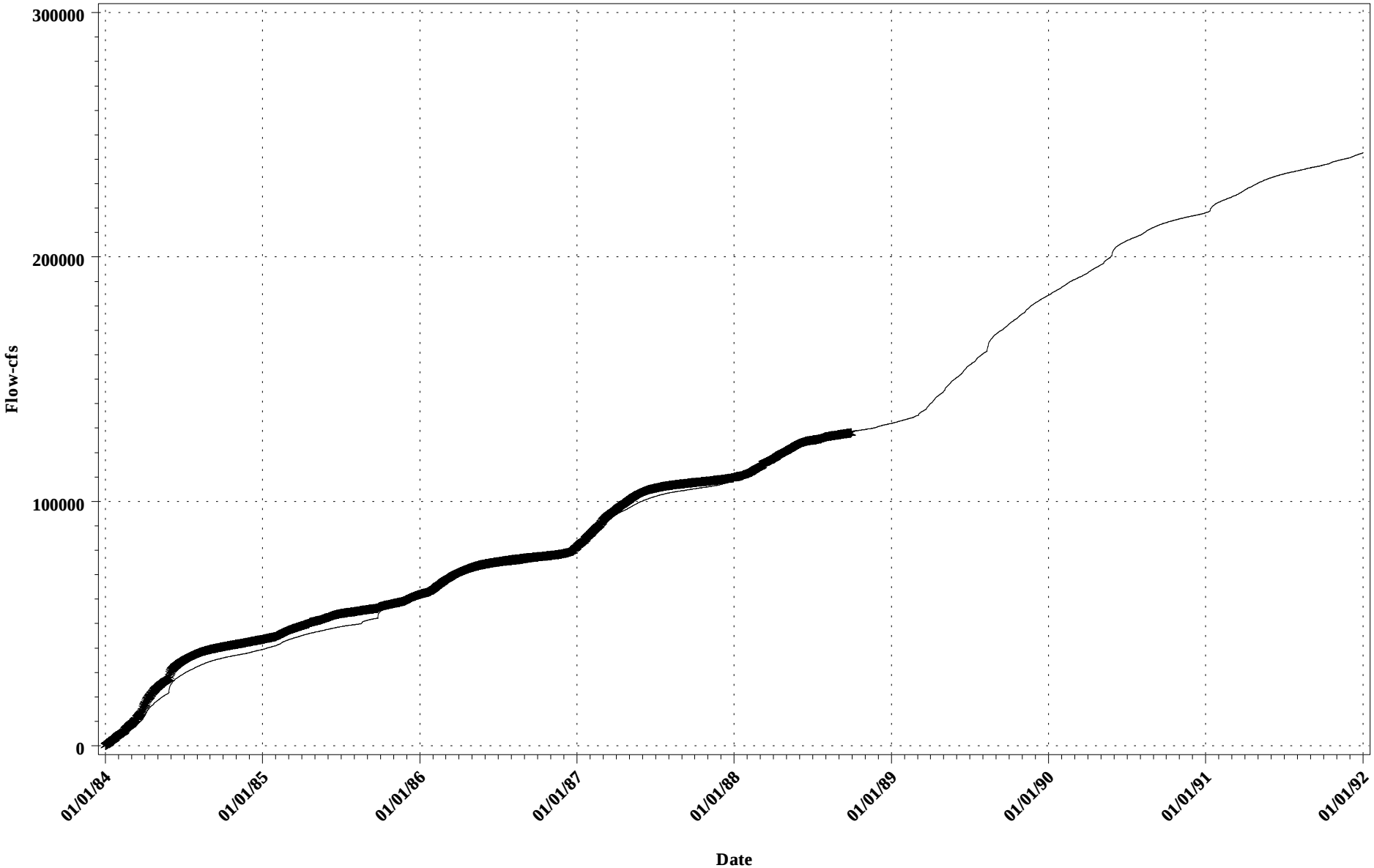
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(nanload.drv 15JUN98 10:58)

Nanticoke River at Segment 780

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

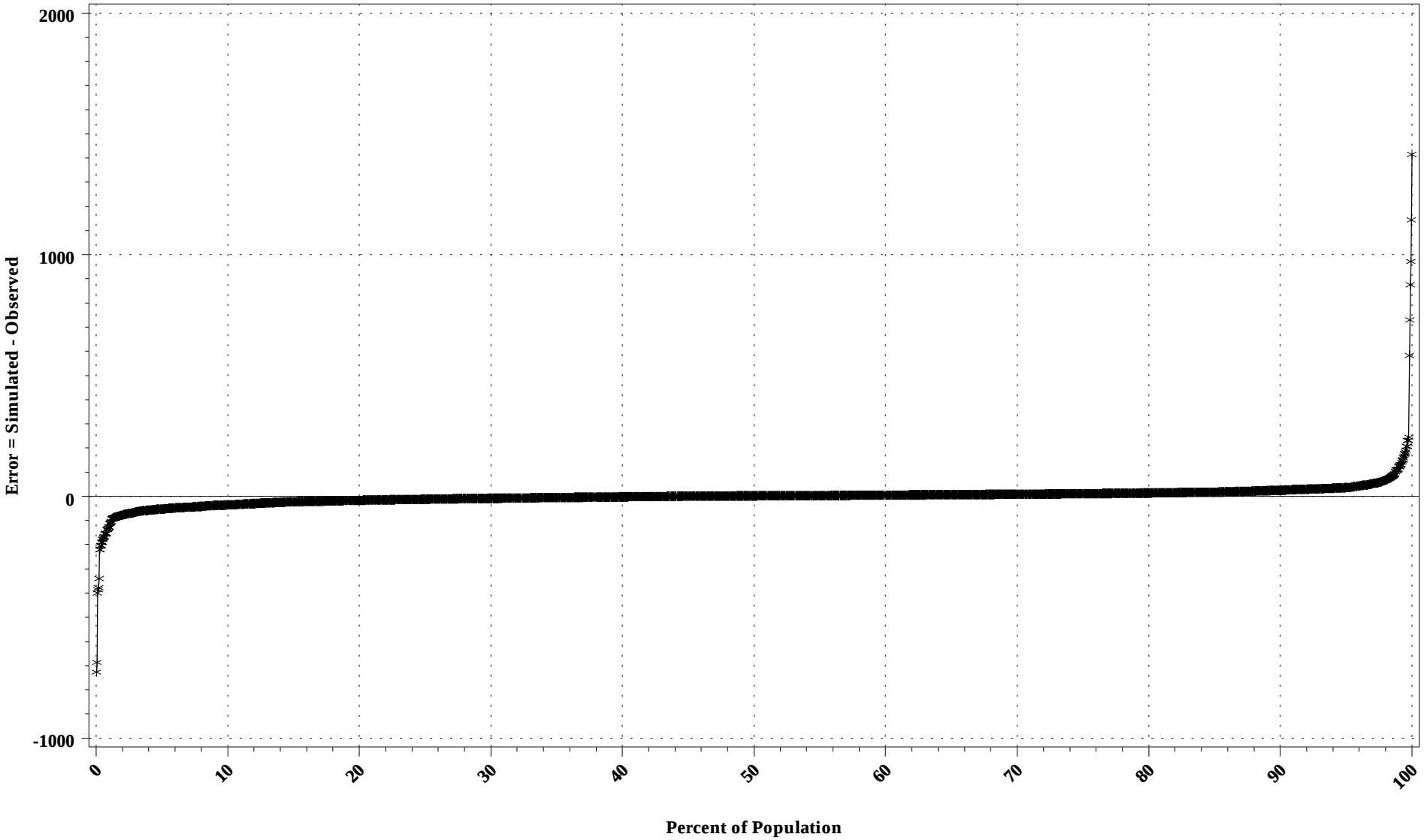
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(nanload.drv 15JUN98 10:58)

Nanticoke River at Segment 780
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

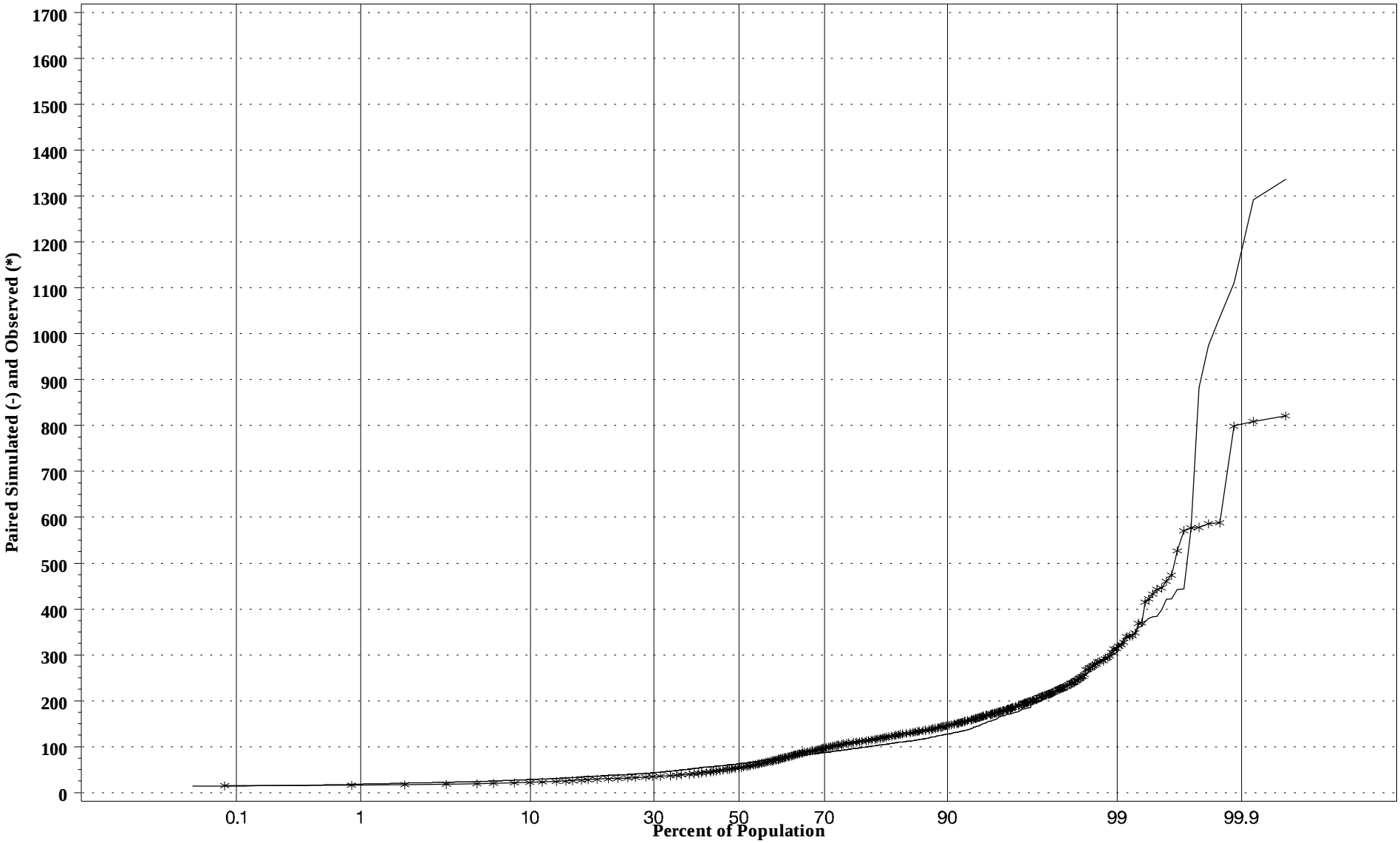


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(nanload.drv 15JUN98 10:58)

Nanticoke River at Segment 780

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

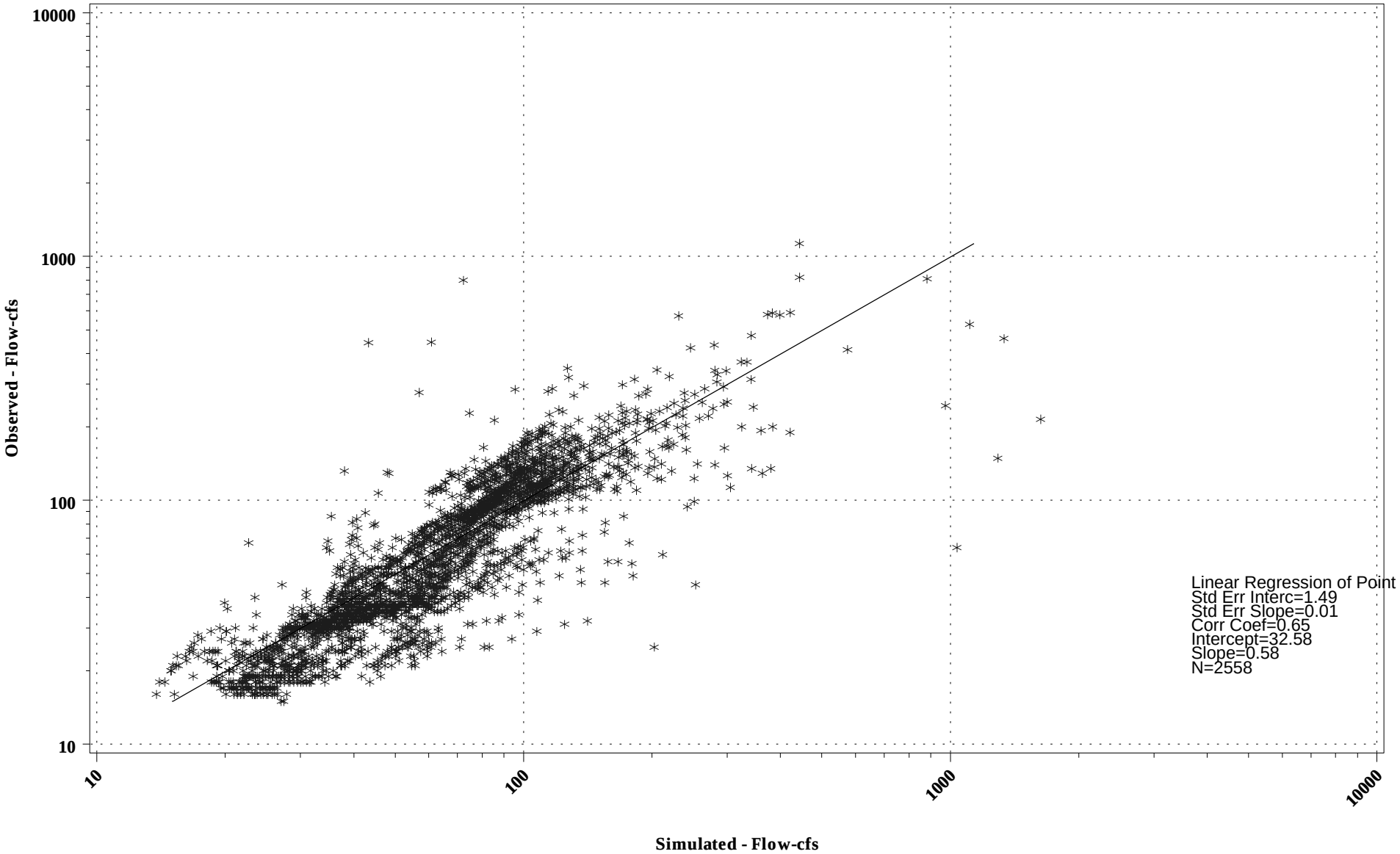


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(nanload.drv 15JUN98 10:58)

Nanticoke River at Segment 780

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(nanload.drv 15JUN98 10:58,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
NANTICOKE RIVER, VA (Segment 780)

Table A.7.0.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	21.49	19.43
1985	8.87	11.21
1986	9.55	10.41
1987	14.05	12.49
1988	10.15	11.53
1989	23.85	25.85
1990	16.83	16.65
1991	12.23	12.09
Mean	13.65	14.96

* Observed flow at Nanticoke River at Matoaca, VA
** Simulated outflow from RCH 780

Table A.7.0.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	1.08	-0.15	0.84	1.21	-11.73	0.93
1985	0.57	0.67	0.37	0.58	19.98	0.24
1986	0.92	0.10	0.74	0.93	2.30	0.74
1987	1.37	-0.69	0.88	1.40	-22.45	0.88
1988	0.94	0.05	0.62	1.00	-2.05	0.74
1989	0.53	0.93	0.69	0.48	31.92	0.58
1990	1.14	-0.30	0.77	1.28	-16.84	0.83
1991	1.03	-0.05	0.79	1.06	-3.00	0.89
1984-1991	0.95	0.07	0.71	0.99	-0.23	0.73

Table A.7.0.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.22	1.70	0.12	0.65	0.85	0.53	1.25	-0.54	0.96	0.46	0.79	0.64
1985	1.45	-0.88	0.83	0.72	0.54	0.15	0.33	0.96	0.18	0.67	0.45	0.44
1986	1.56	-1.04	0.93	1.40	-0.62	0.94	0.20	1.08	0.04	0.72	0.29	0.87
1987	0.33	1.53	0.19	1.01	0.12	0.44	1.10	-0.25	0.87	0.44	0.65	0.73
1988	0.94	-0.09	0.56	0.59	-0.85	0.19	0.79	0.25	0.42	1.91	-1.24	0.90
1989	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.53	0.93	0.69
1990	0.83	0.41	0.46	0.76	0.59	0.65	0.98	-0.08	0.58	0.67	0.46	0.67
1991	0.78	0.45	0.76	0.92	0.21	0.37	1.00	-0.01	0.58	0.66	0.51	0.66
1984-1991	0.55	0.88	0.57	0.81	0.30	0.76	0.83	0.34	0.72	0.91	0.26	0.81

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

A.8.0 CHOPTANK RIVER NEAR GREENSBORO, MD AT SEGMENT 770(1491000)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

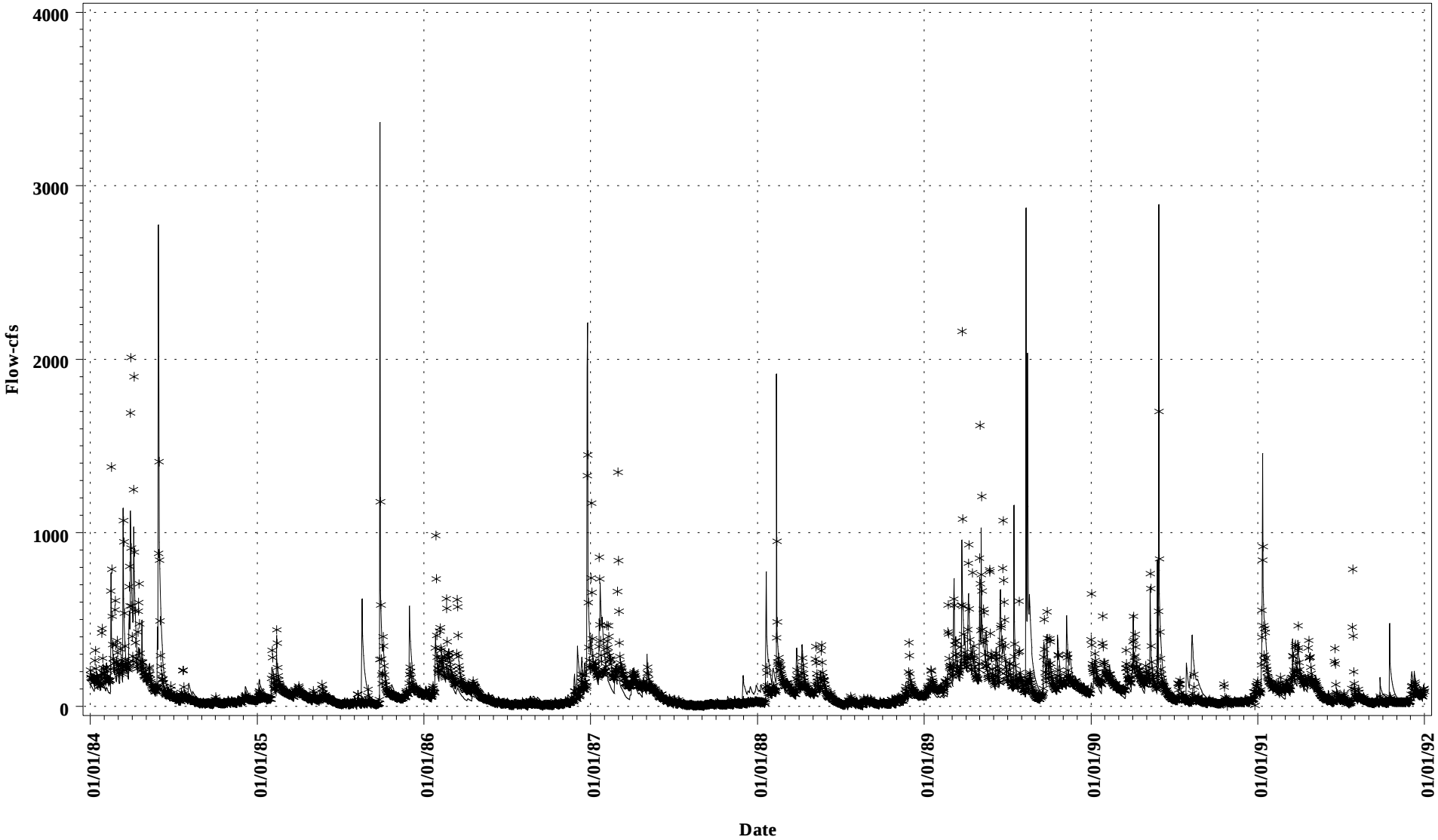
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

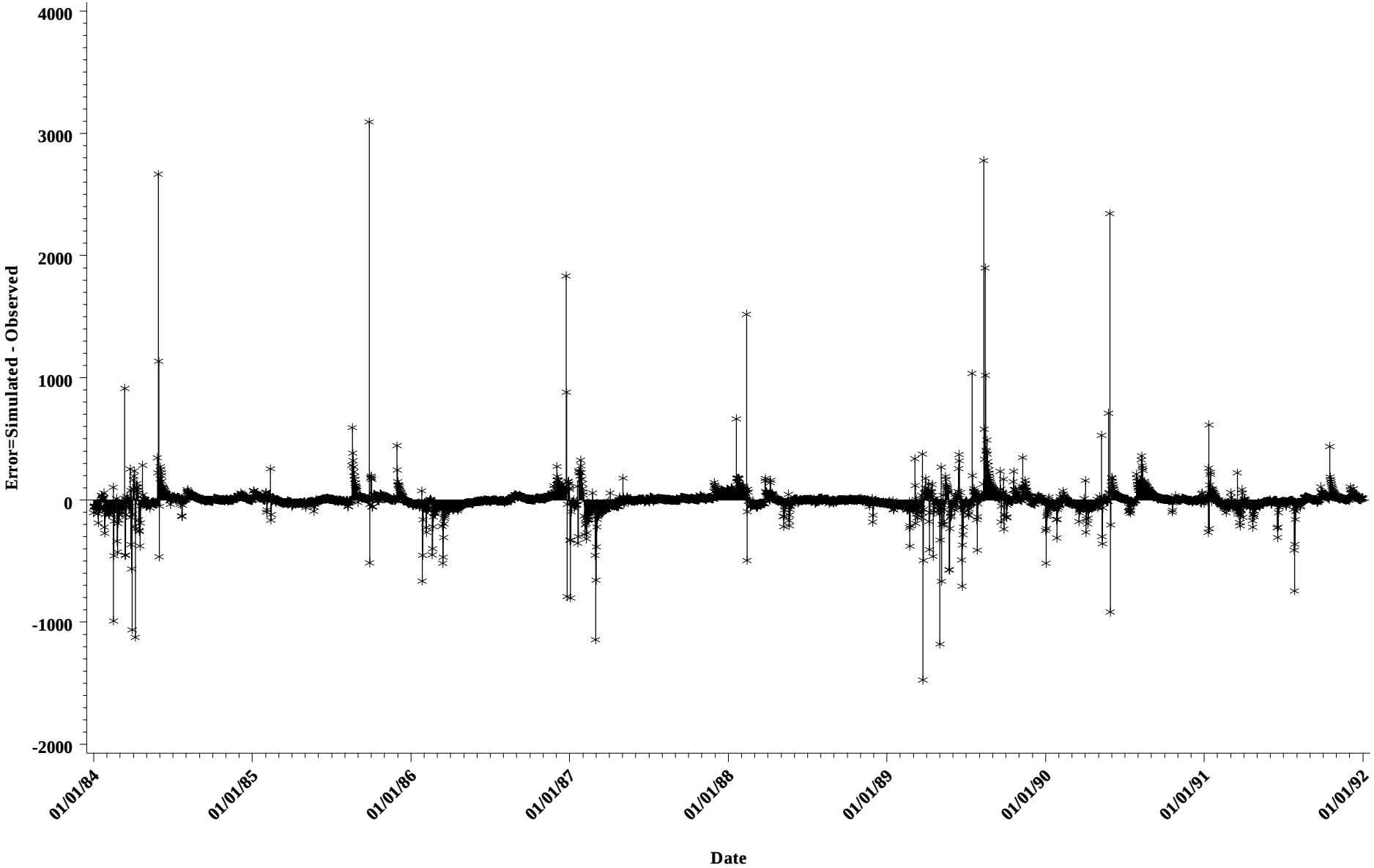
Choptank River at Segment 770
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(flow.drv 15JUN98 15:15)

Choptank River at Segment 770
Actual Error versus Time
Flow-cfs



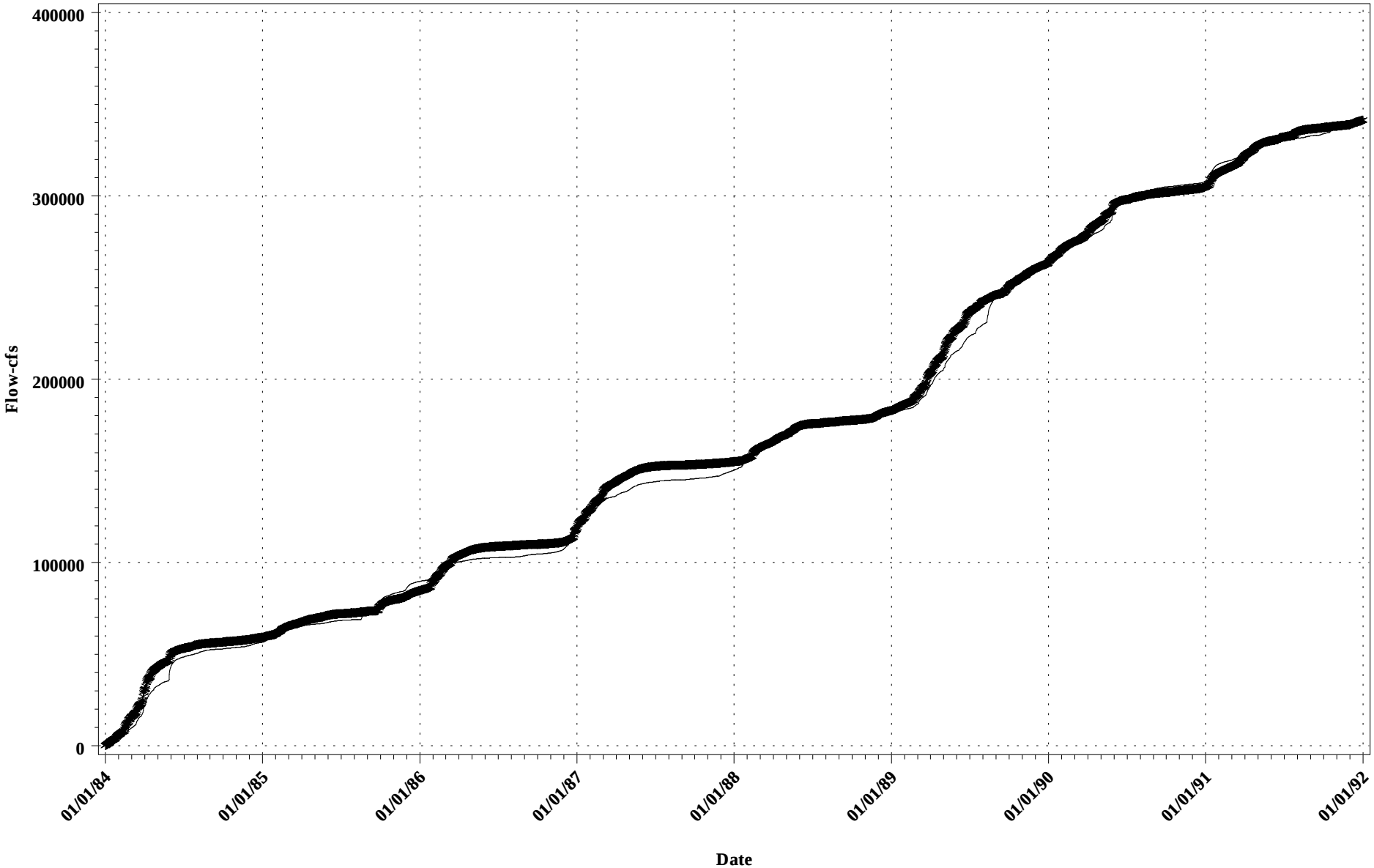
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(flow.drv 15JUN98 15:15)

Choptank River at Segment 770

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

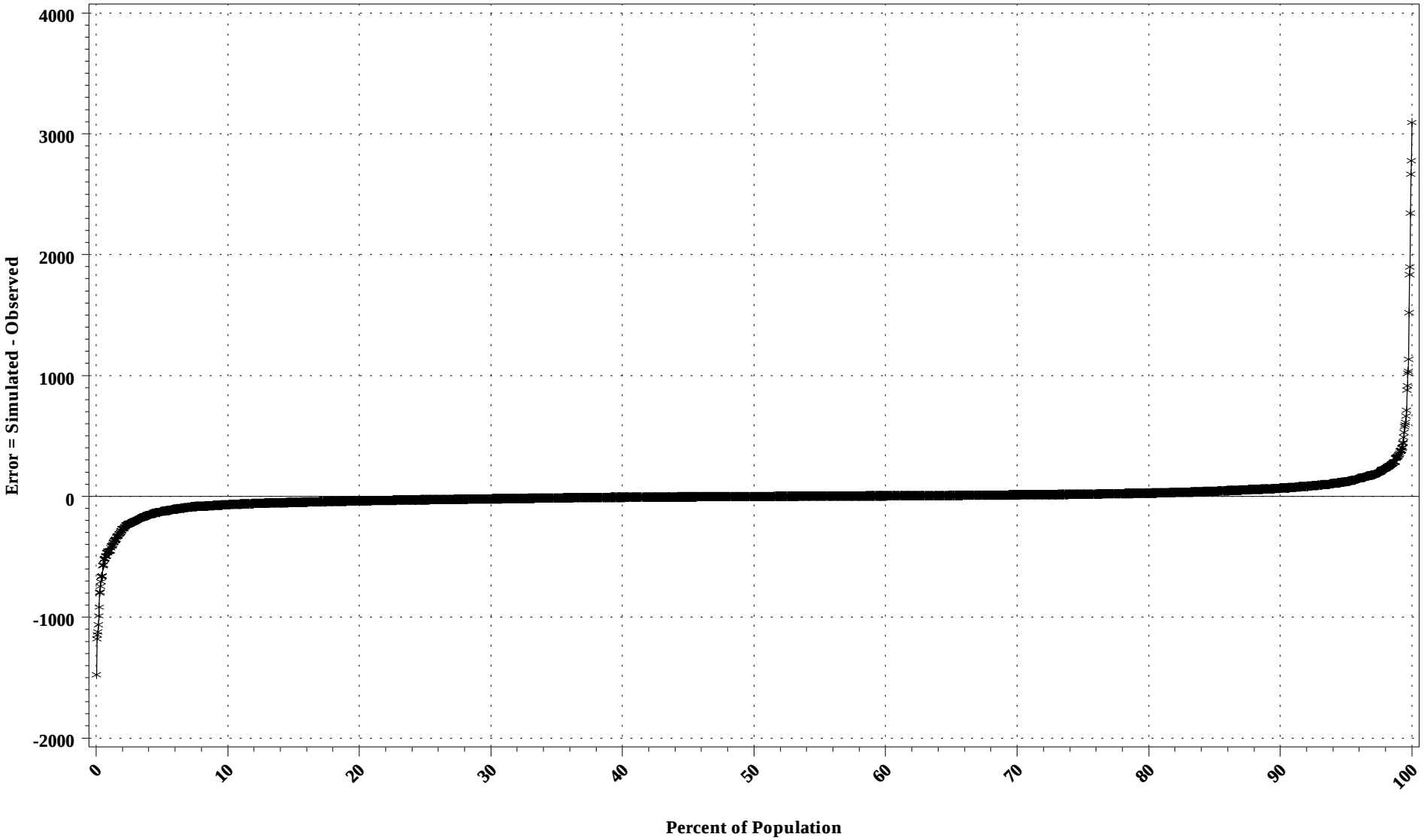
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(flow.drv 15JUN98 15:15)

Choptank River at Segment 770
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

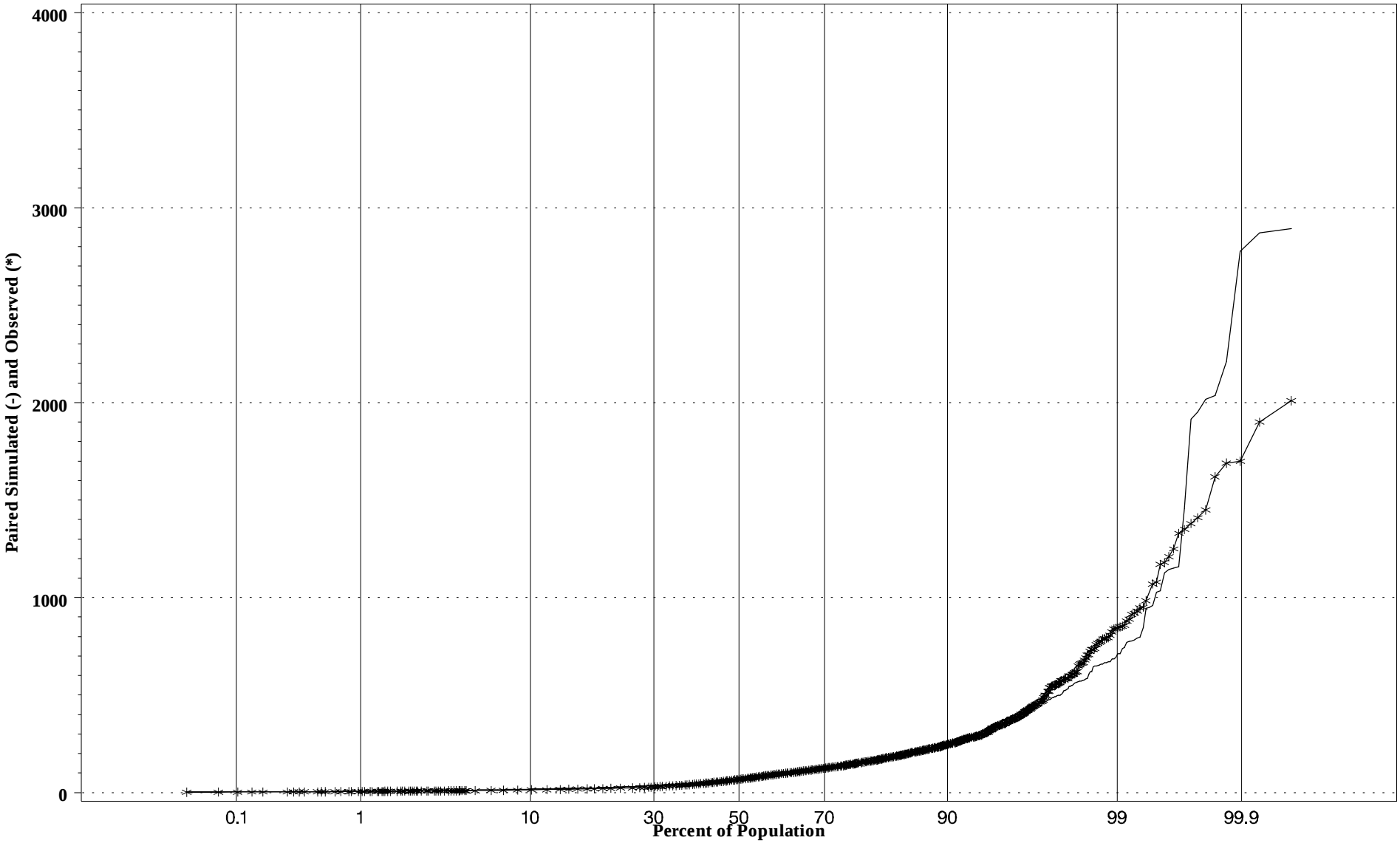


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(flow.drv 15JUN98 15:15)

Choptank River at Segment 770

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

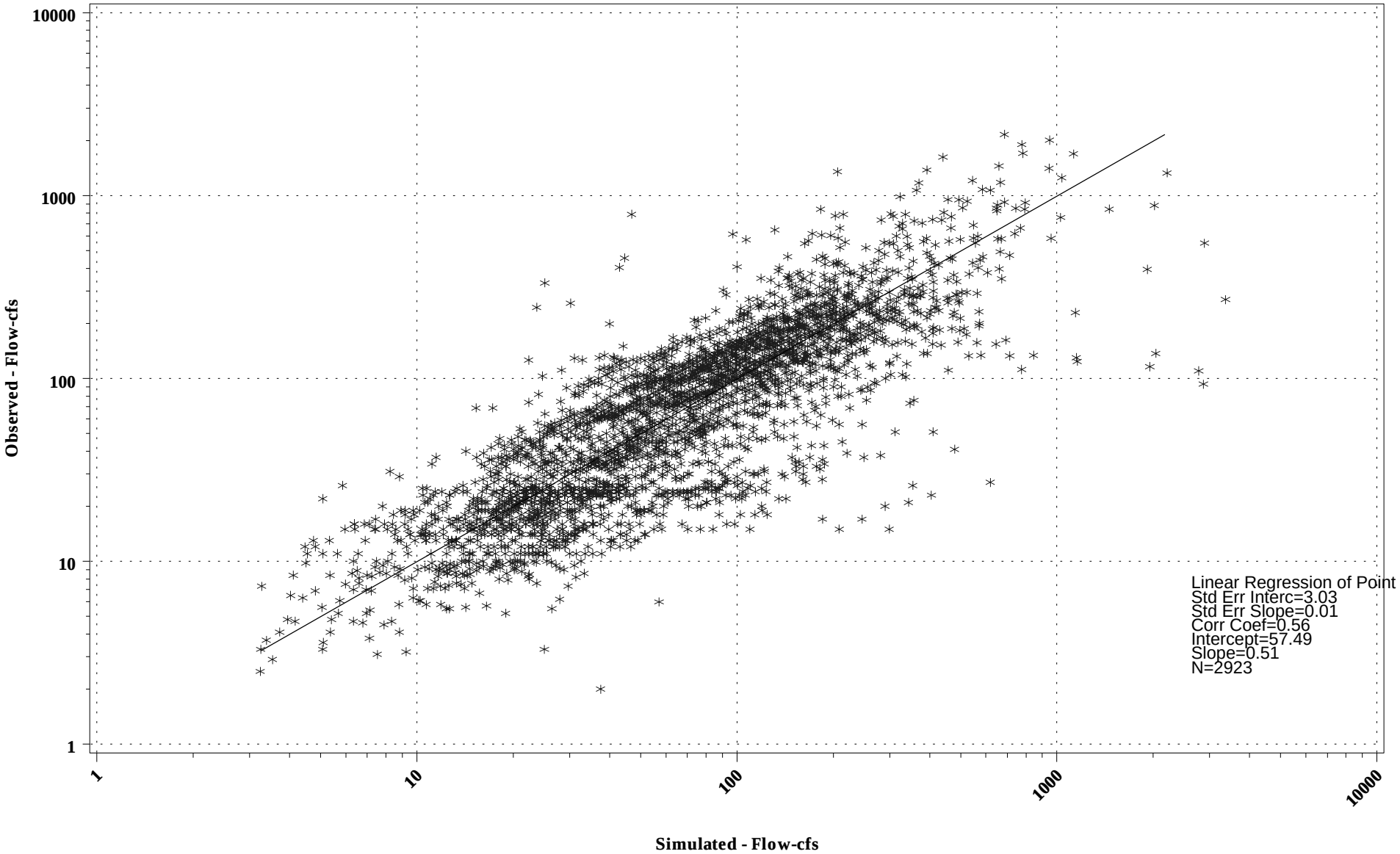


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(flow.drv 15JUN98 15:15)

Choptank River at Segment 770

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(flow.drv 15JUN98 15:15,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
CHOPTANK RIVER, MD (Segment 770)

Table A.8.0.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	19.52	18.81
1985	8.36	11.07
1986	11.07	9.80
1987	12.10	10.45
1988	9.19	10.27
1989	26.30	27.73
1990	13.78	14.52
1991	11.96	11.14
Mean	14.04	14.22

* Observed flow at Choptank River near Greensboro, MD
** Simulated outflow from RCH 770

Table A.8.0.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.82	0.37	0.82	0.83	0.35	0.91
1985	0.84	0.31	0.52	0.85	0.30	0.67
1986	0.75	0.36	0.64	0.75	0.36	0.69
1987	0.74	0.44	0.86	0.68	0.61	0.83
1988	0.85	0.28	0.75	0.91	0.17	0.81
1989	0.71	0.65	0.43	0.74	0.59	0.45
1990	0.67	0.66	0.57	0.69	0.62	0.67
1991	0.68	0.56	0.51	0.72	0.49	0.57
1984-1991	0.76	0.45	0.64	0.79	0.39	0.77

Table A.8.0.3 Seasonal r-squared.

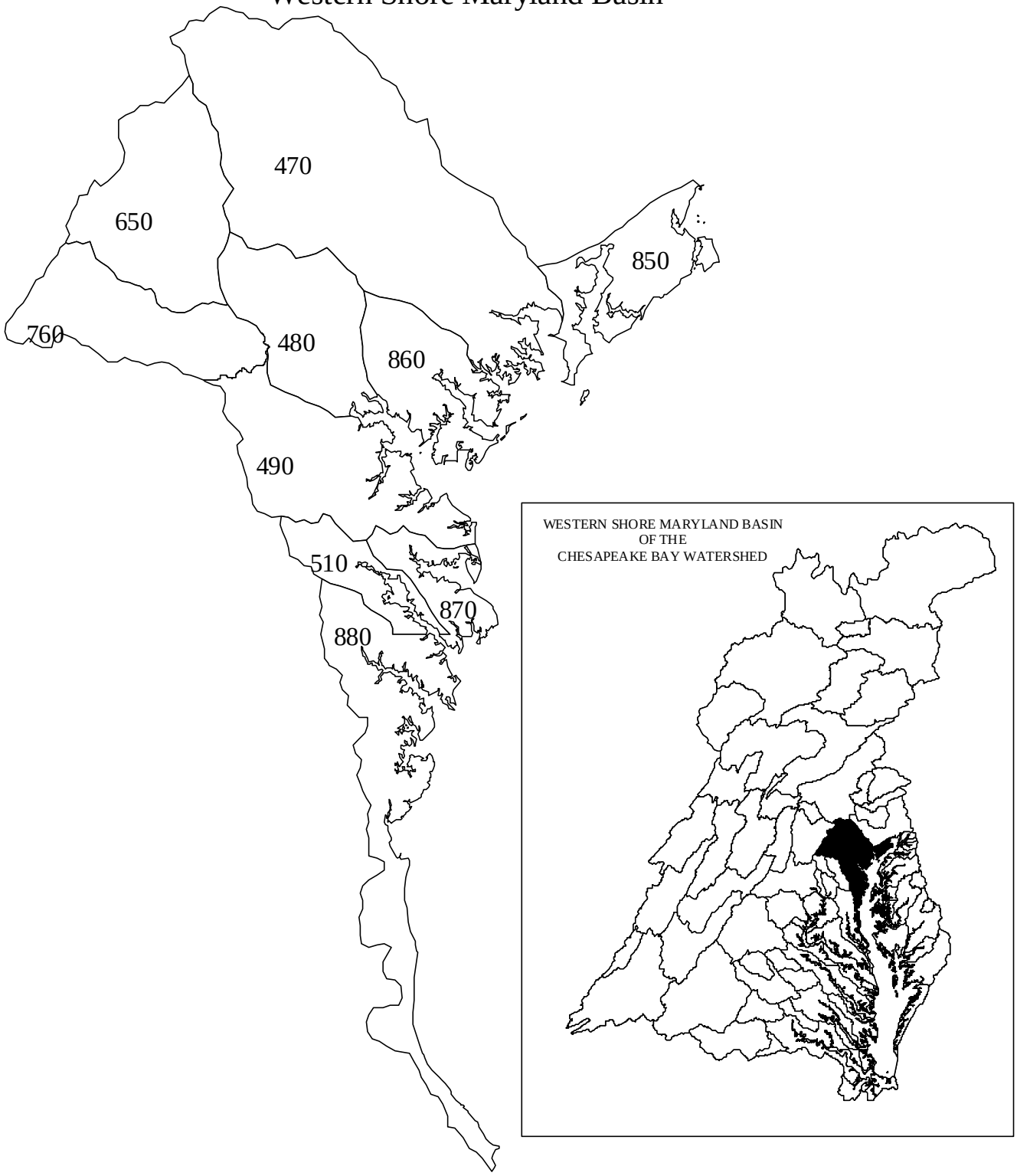
	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.86	0.49	0.58	0.70	0.75	0.53	0.82	0.18	0.81	0.58	0.55	0.73
1985	1.01	-0.21	0.76	0.60	0.83	0.74	0.24	0.96	0.19	0.77	0.39	0.77
1986	0.86	0.50	0.86	1.03	0.30	0.84	0.13	0.97	0.04	0.93	-0.15	0.90
1987	0.36	1.60	0.19	0.55	1.06	0.25	0.90	-0.03	0.72	0.45	0.48	0.70
1988	1.15	-0.63	0.54	0.55	0.98	0.48	0.99	0.01	0.64	1.20	-0.26	0.92
1989	0.87	0.46	0.84	0.77	0.62	0.47	0.42	1.20	0.17	0.63	0.77	0.67
1990	0.61	0.95	0.27	0.59	0.97	0.59	0.43	0.85	0.23	0.76	0.31	0.34
1991	0.63	0.84	0.79	0.87	0.40	0.79	0.64	0.69	0.14	0.61	0.44	0.47
1984-1991	0.62	0.75	0.47	1.05	-0.24	0.75	0.87	0.28	0.61	0.82	0.43	0.72

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

Figure A.9

Monitoring Stations

Chesapeake Bay Watershed
Phase IV Model Segments:
Western Shore Maryland Basin



KAG Map Date: January 1998

N
W
E
S

Source: USGS and Chesapeake Bay Program Modeling Team

A.9.0 PATAPSCO RIVER AT HOLLOFIELD, MD AT SEGMENT 760(1589000)

Observed and Simulated versus Date

Actual Error versus Date

Observed and Simulated Cumulative Flows (CF) 1984-1991

Actual Error versus Percentile Sample Population

Frequency Distribution-Pair, Simulated and Observed Data versus Percentile of Population

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

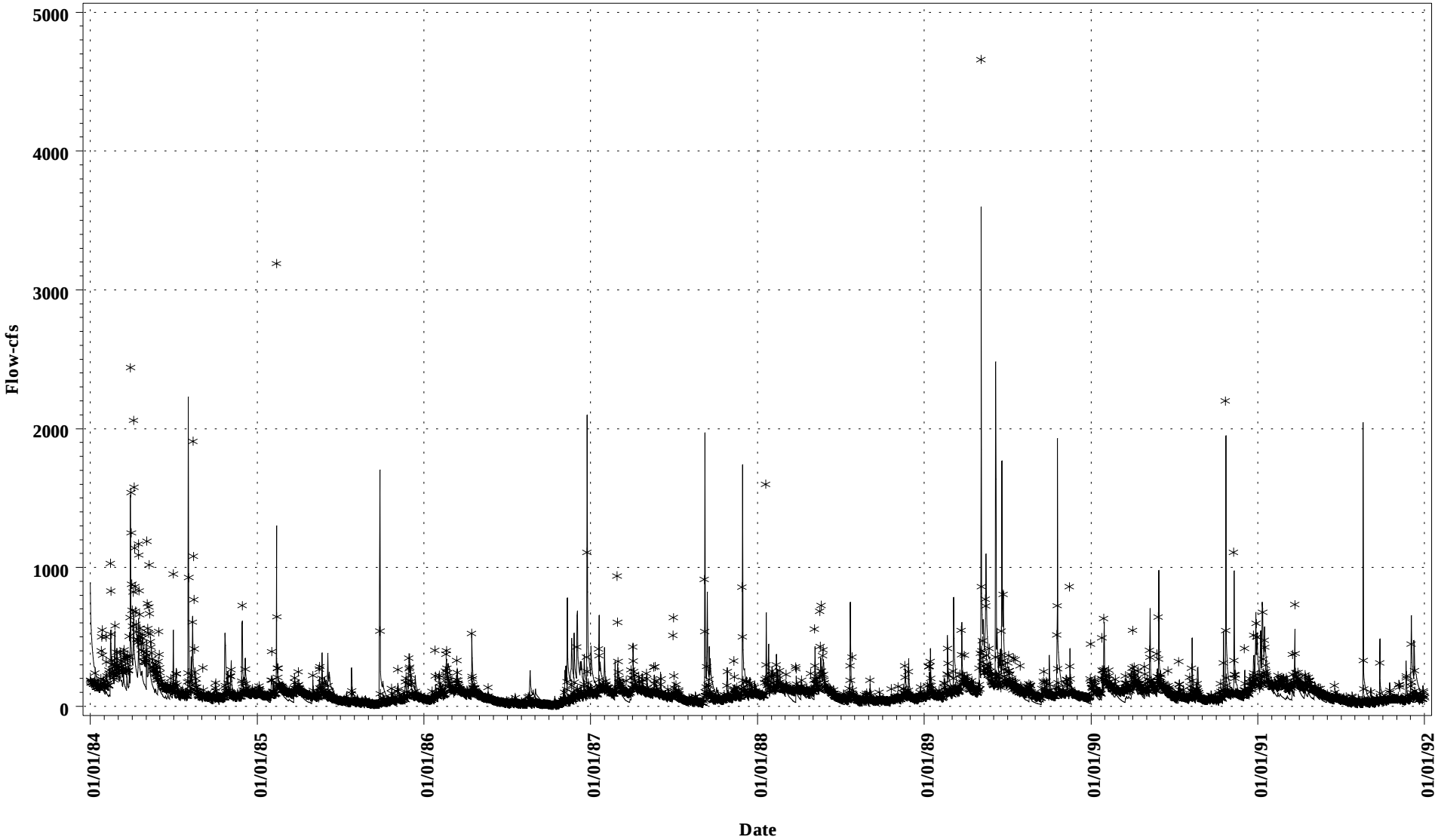
Comparison of Annual Total Observed and Simulated

Average Daily and Monthly Regressions for 1984-1991

Average Seasonal Regressions for 1984-1991

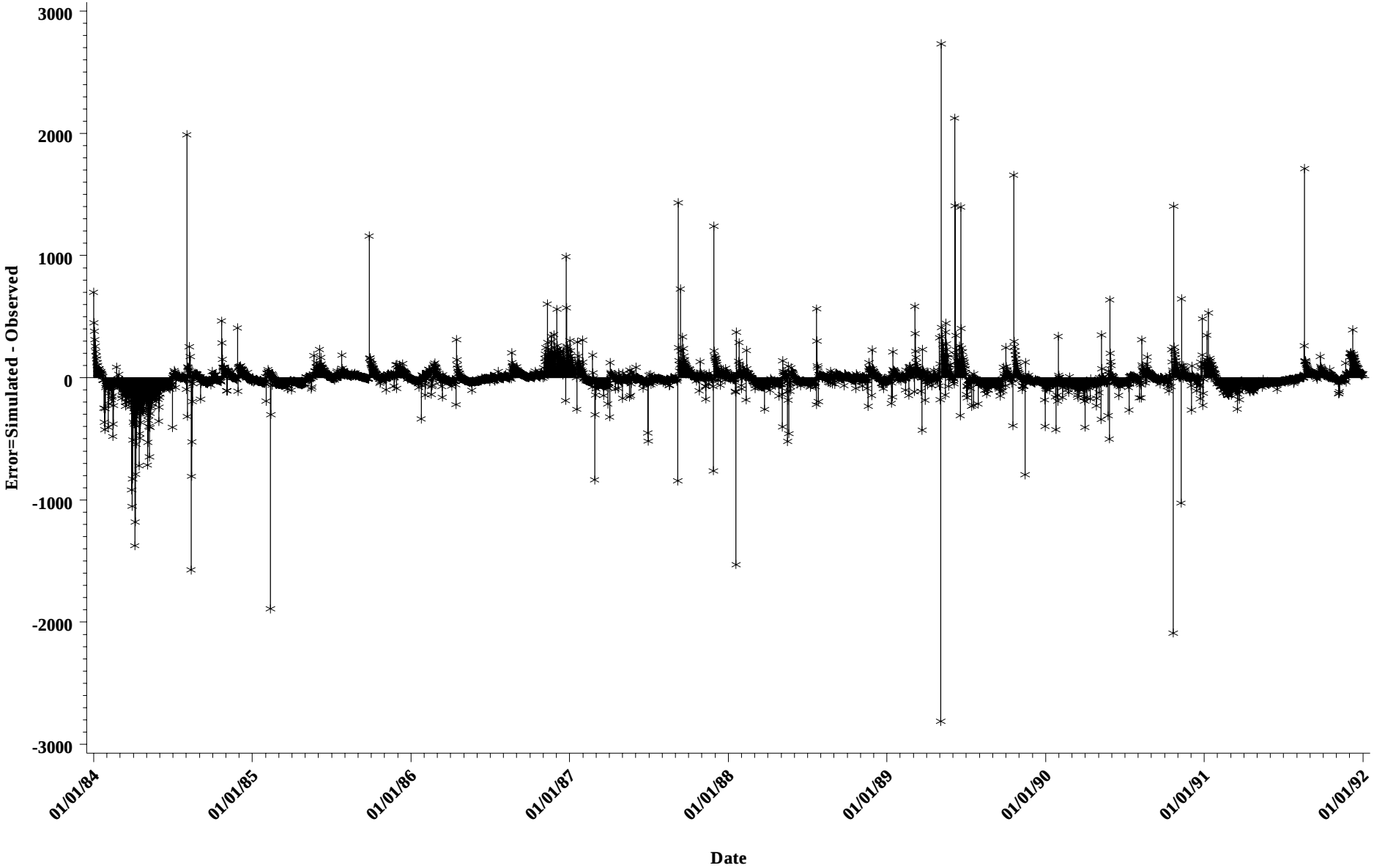
Patapsco River at Segment 760
Observed and Simulated versus Time
Flow-cfs

(*=Observed, -=Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] plotomt - omtime)
(patflow.drv 15JUN98 15:36)

Patapsco River at Segment 760
Actual Error versus Time
Flow-cfs



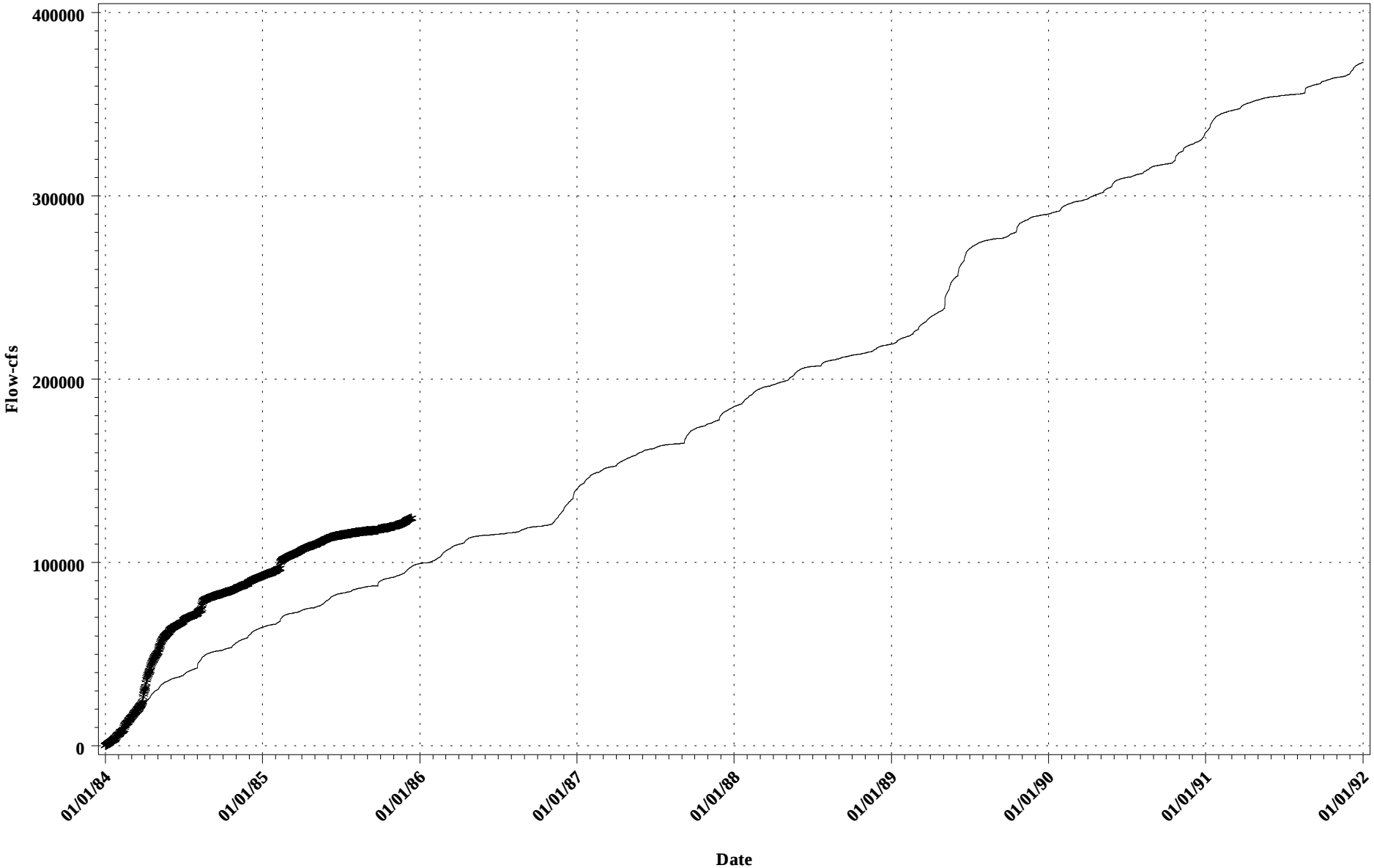
(y21_plot1.sas datastore2:[nps.p3.james.sas] omerr)
(patflow.drv 15JUN98 15:36)

Patapsco River at Segment 760

Observed and Simulated Cumulative Flows versus Time

Flow-cfs

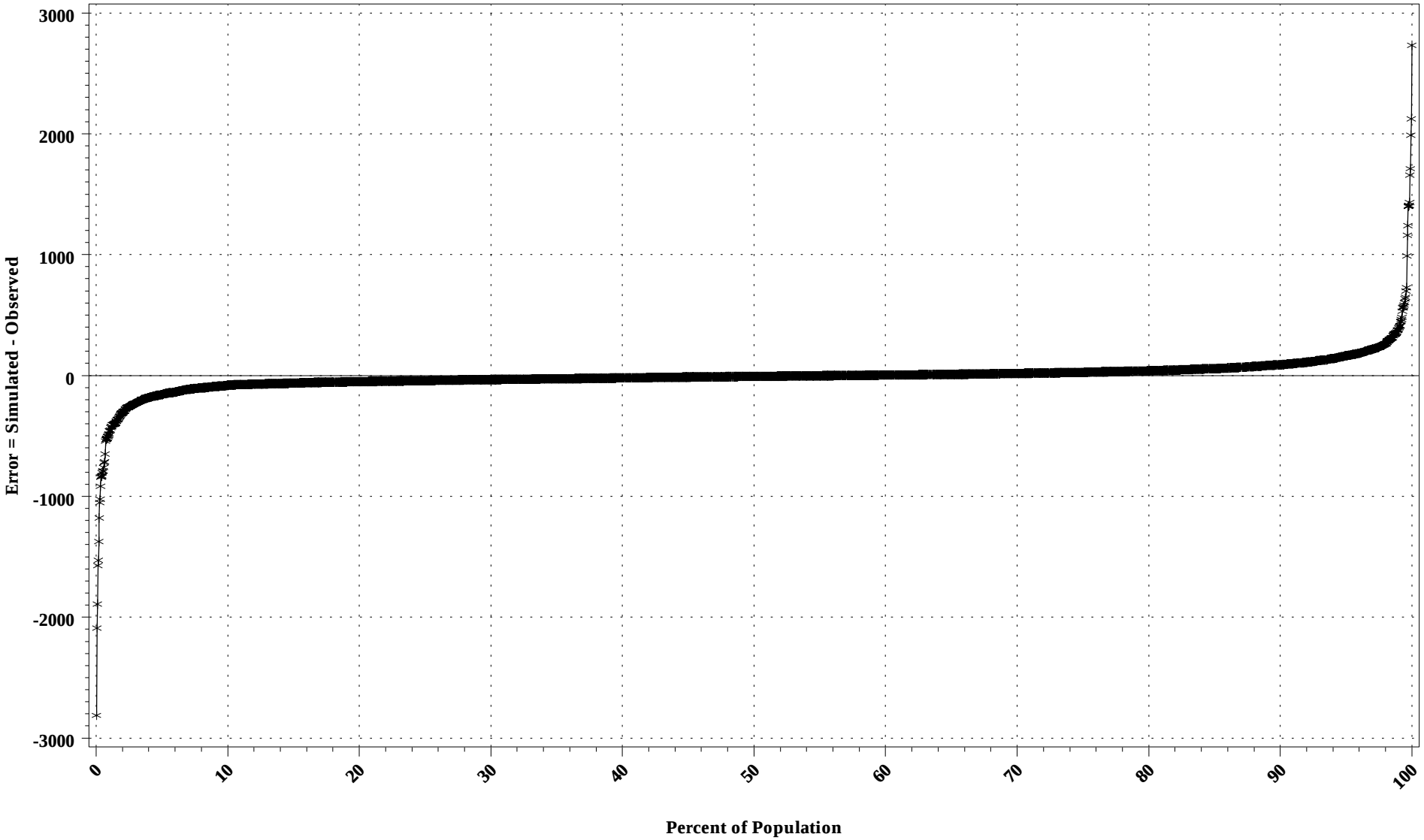
(* = Observed, _ = Simulated)



(y21_plot1.sas datastore2:[nps.p3.james.sas] cumflo)
(patflow.drv 15JUN98 15:36)

Patapsco River at Segment 760
Actual error versus Percentile Sample Population
Flow-cfs

Frequency Distribution - All Simulated and Observed Data

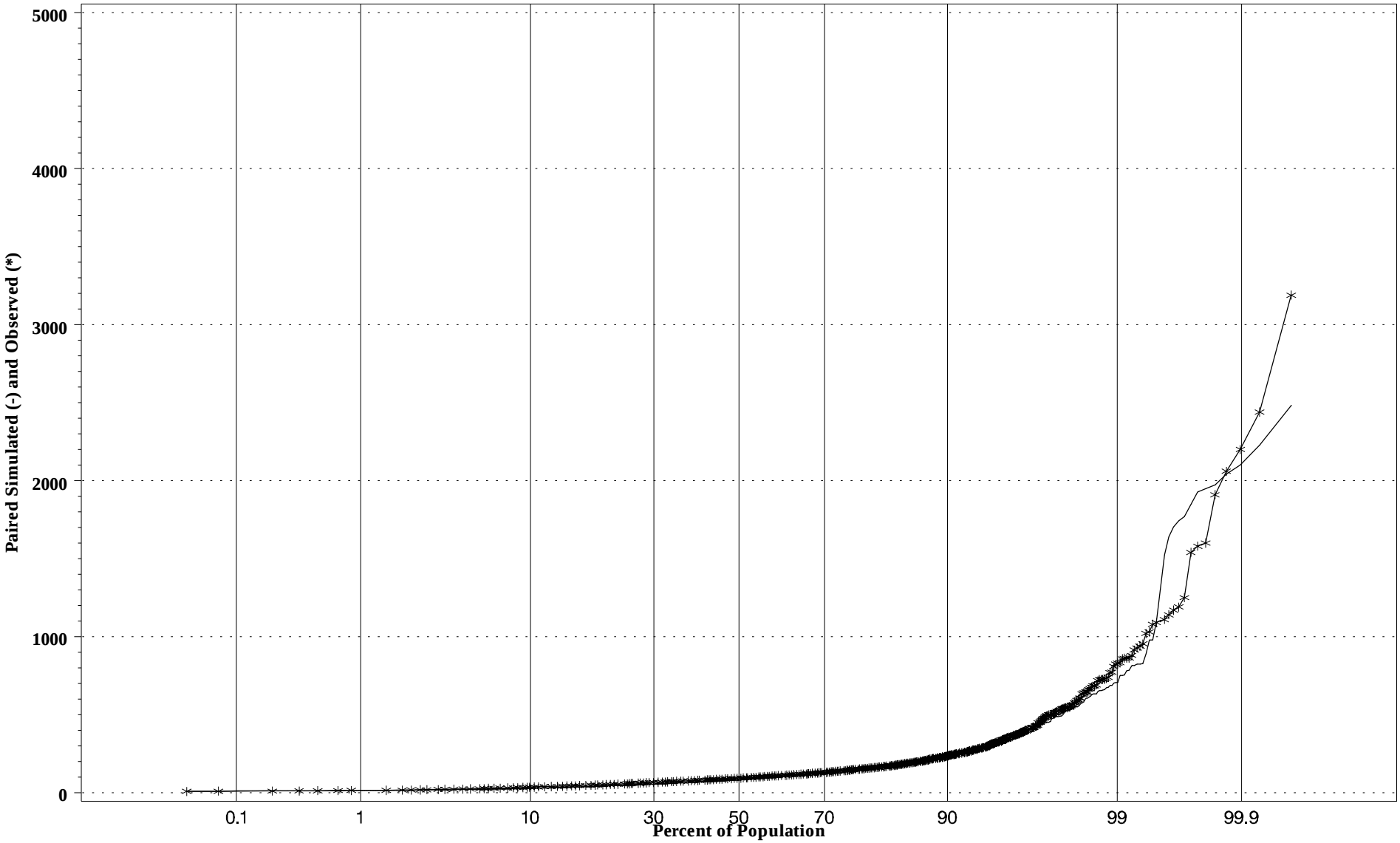


(y21_plot1.sas datastore2:[nps.p3.james.sas] cmabserr)
(patflow.drv 15JUN98 15:36)

Patapsco River at Segment 760

Frequency Distribution, Paired Simulated and Observed Data versus Percentile of Population

Flow-cfs

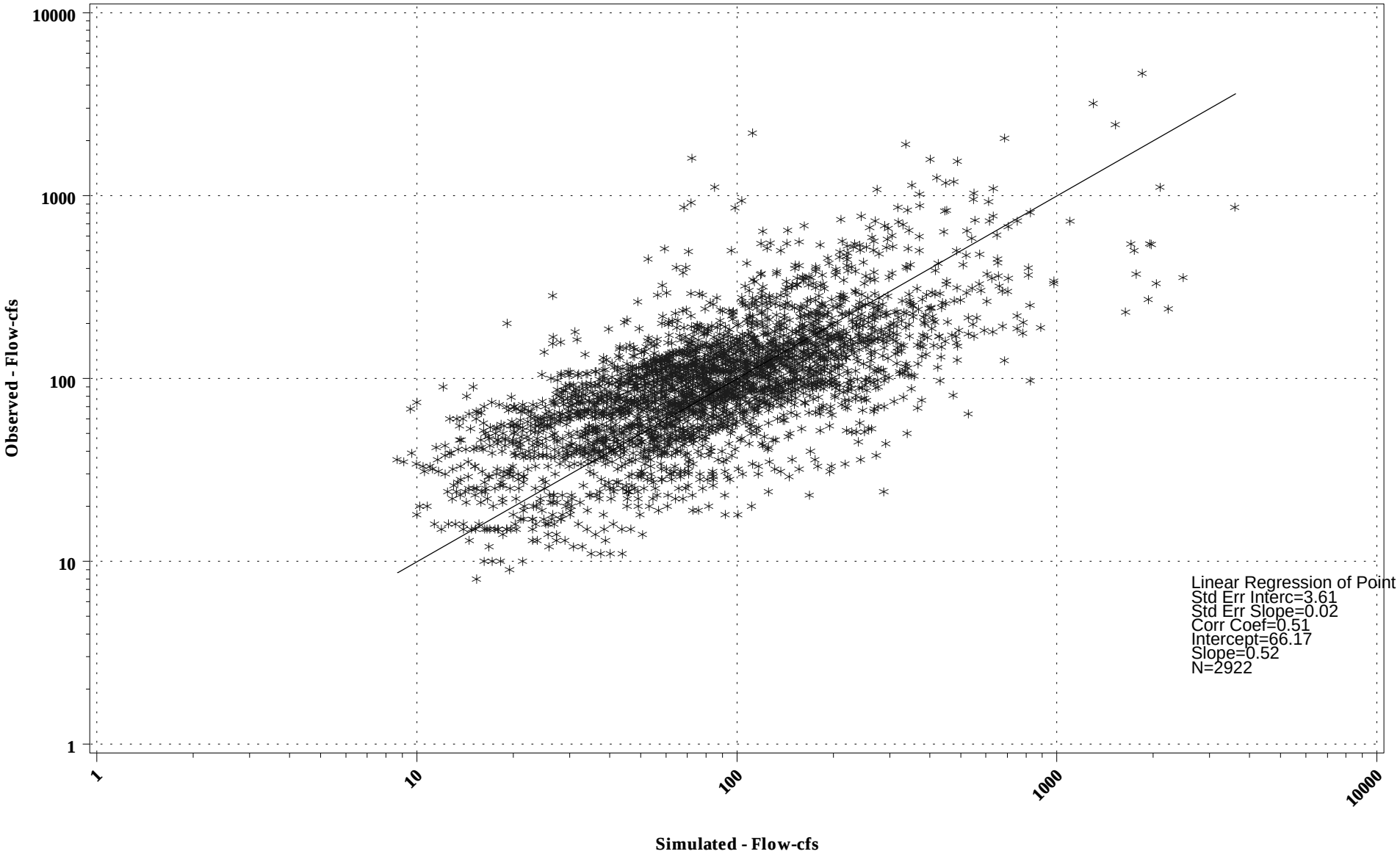


(y21_plot1.sas datastore2:[nps.p3.james.sas] ppsopair)
(patflow.drv 15JUN98 15:36)

Patapsco River at Segment 760

Scatter Plot and Regression of Simulated versus Observed with Ideal Line

Flow-cfs: 01JAN84 - 01JAN92



(y21_plot1.sas datastore2:[nps.p3.james.sas] llomregr)
(patflow.drv 15JUN98 15:36,proc reg,model y=x)

CHESAPEAKE BAY WATERSHED HYDROLOGIC CALIBRATION
PATAPSCO RIVER, MD (Segment 760)

Table 9.0.1 Comparison of Annual Total Observed and Simulated flows.

	Observed Flow	**Simulated Flow**
Year	(inches)*	(inches)**
1984	27.48	19.15
1985	9.74	10.33
1986	8.07	12.00
1987	12.44	13.39
1988	11.86	10.12
1989	17.93	21.02
1990	15.58	13.11
1991	11.38	11.44
Mean	14.31	13.82

* Observed flow at Patapsco River near
** Simulated outflow from RCH 760

Table 9.0.2 Regression of log simulated flow on log observed flow daily and monthly r-squared.

	Average Daily			**Average Monthly**		
Year	m	b	r2	m	b	r2
1984	0.81	0.51	0.51	0.99	3.86	0.58
1985	0.67	0.57	0.47	0.71	15.02	0.27
1986	0.59	0.65	0.48	0.61	18.71	0.44
1987	0.47	1.06	0.42	0.43	34.70	0.48
1988	0.54	0.94	0.43	0.82	13.00	0.64
1989	0.44	1.20	0.51	0.47	35.00	0.74
1990	0.50	1.10	0.35	0.65	24.36	0.41
1991	0.53	0.94	0.39	0.52	29.00	0.31
1984-1991	0.57	0.87	0.45	0.65	21.71	0.48

Table A.9.0.3 Seasonal r-squared.

	Season 1			Season 2			Season 3			Season 4		
Year	m	b	r2	m	b	r2	m	b	r2	m	b	r2
1984	0.17	1.96	0.03	1.02	0.27	0.84	0.63	0.85	0.48	0.47	1.01	0.51
1985	0.76	0.60	0.73	0.33	1.41	0.41	0.65	0.43	0.84	0.66	0.50	0.42
1986	0.56	0.92	0.65	0.51	1.05	0.77	0.03	1.34	0.00	0.79	0.00	0.82
1987	0.24	1.58	0.08	0.38	1.37	0.32	0.45	1.05	0.48	0.56	0.80	0.36
1988	0.37	1.33	0.14	0.46	1.28	0.44	0.34	1.22	0.27	0.40	1.09	0.27
1989	0.62	0.77	0.52	0.66	0.71	0.58	0.36	1.42	0.64	0.32	1.39	0.24
1990	0.50	1.21	0.46	0.34	1.53	0.29	0.47	1.06	0.37	0.55	0.94	0.42
1991	0.25	1.71	0.35	0.65	0.95	0.73	0.23	1.27	0.12	0.35	1.13	0.32
1984-1991	0.82	0.33	0.41	0.92	0.00	0.56	0.79	0.33	0.44	0.73	0.60	0.39

Season 1 is from Julian day 1 to 60.
Season 2 is from Julian day 61 to 150.
Season 3 is from Julian day 151 to 270.
Season 4 is from Julian day 271 to 365.

This report is cited in the following way:
Greene, K and L.C. Linker. 1998. Chesapeake Bay Watershed Model Application & Calculation of Nutrient & Sediment Loadings-Appendix A: Phase IV Chesapeake Bay Watershed Model Hydrology Calibration Results Report of the Modeling Subcommittee. May, 1998. Chesapeake Bay Program Office, Annapolis, MD. *http://www.chesapeakebay.net/modsc.htm - Publications Tab.* Date Retrieved: *retrieval date*