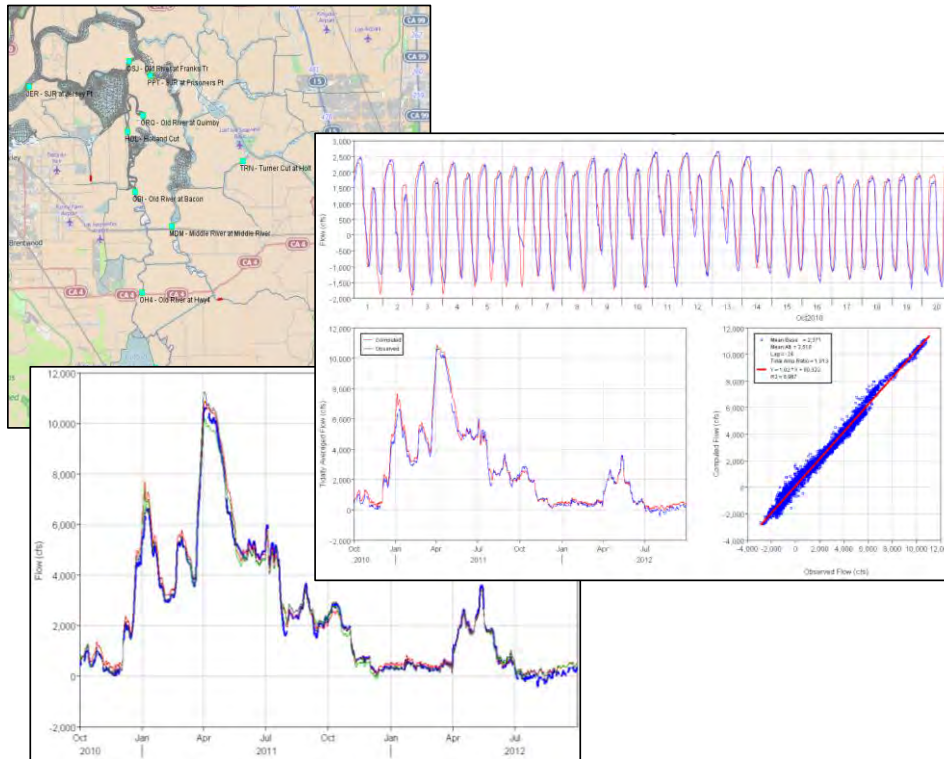


**Appendix C**  
**DSM2 and RMA2**  
**South Delta Flow Comparison**  
**Draft Technical Memorandum**

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# CAMT – DSM2 and RMA2 South Delta Flow Comparison Draft Technical Memorandum

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## Contents

Overview .....	1
Models .....	1
DSM2.....	1
RMA2.....	1
Boundary Conditions.....	2
Model Error Metrics and Model Skill .....	12
Error Metrics .....	12
Model Skill.....	14
Flow Results Comparison.....	14
Velocity Results Comparison.....	95
Stage Results Comparison.....	164
References .....	232

## Table of Figures

Figure 1 DSM2 model grid (CH2MHill, 2009). ....	5
Figure 2 RMA2 model grid with boundary condition locations. ....	6
Figure 3 DSM2 and RMA2 Sacramento River inflows. ....	7
Figure 4 DSM2 and RMA2 San Joaquin River inflows. ....	7
Figure 5 DSM2 and RMA2 Yolo Bypass/Cache Slough region inflows and withdrawals.....	8
Figure 6 DSM2 and RMA2 Yolo Bypass/Cache Slough region inflows and withdrawals (enhanced flow scale). ....	8
Figure 7 DSM2 and RMA2 Calaveras, Cosumnes and Mokelumne River inflows. ....	9
Figure 8 DSM2 and RMA2 Paradise Cut flows. ....	9
Figure 9 RMA2 Sacramento Regional Wastewater Treatment Plant Discharge flows (not included in DSM2).....	10
Figure 10 DSM2 and RMA2 export flows for SWP (daily average of 15-minute values) and CVP.....	10
Figure 11 DSM2 and RMA2 Contra Costa export flows at Rock Slough, Old River and Victoria Canal.....	11
Figure 12 DSM2 and RMA2 North Bay Aqueduct exports from Barker Slough. ....	11
Figure 13 DSM2 and RMA2 15-minute and tidally averaged stage at Martinez. ....	12
Figure 14 Flow comparison plot locations. ....	19
Figure 15 Computed (DSM2) and observed flow comparison plots for San Joaquin River at Brandt Bridge. ....	20

Figure 16 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for San Joaquin River at Brandt Bridge. ....	21
Figure 17 Computed (RMA2) and observed flow comparison plots for San Joaquin River at Brandt Bridge. ....	22
Figure 18 Computed (DSM2) and observed flow comparison plots for Prisoners Point. ....	23
Figure 19 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Prisoners Point. ....	24
Figure 20 Computed (RMA2) and observed flow comparison plots for Prisoners Point. ....	25
Figure 21 Computed (DSM2) and observed flow comparison plots for Jersey Point. ....	26
Figure 22 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Jersey Point. ....	27
Figure 23 Computed (RMA2) and observed flow comparison plots for Jersey Point (USGS observed data). ....	28
Figure 24 Computed (DSM2) and observed flow comparison plots for Old River at Franks Tract. ....	29
Figure 25 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Franks Tract. ....	30
Figure 26 Computed (RMA2) and observed flow comparison plots for Old River at Franks Tract. ....	31
Figure 27 Computed (DSM2) and observed flow comparison plots for Holland Cut. ....	32
Figure 28 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Holland Cut. ....	33
Figure 29 Computed (RMA2) and observed flow comparison plots for Holland Cut. ....	34
Figure 30 Computed (DSM2) and observed flow comparison plots for Old River at Bacon. ....	35
Figure 31 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Bacon. ....	36
Figure 32 Computed (RMA2) and observed flow comparison plots for Old River at Bacon. ....	37
Figure 33 Computed (DSM2) and observed flow comparison plots for Old River at Quimby. ....	38
Figure 34 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Quimby. ....	39
Figure 35 Computed (RMA2) and observed flow comparison plots for Old River at Quimby. ....	40
Figure 36 Computed (DSM2) and observed flow comparison plots for Middle River at Middle River. ....	41
Figure 37 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Middle River at Middle River. ....	42
Figure 38 Computed (RMA2) and observed flow comparison plots for Middle River at Middle River. ....	43
Figure 39 Computed (DSM2) and observed flow comparison plots for Turner Cut at Holt. ....	44
Figure 40 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Turner Cut at Holt. ....	45
Figure 41 Computed (RMA2) and observed flow comparison plots for Turner Cut at Holt. ....	46
Figure 42 Computed (DSM2) and observed flow comparison plots for Old River near DMC. ....	47
Figure 43 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River near DMC. ....	48
Figure 44 Computed (RMA2) and observed flow comparison plots for Old River near DMC. ....	49
Figure 45 Computed (DSM2) and observed flow comparison plots for Old River at Tracy. ....	50
Figure 46 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Tracy. ....	51
Figure 47 Computed (RMA2) and observed flow comparison plots for Old River at Tracy. ....	52



Figure 48 Computed (DSM2) and observed flow comparison plots for Old River at Hwy 4. ....	53
Figure 49 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Hwy 4. ....	54
Figure 50 Computed (RMA2) and observed flow comparison plots for Old River at Hwy 4. ....	55
Figure 51 Computed (DSM2) and observed flow comparison plots for SJR at Rough-n-Ready. ....	56
Figure 52 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for SJR at Rough-n-Ready. ....	57
Figure 53 Computed (RMA2) and observed flow comparison plots for SJR at Rough-n-Ready. ....	58
Figure 54 Computed (DSM2) and observed flow comparison plots for SJR at Garwood. ....	59
Figure 55 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for SJR at Garwood. ....	60
Figure 56 Computed (RMA2) and observed flow comparison plots for SJR at Garwood. ....	61
Figure 57 Computed (DSM2) and observed flow comparison plots for Old River at Head. ....	62
Figure 58 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Head. ....	63
Figure 59 Computed (RMA2) and observed flow comparison plots for Old River at Head. ....	64
Figure 60 Computed (DSM2) and observed flow comparison plots for SJR near Lathrop. ....	65
Figure 61 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for SJR near Lathrop. ....	66
Figure 62 Computed (RMA2) and observed flow comparison plots for SJR near Lathrop. ....	67
Figure 63 Computed (DSM2) and observed flow comparison plots for Old River at Clifton Court Intake. ....	68
Figure 64 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Clifton Court Intake. ....	69
Figure 65 Computed (RMA2) and observed flow comparison plots for Old River at Clifton Court Intake. ....	70
Figure 66 Computed (DSM2) and observed flow comparison plots for West Canal at Clifton Court Intake. ....	71
Figure 67 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for West Canal at Clifton Court Intake. ....	72
Figure 68 Computed (RMA2) and observed flow comparison plots for West Canal at Clifton Court Intake. ....	73
Figure 69 Computed (DSM2) and observed flow comparison plots for Old River near DMC. ....	74
Figure 70 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River near DMC. ....	75
Figure 71 Computed (RMA2) and observed flow comparison plots for Old River near DMC. ....	76
Figure 72 Tidally averaged observed and computed flows for SJR at Brandt Bridge. ....	77
Figure 73 Tidally averaged observed and computed flows for SJR Prisoner Point. ....	78
Figure 74 Tidally averaged observed and computed flows for Jersey Point. ....	79
Figure 75 Tidally averaged observed and computed flows for Old River at Franks Tract. ....	80
Figure 76 Tidally averaged observed and computed flows for Holland Cut. ....	81
Figure 77 Tidally averaged observed and computed flows for Old River at Bacon Island. ....	82
Figure 78 Tidally averaged observed and computed flows for Old River at Quimby. ....	83

Figure 79 Tidally averaged observed and computed flows for Middle River at Middle River.....	84
Figure 80 Tidally averaged observed and computed flows for Turner Cut at Holt.....	85
Figure 81 Tidally averaged observed and computed flows for Old River at DMC ds Barrier. ....	86
Figure 82 Tidally averaged observed and computed flows for Old River at Tracy. ....	87
Figure 83 Tidally averaged observed and computed flows for Old River at Hwy 4.....	88
Figure 84 Tidally averaged observed and computed flows for SJR at Rough-n-Ready.....	89
Figure 85 Tidally averaged observed and computed flows for SJR at Garwood.....	90
Figure 86 Tidally averaged observed and computed flows for Old River at Head. ....	91
Figure 87 Tidally averaged observed and computed flows for SJR near Lathrop.....	92
Figure 88 Tidally averaged observed and computed flows for Old River at Clifton Court Intake. ....	93
Figure 89 Tidally averaged observed and computed flows for West Canal at Clifton Court Intake.....	94
Figure 90 Velocity comparison plot locations.....	98
Figure 91 Computed (DSM2) and observed velocity comparison plots for San Joaquin River at Brandt Bridge.....	99
Figure 92 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for San Joaquin River at Brandt Bridge.....	100
Figure 93 Computed (RMA2) and observed velocity comparison plots for San Joaquin River at Brandt Bridge.....	101
Figure 94 Computed (DSM2) and observed velocity comparison plots for San Joaquin River at Prisoners Point.....	102
Figure 95 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for San Joaquin River at Prisoners Point.....	103
Figure 96 Computed (RMA2) and observed velocity comparison plots for San Joaquin River at Prisoners Point.....	104
Figure 97 Computed (DSM2) and observed velocity comparison plots for San Joaquin River at Jersey Point.....	105
Figure 98 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for San Joaquin River at Jersey Point.....	106
Figure 99 Computed (RMA2) and observed velocity comparison plots for San Joaquin River at Jersey Point.....	107
Figure 100 Computed (DSM2) and observed velocity comparison plots for Old River at Franks Tract. .	108
Figure 101 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Franks Tract.....	109
Figure 102 Computed (RMA2) and observed velocity comparison plots for Old River at Franks Tract. .	110
Figure 103 Computed (DSM2) and observed velocity comparison plots for Holland Tract. ....	111
Figure 104 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Holland Tract. ....	112
Figure 105 Computed (RMA2) and observed velocity comparison plots for Holland Tract.....	113
Figure 106 Computed (DSM2) and observed velocity comparison plots for Old River at Bacon Island..	114
Figure 107 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Bacon Island.....	115
Figure 108 Computed (RMA2) and observed velocity comparison plots for Old River at Bacon Island.	116

Figure 109 Computed (DSM2) and observed velocity comparison plots for Old River at Quimby. ....	117
Figure 110 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Quimby.....	118
Figure 111 Computed (RMA2) and observed velocity comparison plots for Old River at Quimby. ....	119
Figure 112 Computed (DSM2) and observed velocity comparison plots for Turner Cut at Holt.....	120
Figure 113 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Turner Cut at Holt.....	121
Figure 114 Computed (RMA2) and observed velocity comparison plots for Turner Cut at Holt. ....	122
Figure 115 Computed (DSM2) and observed velocity comparison plots for Old River at Tracy. ....	123
Figure 116 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Tracy.....	124
Figure 117 Computed (RMA2) and observed velocity comparison plots for Old River at Tracy. ....	125
Figure 118 Computed (DSM2) and observed velocity comparison plots for Old River at Hwy 4. ....	126
Figure 119 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Hwy 4. ....	127
Figure 120 Computed (RMA2) and observed velocity comparison plots for Old River at Hwy 4.....	128
Figure 121 Computed (DSM2) and observed velocity comparison plots for SJR at Rough-n-Ready.....	129
Figure 122 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for SJR at Rough-n-Ready. ....	130
Figure 123 Computed (RMA2) and observed velocity comparison plots for SJR at Rough-n-Ready. ....	131
Figure 124 Computed (DSM2) and observed velocity comparison plots for SJR at Garwood.....	132
Figure 125 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for SJR at Garwood. ....	133
Figure 126 Computed (RMA2) and observed velocity comparison plots for SJR at Garwood. ....	134
Figure 127 Computed (DSM2) and observed velocity comparison plots for Old River at Head.....	135
Figure 128 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Head.....	136
Figure 129 Computed (RMA2) and observed velocity comparison plots for Old River at Head. ....	137
Figure 130 Computed (DSM2) and observed velocity comparison plots for SJR near Lathrop.....	138
Figure 131 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for SJR near Lathrop.....	139
Figure 132 Computed (RMA2) and observed velocity comparison plots for SJR near Lathrop.....	140
Figure 133 Computed (DSM2) and observed velocity comparison plots for Old River at Clifton Court Intake. ....	141
Figure 134 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Clifton Court Intake.....	142
Figure 135 Computed (RMA2) and observed velocity comparison plots for Old River at Clifton Court Intake. ....	143
Figure 136 Computed (DSM2) and observed velocity comparison plots for West Canal at Clifton Court Intake. ....	144
Figure 137 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for West Canal at Clifton Court Intake.....	145

Figure 138 Computed (RMA2) and observed velocity comparison plots for West Canal at Clifton Court Intake. ....	146
Figure 139 Tidally averaged observed and computed velocity for SJR at Brandt Bridge. ....	147
Figure 140 Tidally averaged observed and computed velocity for SJR at Prisoners Point. ....	148
Figure 141 Tidally averaged observed and computed velocity for SJR at Jersey Point. ....	149
Figure 142 Tidally averaged observed and computed velocity for Old River at Franks Tract. ....	150
Figure 143 Tidally averaged observed and computed velocity for Holland Cut. ....	151
Figure 144 Tidally averaged observed and computed velocity for Old River at Bacon. ....	152
Figure 145 Tidally averaged observed and computed velocity for Old River at Quimby. ....	153
Figure 146 Tidally averaged observed and computed velocity for Turner Cut at Holt. ....	154
Figure 147 Tidally averaged observed and computed velocity for Old River near DMC. ....	155
Figure 148 Tidally averaged observed and computed velocity for Old River at Tracy. ....	156
Figure 149 Tidally averaged observed and computed velocity for Old River at Hwy 4. ....	157
Figure 150 Tidally averaged observed and computed velocity for SJR at Rough-n-Ready Island. ....	158
Figure 151 Tidally averaged observed and computed velocity for SJR at Garwood. ....	159
Figure 152 Tidally averaged observed and computed velocity for Old River at Head. ....	160
Figure 153 Tidally averaged observed and computed velocity for SJR near Lathrop. ....	161
Figure 154 Tidally averaged observed and computed velocity for Old River at Clifton Court Intake. ....	162
Figure 155 Tidally averaged observed and computed velocity for West Canal at Clifton Court Intake. ....	163
Figure 156 Stage comparison plot locations. ....	167
Figure 157 Computed (DSM2) and observed stage comparison plots for San Joaquin River at Brandt Bridge. ....	168
Figure 158 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for San Joaquin River at Brandt Bridge. ....	169
Figure 159 Computed (RMA2) and observed stage comparison plots for San Joaquin River at Brandt Bridge. ....	170
Figure 160 Computed (DSM2) and observed stage comparison plots for San Joaquin River at Jersey Point. ....	171
Figure 161 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for San Joaquin River at Jersey Point. ....	172
Figure 162 Computed (RMA2) and observed stage comparison plots for San Joaquin River at Jersey Point. ....	173
Figure 163 Computed (DSM2) and observed stage comparison plots for Middle River at Middle River. ....	174
Figure 164 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Middle River at Middle River. ....	175
Figure 165 Computed (RMA2) and observed stage comparison plots for Middle River at Middle River. ....	176
Figure 166 Computed (DSM2) and observed stage comparison plots for Old River at Hwy 4. ....	177
Figure 167 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Hwy 4. ....	178
Figure 168 Computed (RMA2) and observed stage comparison plots for Old River at Hwy 4. ....	179

Figure 169 Computed (DSM2) and observed stage comparison plots for Old River at Bacon Island. ....	180
Figure 170 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Bacon Island. ....	181
Figure 171 Computed (RMA2) and observed stage comparison plots for Old River at Bacon Island. ....	182
Figure 172 Computed (DSM2) and observed stage comparison plots for SJR at Rough-n-Ready.....	183
Figure 173 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR at Rough-n-Ready. ....	184
Figure 174 Computed (RMA2) and observed stage comparison plots for SJR at Rough-n-Ready. ....	185
Figure 175 Computed (DSM2) and observed stage comparison plots for SJR at Garwood. ....	186
Figure 176 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR at Garwood. ....	187
Figure 177 Computed (RMA2) and observed stage comparison plots for SJR at Garwood. ....	188
Figure 178 Computed (DSM2) and observed stage comparison plots for Old River at Head. ....	189
Figure 179 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Head. ....	190
Figure 180 Computed (RMA2) and observed stage comparison plots for Old River at Head. ....	191
Figure 181 Computed (DSM2) and observed stage comparison plots for SJR near Lathrop.....	192
Figure 182 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR near Lathrop.....	193
Figure 183 Computed (RMA2) and observed stage comparison plots for SJR near Lathrop. ....	194
Figure 184 Computed (DSM2) and observed stage comparison plots for Old River at Tracy. ....	195
Figure 185 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Tracy.....	196
Figure 186 Computed (RMA2) and observed stage comparison plots for Old River at Tracy.....	197
Figure 187 Computed (DSM2) and observed stage comparison plots for Antioch. ....	198
Figure 188 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Antioch.....	199
Figure 189 Computed (RMA2) and observed stage comparison plots for Antioch. ....	200
Figure 190 Computed (DSM2) and observed stage comparison plots for Middle River at Tracy. ....	201
Figure 191 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Middle River at Tracy.....	202
Figure 192 Computed (RMA2) and observed stage comparison plots for Middle River at Tracy. ....	203
Figure 193 Computed (DSM2) and observed stage comparison plots for Old River at Clifton Court Ferry. ....	204
Figure 194 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Clifton Court Ferry. ....	205
Figure 195 Computed (RMA2) and observed stage comparison plots for Old River at Clifton Court Ferry. ....	206
Figure 196 Computed (DSM2) and observed stage comparison plots for Old River at DMC downstream of Barrier. ....	207
Figure 197 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at DMC downstream of Barrier.....	208

Figure 198 Computed (RMA2) and observed stage comparison plots for Old River at DMC downstream of Barrier. ....	209
Figure 199 Computed (DSM2) and observed stage comparison plots for SJR at Venice Island. ....	210
Figure 200 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR at Venice Island. ....	211
Figure 201 Computed (RMA2) and observed stage comparison plots for SJR at Venice Island. ....	212
Figure 202 Computed (DSM2) and observed stage comparison plots for SJR at Rindge Pump. ....	213
Figure 203 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR at Rindge Pump. ....	214
Figure 204 Computed (RMA2) and observed stage comparison plots for SJR at Rindge Pump. ....	215
Figure 205 Computed (DSM2) and observed stage comparison plots for San Joaquin River at Brandt Bridge. ....	216
Figure 206 Computed (DSM2) and observed stage comparison plots for SJR at Jersey Point. ....	217
Figure 207 Computed (DSM2) and observed stage comparison plots for Middle River at Middle River. ....	218
Figure 208 Computed (DSM2) and observed stage comparison plots for Old River at Hwy 4. ....	219
Figure 209 Computed (DSM2) and observed stage comparison plots for Old River at Bacon Island. ....	220
Figure 210 Computed (DSM2) and observed stage comparison plots for SJR at Rough-n-Ready. ....	221
Figure 211 Computed (DSM2) and observed stage comparison plots for SJR at Garwood. ....	222
Figure 212 Computed (DSM2) and observed stage comparison plots for Old River at Head. ....	223
Figure 213 Computed (DSM2) and observed stage comparison plots for SJR near Lathrop. ....	224
Figure 214 Computed (DSM2) and observed stage comparison plots for Old River at Tracy. ....	225
Figure 215 Computed (DSM2) and observed stage comparison plots for Antioch. ....	226
Figure 216 Computed (DSM2) and observed stage comparison plots for Middle River at Tracy. ....	227
Figure 217 Computed (DSM2) and observed stage comparison plots for Old River at Clifton Court Ferry. ....	228
Figure 218 Computed (DSM2) and observed stage comparison plots for Old River at DMC ds Barrier. ....	229
Figure 219 Computed (DSM2) and observed stage comparison plots for SJR at Venice Island. ....	230
Figure 220 Computed (DSM2) and observed stage comparison plots for SJR at Rindge Pump. ....	231

## List of Tables

Table 1 Skill metric threshold values for three categories of model accuracy (MacWilliams et al., 2015). ....	14
Table 2 Flow error metrics summary by location. ....	17
Table 3 Summary of flow error metrics and model skill with shading ranging from green for better fit to red for worse fit. ....	18
Table 4 Velocity error metrics summary. Asterisks after station names indicate that observed data are from CDEC, which can contain time shift errors. ....	96
Table 5 Summary of velocity error metrics and model skill with shading ranging from green for better fit to red for worse fit. Asterisks after station names indicate that observed data are from CDEC, which can contain time shift errors. ....	97

Table 6 Stage error metrics summary. Asterisks after station names indicate that observed data are from CDEC, which can contain time shift errors.....	165
Table 7 Summary of stage error metrics and model skill, with shading ranging from green for better fit to red for worse fit. Asterisks after station names indicate that observed data are from CDEC, which can contain time shift errors. ....	166

## Overview

The Collaborative Adaptive Management Team (CAMT) Salmon Scoping Team has requested that comparative modeling simulations be performed to help determine if there is a model that can be used in a short time scale and at a small geographic scale to compliment the fine scale acoustic tagged fish data they have collected.

Hydrodynamic modeling and individual based modeling of salmon are useful tools in understanding salmon entrainment and the effectiveness of any measures to decrease this entrainment. Several modeling platforms are potentially suitable for modeling hydrodynamics and particle-tracking/individual based modeling in the Delta. Two models that are currently frequently applied are DSM2 and RMA2. The purpose of this document is to assess the accuracy of the two models by comparing the calibration of up to date versions of the models in the south Delta region.

Model simulations were performed for the period of October 1, 2010 through September 30, 2012. Water year (WY) 2011 was a wet year, and WY 2012 was a below normal/dry year.

## Models

### DSM2

The Delta Simulation Model II (DSM2), developed by State of California, Department of Water Resources (DWR), is a one-dimensional mathematical model for dynamic simulation of one-dimensional hydrodynamics, water quality and particle tracking in a network of riverine or estuarine channels (<https://dsm2ug.water.ca.gov/home>).

#### Geometric Extents

The DSM2 model grid, shown in Figure 1, extends from Martinez to the at the west end of Suisun Bay to the Sacramento River at Sacramento, and to the San Joaquin River near Vernalis.

### RMA2

RMA2 is a two-dimensional depth-averaged finite element hydrodynamic model developed by Resource Management Associates (RMA) (<http://www.water.ca.gov/frankstract/docs/%288%29RMA-Calibration%20Report.pdf>). The “salinity-coupled” version of the RMA2 program has been applied in this study. This version includes the relevant water quality transport routines from the RMA11 program in order to compute the salinity distribution throughout the model domain during the hydrodynamic simulation. The salinities or Electrical Conductivity (EC) values are then utilized in the computation of the baroclinic term of the flow equation. Salinity transport and flow are not computed simultaneously. Rather, the salinities from the previous computational time step are used to compute the fluid densities for the current hydrodynamic time step. Once a converged solution for the flow computation is achieved, the resulting flow field is utilized for the computation of the salinity transport. On average, the “salinity-coupled” model increases computed Delta stages about 0.3 feet over the standard RMA-2



model, with the effect greater in the summer and fall, and less during the wet season when Suisun Bay salinities are lower.

### Geometric Extents

The RMA Delta model, shown in Figure 2, extends from Martinez at the west end of Suisun Bay to the Sacramento River above the confluence with the American River, and to the San Joaquin River near Vernalis. A two-dimensional depth-averaged approximation is used to represent the Suisun Bay region, the Sacramento-San Joaquin confluence area, Sherman Lake, the Sacramento River up to Rio Vista, Cache Slough, Liberty Island, Shag Slough, portions of Lindsey Slough, the Sacramento River Deep Water Ship Channel (DWSC) and Miner Slough, Big Break, the San Joaquin River up to its confluence with Middle River, False River, Franks Tract and surrounding channels, Mildred Island, Old River south of Franks Tract, and the Delta Cross Channel area. The other Delta and Suisun Marsh channels and tributary streams are represented using a one-dimensional cross-sectionally averaged approximation.

## Boundary Conditions

The DSM2 grid and boundary condition locations are shown here in Figure 1.

The RMA Bay-Delta model grid and boundary condition locations are shown in Figure 2. The typical RMA2 model applied boundary conditions are slightly different than what is applied in DSM2. There are several reasons for the differences, including:

- Boundary location – in RMA2 the Sacramento River extends further upstream than DSM2 and includes the American River, while DSM2 does not. Therefore, Sacramento and American River flows are typically applied separately in RMA2.
- Internally calculated flows versus boundary condition inputs – DSM2 calculates Paradise Cut flows internally while RMA2 applies them as boundary conditions estimated from observed San Joaquin River flows upstream and downstream of the Paradise Cut weir.
- Selection of different data sets – many agencies collect and publish data, resulting in multiple non-identical data sets at some locations. For RMA2, we use what we feel are the best data sets available from US Geological Survey (USGS), California Data Exchange Center (CDEC), Water Data Library (WDL) and DWR to set model boundary conditions. Where data are not available, RMA2 uses flows estimated based on flow balances or seasonal trends (these methods have been used to estimate Yolo Bypass/Cache Slough region flows).

To more carefully compare the results of the DSM2 and RMA2 model simulations and differentiate between the effects of boundary conditions and the effects of the models themselves (computational engine, model geometry, model parameters, etc.), the RMA2 model was run with boundary conditions identical to DSM2 (to the extent possible) and with typical RMA2 boundary conditions. DSM2 and typical RMA2 model boundary conditions are plotted in Figure 3 through Figure 13 below.

### Sacramento River

On the Sacramento River (Figure 3), the RMA model extends upstream above the American River. Therefore, American River and Sacramento River flows are both applied, whereas DSM2 has only a Sacramento River inflow boundary. There are slight differences between the DSM2 Sacramento River flows and the RMA2 Sacramento + American River flows that are likely due to the use of different data sources.

#### San Joaquin River

DSM2 and RMA2 San Joaquin River flows (Figure 4) differ slightly. RMA2 uses USGS Vernalis flows while DSM2 uses DWR Vernalis flows (CH2MHill, 2009).

#### Yolo Bypass/Cache Slough Region

DSM2 and RMA2 flow boundary conditions in the Yolo Bypass/Cache Slough region (Figure 5) differ significantly. RMA2 uses a combination of WDL, USGS, DWR and CDEC data to estimate and set flows for the Bypass, Toe Drain and other inflows and withdrawals in the region. The summed RMA2 flows in the region are higher than the single DSM2 inflow to Yolo Bypass during the high flow period. Figure 6 shows the same boundary conditions with the flow scale enhanced to emphasize the low flow periods. This plot indicates that DSM2 generally applies higher flows during the summer and fall and the RMA2 model actually applies negative flows (representing agricultural withdrawals) during this period with the theory that DICU is not high enough to account for the actual withdrawals. The “Upper Cache Slough Flows” plotted in diversion and return flows in the Cache Slough complex were derived by mass balance using ADCP flow measurements in Upper Cache Slough and Lindsey Slough.

#### Calaveras, Cosumnes and Mokelumne Rivers

DSM2 and RMA2 Calaveras, Cosumnes and Mokelumne River flows (Figure 7) differ slightly. DSM2 uses DWR data for each of these inflows. RMA2 uses a combination of DWR, CDEC and USGS flows with some time shifts to account for travel time.

#### Paradise Cut

DSM2 computes Paradise Cut flow during the model simulation based on flow in the San Joaquin River. RMA2 uses applied flow boundary conditions, withdrawing flow from the San Joaquin River at Paradise Cut, with a corresponding inflow to Paradise Cut. The flow is estimated by subtracting Mossdale flows from Vernalis flows when Vernalis flows exceed 15,000 cfs. Paradise Cut flows for both models are plotted in Figure 8.

#### Sacramento Regional Wastewater Treatment Plant (SRWWTP) Discharge

RMA2 applies discharge from SRWWTP (Figure 9), whereas this is not included in DSM2.

#### SWP and CVP Exports

SWP and CVP exports are generally identical between the two models (Figure 10). The SWP exports applied in RMA2 are in fact computed by DSM2.

During periods when gate opening heights and water surface elevation data inside and outside Clifton Court Forebay are available, RMA uses SWP exports that are computed using this data with gate equations, resulting in a more accurate boundary condition. These data are not, however, available during the WY2011-2012 simulation period used in this study.

#### Contra Costa Exports

Contra Costa exports at Rock Slough, Old River and Victoria Canal (Figure 11) are identical between the two models.

#### North Bay Aqueduct Exports

North Bay Aqueduct exports in Barker Slough (Figure 12) are generally identical between the two models.

#### Martinez Stage

DSM2 and RMA2 stage boundary conditions (Figure 13) are identical throughout most of the simulation period. There are some brief periods of difference resulting from employment of different methods of filling data gaps or correcting bad data.

The two models use identical DICU and gate and barrier operation schedules.

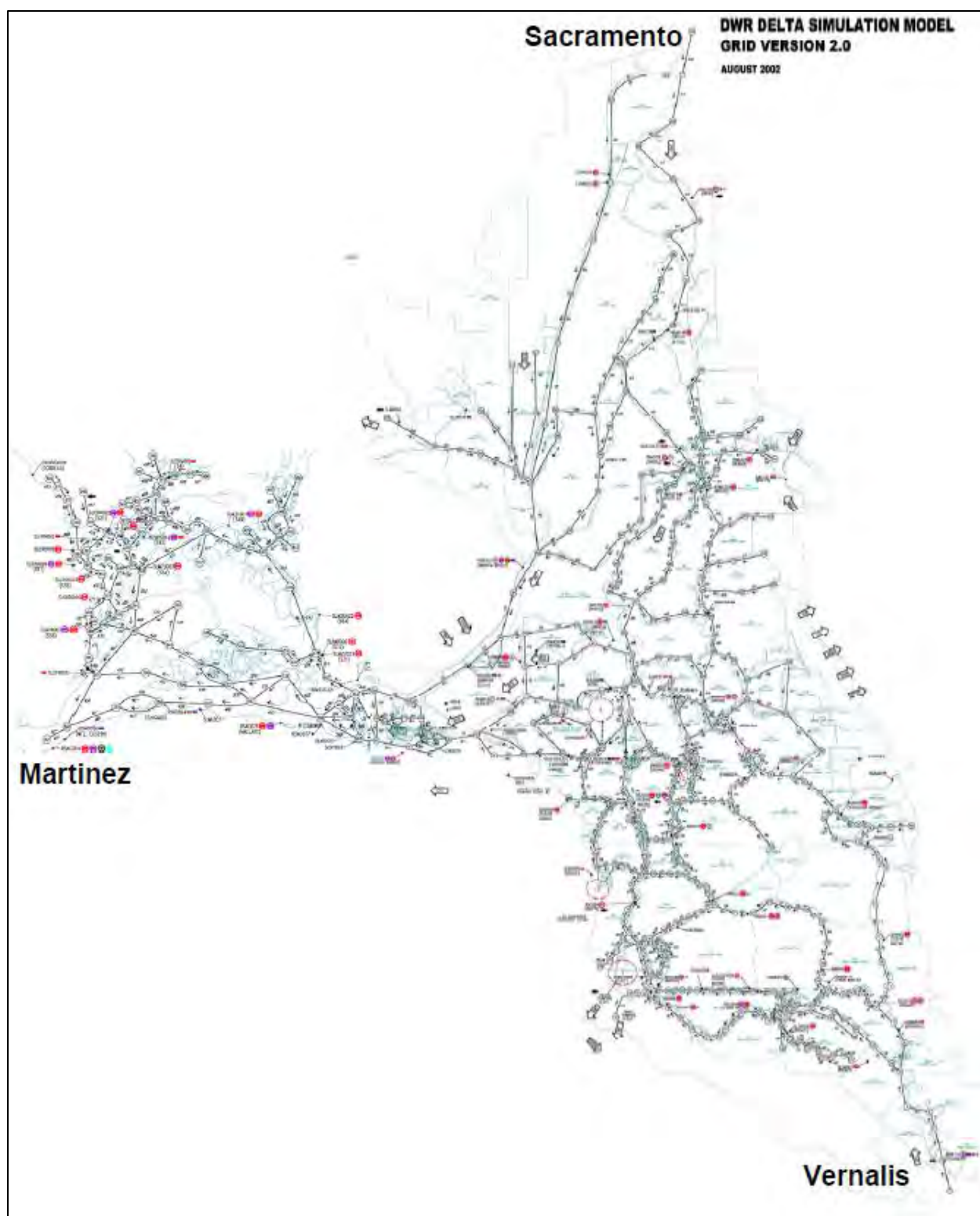


Figure 1 DSM2 model grid (CH2MHill, 2009).

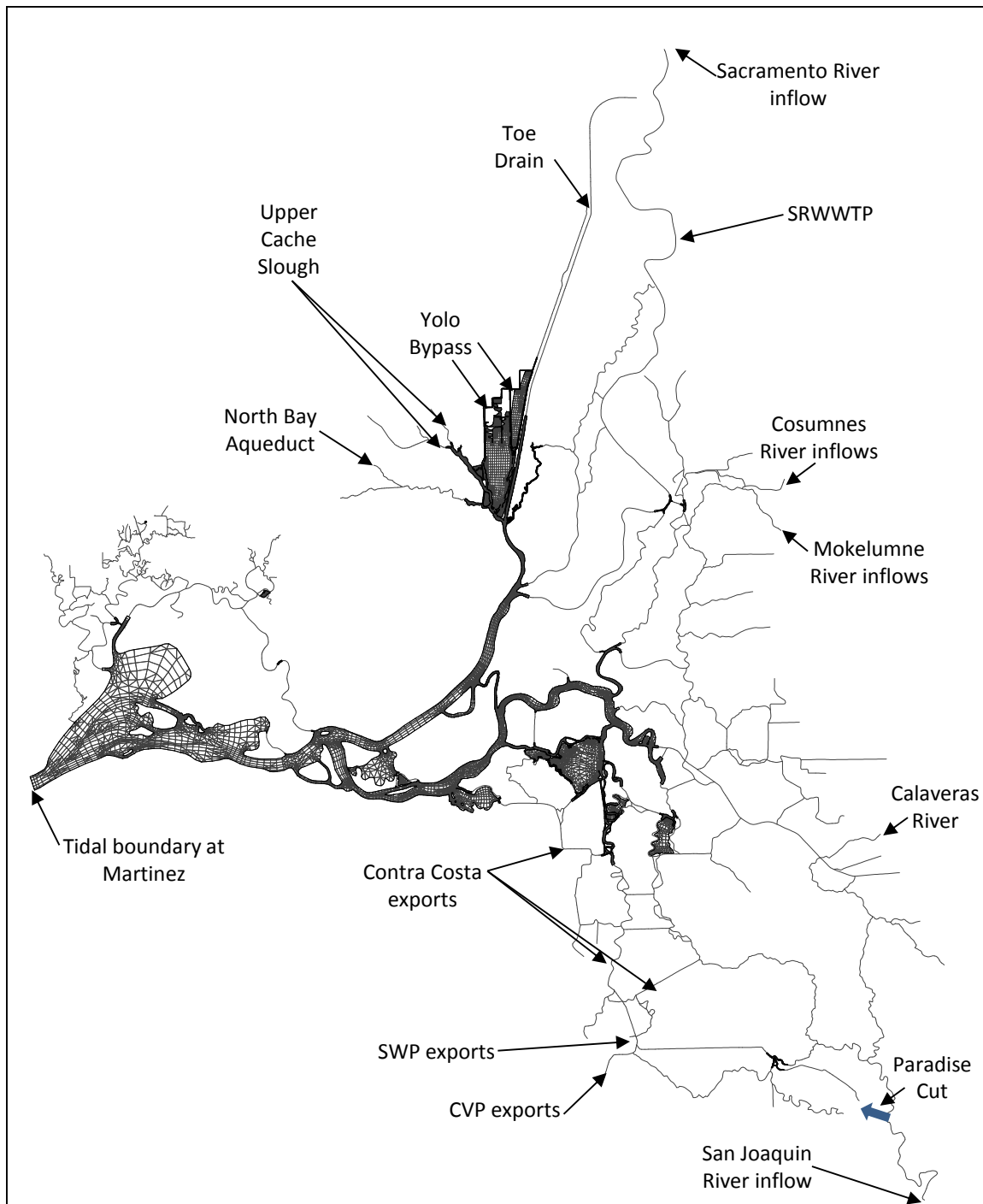


Figure 2 RMA2 model grid with boundary condition locations.

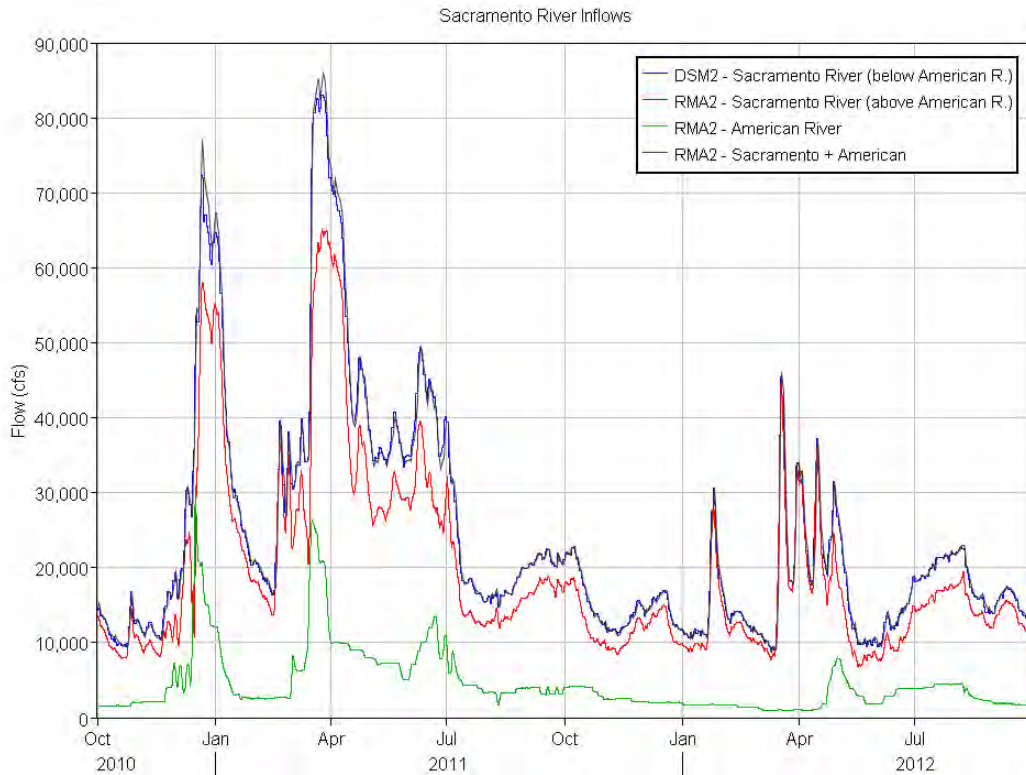


Figure 3 DSM2 and RMA2 Sacramento River inflows.

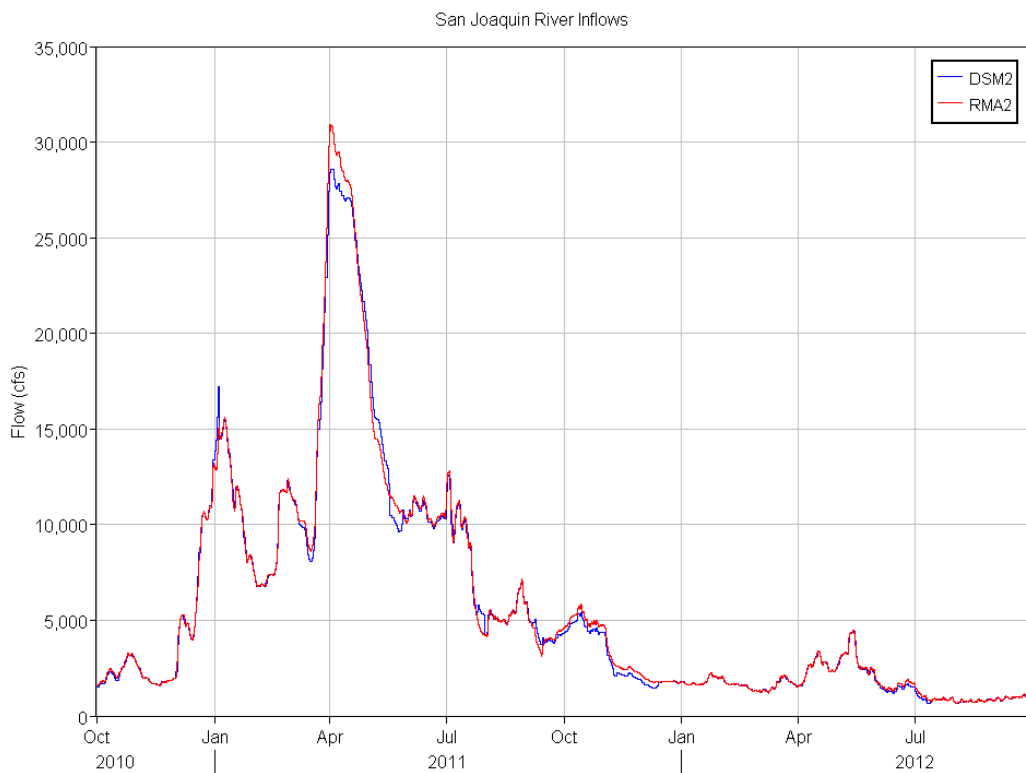


Figure 4 DSM2 and RMA2 San Joaquin River inflows.

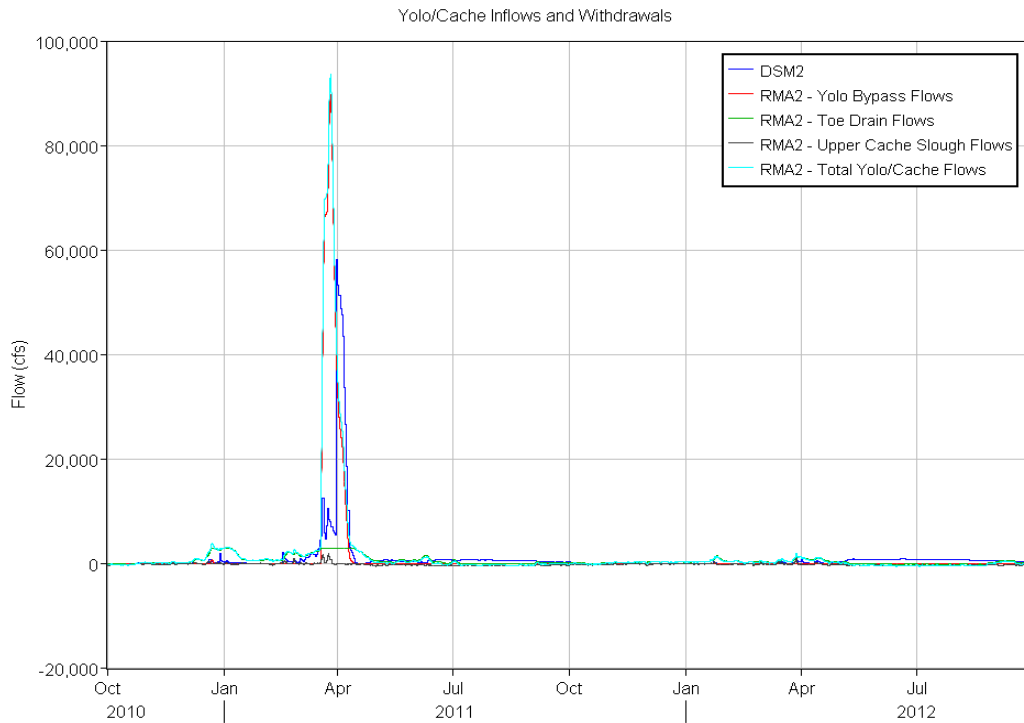


Figure 5 DSM2 and RMA2 Yolo Bypass/Cache Slough region inflows and withdrawals.

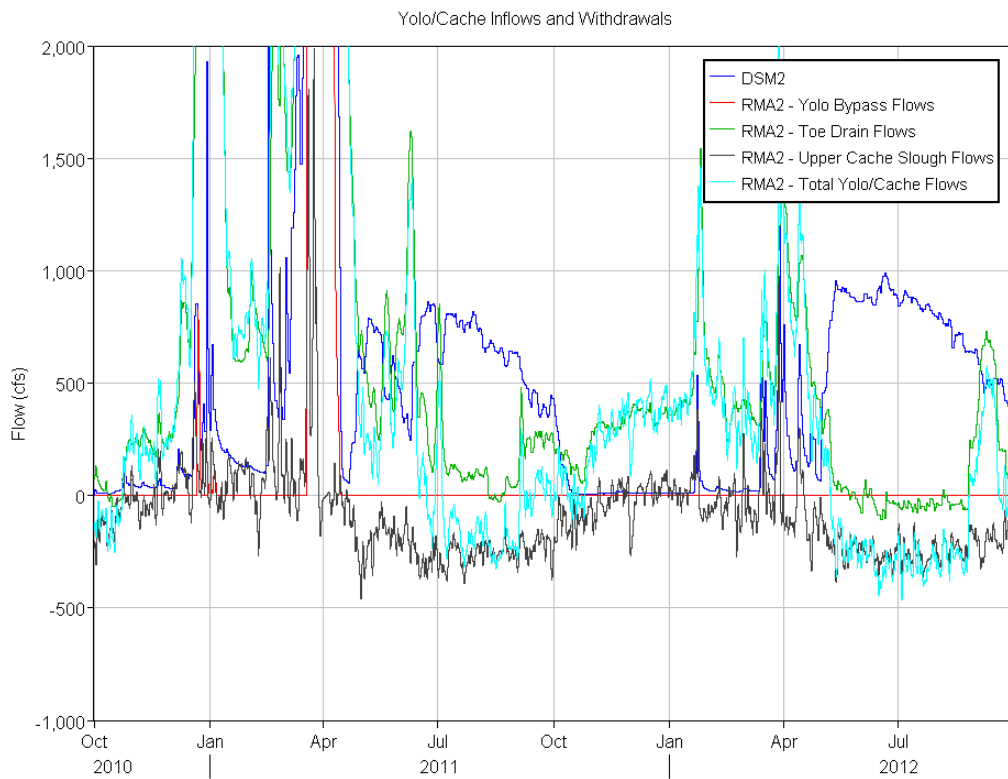


Figure 6 DSM2 and RMA2 Yolo Bypass/Cache Slough region inflows and withdrawals (enhanced flow scale).

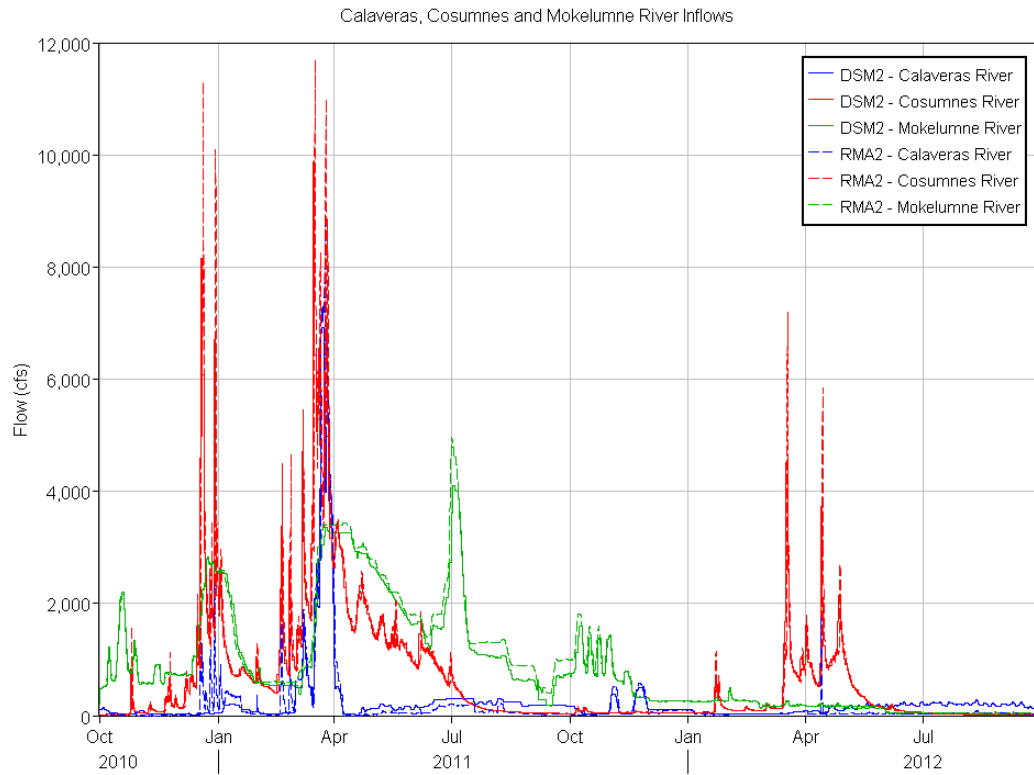


Figure 7 DSM2 and RMA2 Calaveras, Cosumnes and Mokelumne River inflows.

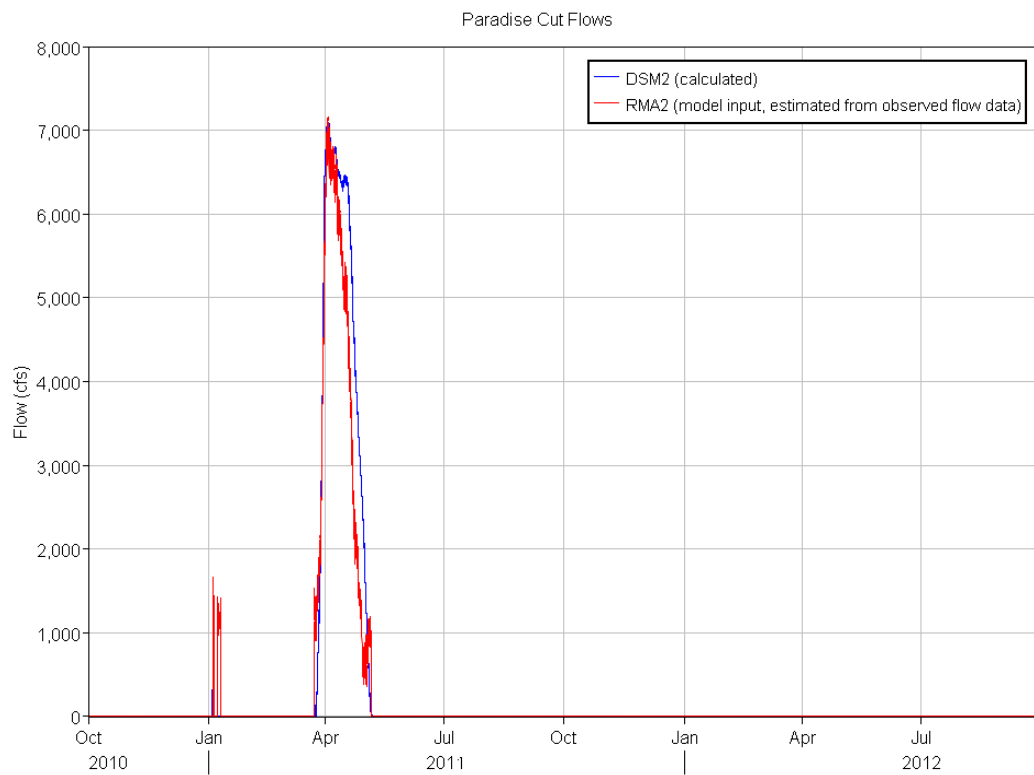


Figure 8 DSM2 and RMA2 Paradise Cut flows.



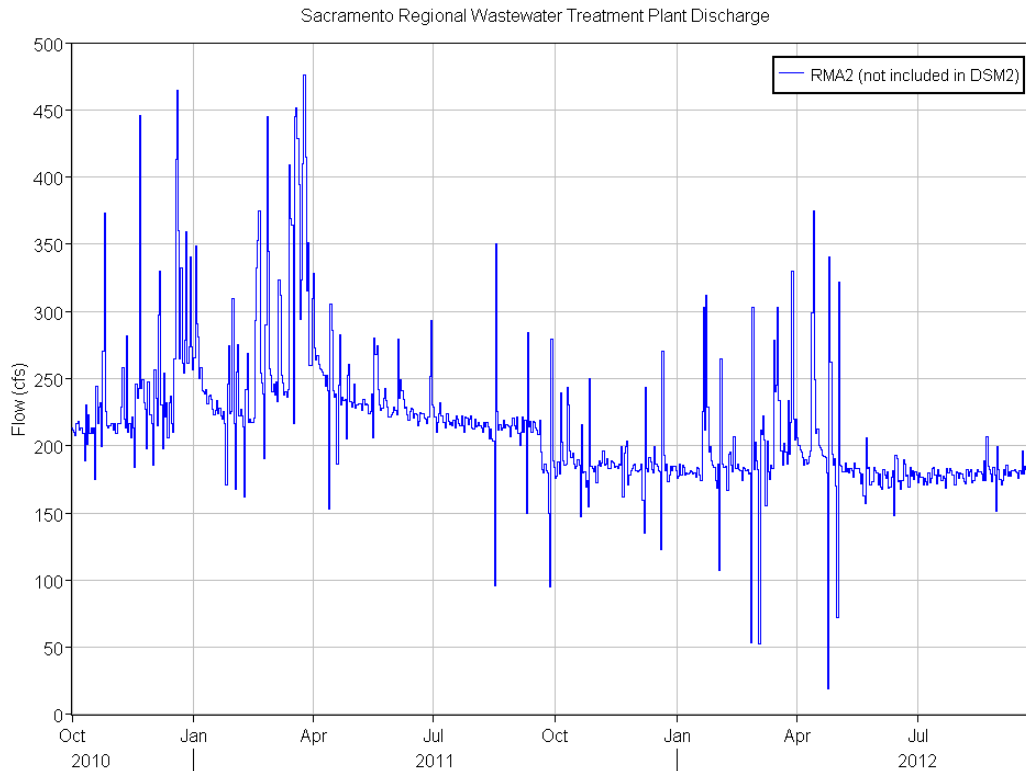


Figure 9 RMA2 Sacramento Regional Wastewater Treatment Plant Discharge flows (not included in DSM2).

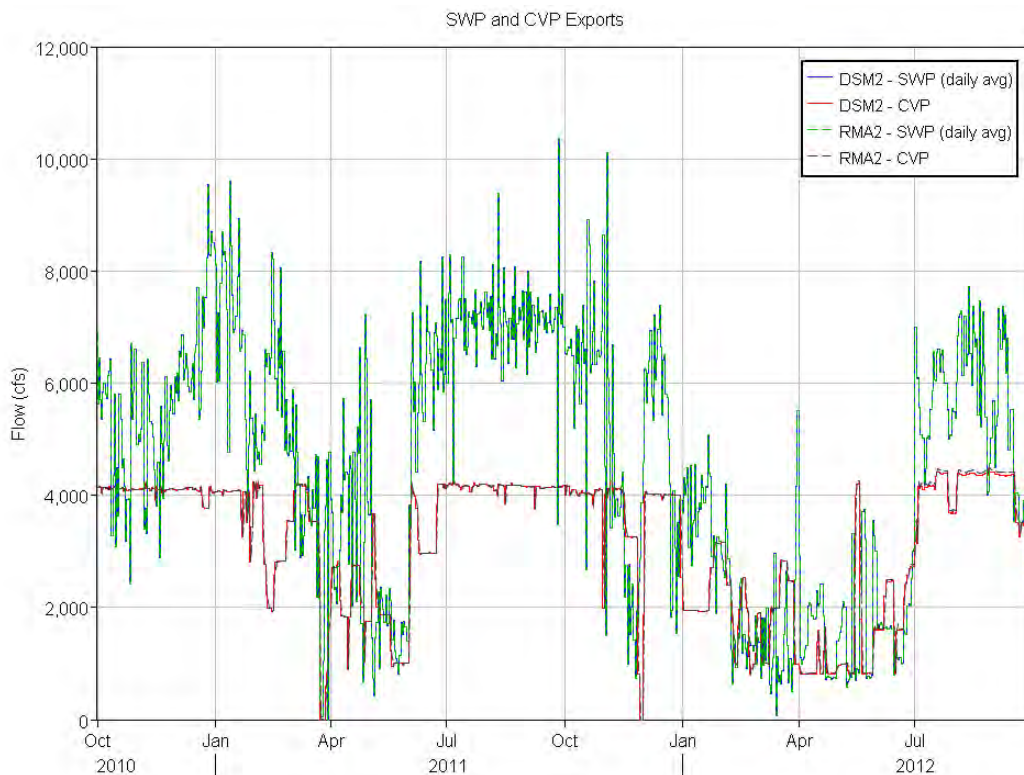


Figure 10 DSM2 and RMA2 export flows for SWP (daily average of 15-minute values) and CVP.

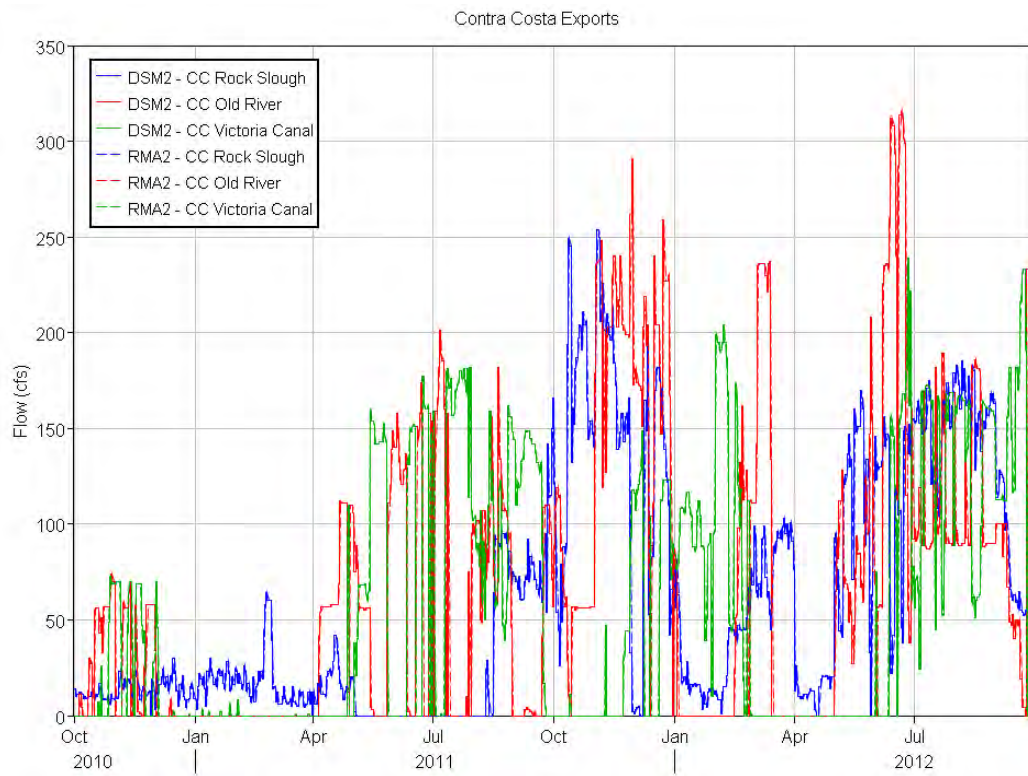


Figure 11 DSM2 and RMA2 Contra Costa export flows at Rock Slough, Old River and Victoria Canal.

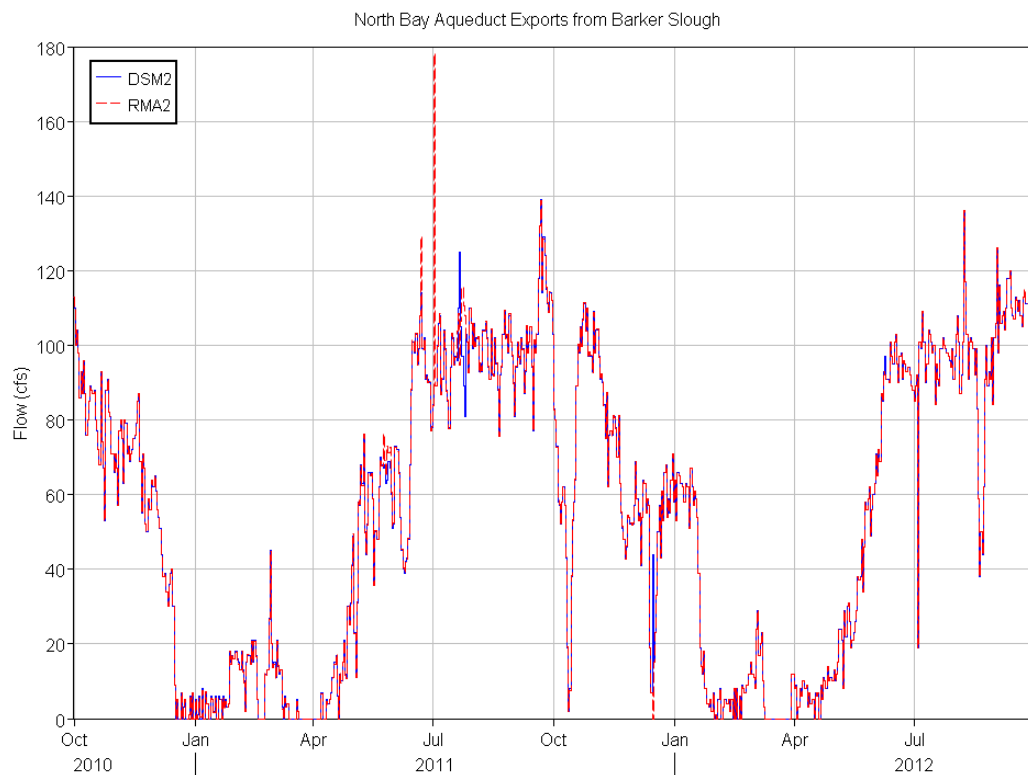


Figure 12 DSM2 and RMA2 North Bay Aqueduct exports from Barker Slough.

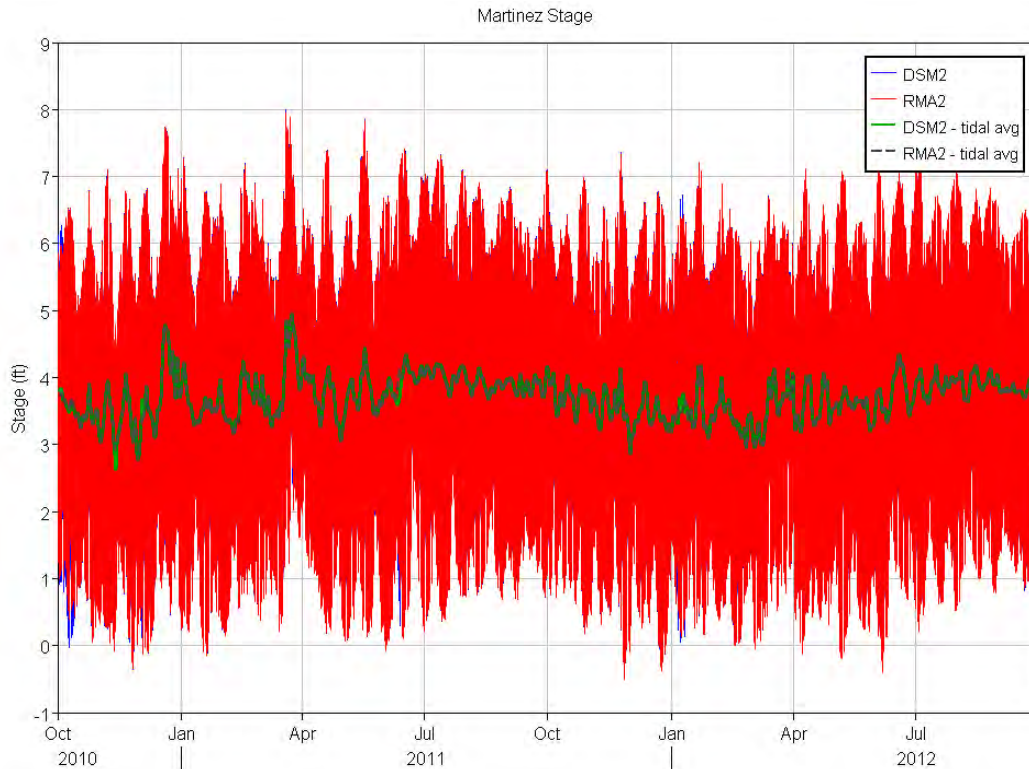


Figure 13 DSM2 and RMA2 15-minute and tidally averaged stage at Martinez.

## Model Error Metrics and Model Skill

The quality of fit between computed model results and observed data in a tidally driven system is typically presented in the form of time series plots of dynamic and tidally averaged values. A visual comparison of the “dynamic” plot of 15-minute interval observed and computed flow/velocity/stage illustrates how well the model reproduces the tidal dynamics of the system. A comparison of the tidally averaged or tidal filtered time series shows how well model reproduces the net channel flows/velocities or overall stage. In addition to the visual representations, statistics can be derived to quantify the differences between computed and observed records for the tidally driven system.

### Error Metrics

Four types of error metrics have been selected for presentation in this report.

**Mean:** Comparison of simple mean value of the computed and observed time series. This provides a measure of how well the model matches net observed channel flows or average stage. The mean diff is calculated as mean computed minus mean observed. This is also viewed as a percent difference from observed.

**Lag:** The average lag, or phase shift in time between the computed and observed tidal signals determined from a cross-correlation analysis.

Linear Regression: After the phase shift is removed, the observed and computed time series are compared on a point by point basis through a linear regression analysis. The better the model is at reproducing detailed variation of the observed tidal signal and base values, the smaller the scatter will be. One measure of the scatter is the coefficient of determination,  $R^2$  (R2 in plots and tables). Additionally, the slope of the regression line should be close to 1 and the intercept should be close to 0.

Amp Ratio (Amplitude Ratio): This is computed from a second linear regression analysis where the tidally averaged signal is removed from the observed and computed records. The remaining time series is more representative of the daily tides, and the Tidal Amplitude Ratio is taken as the slope of the regression line.

For each observed data location, three plots of computed and observed flow/velocity/stage are provided: dynamic and tidally averaged time series plots and a scatter plot of computed versus observed data with linear regression statistics.

“Tidally averaged” stage, shown in the lower left of each figure, is plotted for the entire simulation period. The “tidally averaged” time series is computed with two passes of a 24.75 hour moving average window. With only a single pass of the averaging window, a significant tidal signal was still present especially for a flow record where the net flow may be a small fraction of the peak tidal flow. A Godin tidal filter produces somewhat more smoothing than the two pass filter, which may not always be desirable. Digital filters can provide better control of the frequency content of the filtered record but can have undesirable effects at the ends of the time series, and at data gaps, which are common in the observed records.

The lower right plot shows a scatter plot of observed and computed data and the “best-fit” linear regression line. The scatter plot is produced by first computing a cross-correlation between the observed data and model result to find the average model phase lag over the simulation period. The phase lag is removed from the computed time series before creating the scatter plot and performing the linear regression analysis. The regression plot includes error between the observed and model tidal signal, but also includes the variation in differences in the “Tidally Averaged Stage” shown in the lower left plot. To get a better measure of how the modeled and observed tidal signals match, a second regression analysis is performed by first subtracting out the tidally filtered values from the “dynamic” record. The slope of the linear regression line for the derived records should thus provide a better measure of the computed vs. observed tidal amplitude. The plots show the scatter plots and regression statistics for the computed and observed time series where tidal averages are not removed. The slope of the regression line for the time series with the tidal averages removed is presented in the plots and the tables as the “Tidal Amplitude Ratio”.

Along with the regression and correlation statistics, the mean values are listed for the observed and computed flows/velocities/stages. The “observed” mean value is computed using the available data points of the calibration or verification period. The “computed” mean value computation excludes the times where the observed data are missing.

Error metrics are summarized in tabular format at the beginning of each series of plots.

## Model Skill

Model skill is a measure of hydrodynamic model performance which captures the degree to which deviations in the modeled data about the observed data average correlate with deviations in the observed data about the observed data average (Willmott 1981). Values range from 0.0 (completely uncorrelated) to 1.0 (model exactly matches observed). This metric has the advantage of being used in many recent studies to evaluate model performance, which provides some context in evaluating how well a model performs. A review of these recent studies by MacWilliams et al. (2015) led the authors to propose skill metric threshold values for different parameters to separate model performance into "accurate," "acceptable," and "poor agreement" classes. Threshold values are shown in Table 1. These classes were adopted for this report after visually assessing their validity on model results presented herein. (I.e., we verified that what appeared to be an accurate model result fell into the "accurate" class and what looked like a poor model result fell into the "poor agreement" class.) It is important to note, however, that the model skill should always be considered alongside the error metrics, as it may not tell the whole story alone. As an example, a flow result may fall into the accurate category despite large net flow errors.

Model skill is calculated for each model parameter and at each location. From these values, an overall average skill for each model and parameter is computed.

**Table 1 Skill metric threshold values for three categories of model accuracy (MacWilliams et al., 2015).**

<b>Model Accuracy Category</b>	<b>Flow</b>	<b>Water Surface Elevation</b>	<b>Velocity</b>
Accurate	> 0.975	> 0.975	> 0.9
Acceptable	0.95–0.975	0.95–0.975	0.8–0.9
Poor agreement	< 0.95	< 0.95	< 0.8

## Flow Results Comparison

In Figure 15 through Figure 68, computed flows from each model simulation are compared with observed data from USGS and Water Data Library (WDL) (plot titles indicate data source). [Error metrics](#) from these plots are summarized by location in Table 2. Plot locations are shown in Figure 14. For easy comparison among the models at each of these locations, tidally averaged flows from all three models are plotted with tidally averaged observed flows in Figure 72 through Figure 89.

Table 3 summarizes flow results for each model by error metric (percent difference from observed, lag, amplitude ratio and  $R^2$ ) and model skill. Table cells are color coded for a quick assessment of goodness of fit with observed data, ranging from green for better fit to red for worse fit. The DSM2 and RMA models both compare favorably with observed data throughout much of the south Delta. The RMA model compares more favorably with observed data than DSM2 with regard to percent difference from observed and lag, while amplitude ratio and  $R^2$  values for DSM2 are slightly better than for the RMA

simulations. For flow, a skill accuracy greater than 0.975 is considered accurate, 0.95-0.975 is considered acceptable and a skill accuracy below 0.95 is considered poor agreement. The average flow model skill for DSM2 is 0.957. The RMA2 flow model skill is 0.976.

For the RMA model, the mean percent difference from observed is generally within about 10% or less at most locations analyzed (notable exceptions are discussed below) with an average absolute difference of 17%. DSM2 has a few more problem locations, but is within about 10% of observed at about half of the stations as well. The DSM2 average of absolute difference from observed is 50%.

DSM2 lags observed data at all stations, with an average lag of 28 minutes. The RMA model has a mix of positive and negative lags with an average of the absolute lag values of 12 minutes.

Amplitude ratios and slopes range from about 0.8 to 1.1 at most locations for both models, with averages of 0.94.  $R^2$  values exceed 0.9 at most locations for both models and average about 0.94 for both models.

During low flow periods, DSM2 and RMA2 produce similar flow results at many locations in the south Delta. The differences between DSM2 and RMA2 San Joaquin River and Paradise Cut flows impact results in the south Delta, particularly during high flow periods, however the effects of other boundary condition differences appear to be small.

There tends to be more disparity among the models and between the model result and observed data during the high flow period in April 2011. One contributing factor could be that geometry in either model may not be as accurate at higher water levels, particularly where trapezoidal channel cross-sections are employed such as in the 1D sections of the RMA2 model grid, which represents most of the south Delta. Additionally, gauges may not be as accurate at high flows for some locations.

The largest differences between DSM2 and RMA2 occur at Old River at Franks Tract, Old River at Quimby, Turner Cut and Holland Cut.

At Old River at Franks Tract, model skill shows DSM2=poor agreement and RMA2=acceptable. The tidally averaged RMA2 result is about 200 to 700 cfs below observed throughout most of the simulation period. During March through October 2011 RMA2 is as much as 4000 cfs low compared with CDEC data and as much as 2000 cfs low compared with USGS data. DSM2 is generally 2000 – 3000 cfs lower than RMA2. The RMA2 tidal flows are slightly muted while the DSM2 tidal flows match well in the ebb tide direction but are quite low on the flood tide. On average, DSM2 flows are about 250% lower than observed flows, while RMA2 is about 85% lower at this location.

At Old River at Quimby, both models show accurate model skill. The RMA2 results are generally in good agreement with observed data with the exception of January through April 2011. The DSM2 tidally averaged result is generally 1000-4000 cfs lower than observed. On average, DSM2 flows are 305% lower than observed, while RMA2 is about 20% lower than observed at this location.

In Turner Cut, both models fall into the poor agreement category for model skill. The RMA2 tidally averaged flows are generally in good agreement with observed data, with the exception of April – May

2011. The tidal flows are dampened, particularly on the flood tide. On a tidally averaged basis, DSM2 misses the larger negative flows by as much as about 750 cfs. The tidal flows are out of phase with observed, but match the flood tide flow magnitudes more closely than RMA2. Ebb tide flows are too large. On average, DSM2 flows are 40% higher than observed, while RMA2 is about 10% lower than observed at this location.

At Holland Cut, tidally averaged DSM2 flows are generally less in the upstream direction than RMA2. Peak flows in April 2011 are slightly lower for DSM2 than for RMA2. DSM2 shows less tidal variation than RMA2. Observed data at this location are suspect. The characteristics of the flow data change rather suddenly in 2011. On average, DSM2 flows are 90% higher than observed, while RMA2 is 55% higher than observed at this location.

Both models have difficulties at Prisoner Point. DSM2 average flows are 150% high and RMA2 average flows are about 80% high. DSM2 lags observed by 44 minutes and RMA2 lags by 27 minutes. The model skill falls in the poor agreement range for DSM2 and in the accurate range for RMA2. After July 2012, the flow data at this location are suspect, as there is a gap in the time series and then a large shift. If these data are invalid, they do unfavorably skew the error metrics.



Table 2 Flow error metrics summary by location.

	DSM2	RMA2 w DSM2 BC	RMA2
<b>SJR at Brandt Bridge</b>			
mean diff (cfs)	139	14	66
lag (minutes)	-24	2	2
ampRatio	1.013	1.047	1.045
slope	1.020	0.989	1.017
intercept	90.3	40.3	25.5
R2	0.987	0.985	0.990
<b>SJR at Prisoners Point</b>			
mean diff (cfs)	3308	1826	1864
lag (minutes)	-44	-27	-27
ampRatio	0.808	0.970	0.970
slope	0.806	0.967	0.967
intercept	2880.3	1752.8	1791.6
R2	0.975	0.972	0.973
<b>SJR at Jersey Pt</b>			
mean diff (cfs)	-236	-211	-13
lag (minutes)	-27	-14	-14
ampRatio	0.879	0.961	0.961
slope	0.878	0.959	0.960
intercept	511.5	37.5	232.0
R2	0.987	0.988	0.989
<b>Old River at Franks Tr</b>			
mean diff (cfs)	-3071	-1046	-1070
lag (minutes)	-23	7	7
ampRatio	1.199	0.776	0.776
slope	1.196	0.777	0.778
intercept	-2827.2	-1323.9	-1346.7
R2	0.935	0.915	0.916
<b>Holland Cut</b>			
mean diff (cfs)	1312	794	803
lag (minutes)	-28	-21	-20
ampRatio	0.670	1.007	1.007
slope	0.671	1.005	1.005
intercept	837.2	800.9	810.3
R2	0.974	0.973	0.974
<b>Old River at Bacon</b>			
mean diff (cfs)	-100	159	167
lag (minutes)	-17	-18	-17
ampRatio	0.934	1.058	1.059
slope	0.944	1.058	1.060
intercept	-219.0	281.9	293.2
R2	0.973	0.977	0.979

DSM2	RMA2 w DSM2 BC	RMA2
<b>Old River at Quimby</b>		
-1788	-136	-128
-11	-15	-15
0.900	1.023	1.023
0.896	1.012	1.013
-1848.5	-129.0	-120.2
0.965	0.967	0.969
<b>Middle River at Middle River</b>		
182	68	79
-39	-11	-11
0.815	0.878	0.880
0.821	0.887	0.888
-331.9	-258.1	-241.5
0.960	0.967	0.968
<b>Turner Cut at Holt</b>		
456	-97	-100
-96	-7	-7
1.103	0.568	0.569
1.068	0.581	0.581
530.9	-556.2	-558.4
0.907	0.816	0.816
<b>Old River near DMC</b>		
150	-25	-24
-30	7	7
0.875	0.892	0.894
0.964	0.929	0.930
173.0	19.8	19.9
0.894	0.901	0.900
<b>Old River at Tracy</b>		
50	-62	-60
-23	23	23
1.247	0.858	0.861
1.393	1.097	1.098
-135.6	-107.8	-106.3
0.916	0.879	0.876
<b>Old River at Hwy 4</b>		
-103	-71	-63
-25	-9	-9
0.984	1.035	1.036
1.004	1.044	1.047
-92.1	67.8	83.8
0.922	0.928	0.930

DSM2	RMA2 w DSM2 BC	RMA2
<b>SJR at Rough-n-Ready</b>		
-37	-33	14
-29	-4	-4
0.831	1.095	1.095
0.816	0.995	1.005
373.6	-22.7	3.0
0.928	0.913	0.921
<b>SJR at Garwood</b>		
110	-10	42
-34	-12	-11
0.950	1.097	1.096
0.976	0.988	1.012
168.1	19.3	12.8
0.973	0.968	0.978
<b>Old River at Head</b>		
-65	49	115
-16	14	14
0.939	0.862	0.858
0.954	0.999	1.050
68.2	51.8	-30.6
0.956	0.960	0.977
<b>SJR nr Lathrop</b>		
321	201	253
-20	4	4
0.914	0.970	0.967
1.063	1.028	1.059
183.0	139.3	122.2
0.954	0.955	0.959
<b>Old R at Clifton Court Intake</b>		
-177	-5	5
-11	9	9
0.879	0.879	0.879
0.944	0.970	0.971
-196.9	-15.7	-4.7
0.858	0.859	0.859
<b>West Canal at Clifton Ct Intake</b>		
-335	38	47
-4	12	12
0.973	0.918	0.919
0.996	0.949	0.952
-350.8	-156.4	-138.8
0.873	0.882	0.883



Table 3 Summary of flow error metrics and model skill with shading ranging from green for better fit to red for worse fit.

Station	% diff from observed			lag (minutes)			ampRatio			R2			Model Skill		
	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2
SJR at Brandt Bridge	5.9%	0.6%	2.8%	-24	2	2	1.013	1.047	1.045	0.987	0.985	0.990	0.994	0.996	0.997
SJR at Prisoners Point	149.9%	82.7%	84.4%	-44	-27	-27	0.808	0.970	0.970	0.975	0.972	0.973	0.945	0.978	0.979
SJR at Jersey Pt	-3.9%	3.4%	0.2%	-27	-14	-14	0.879	0.961	0.961	0.987	0.988	0.989	0.980	0.993	0.994
Old River at Franks Tr	-246.7%	-84.0%	-85.9%	-23	7	7	1.199	0.776	0.776	0.935	0.915	0.916	0.939	0.962	0.962
Holland Cut	90.9%	55.0%	55.6%	-28	-21	-20	0.670	1.007	1.007	0.974	0.973	0.974	0.938	0.983	0.984
Old River at Bacon	-4.8%	7.6%	8.0%	-17	-18	-17	0.934	1.058	1.059	0.973	0.977	0.979	0.987	0.987	0.988
Old River at Quimby	-305.5%	-23.3%	-21.8%	-11	-15	-15	0.900	1.023	1.023	0.965	0.967	0.969	0.979	0.987	0.987
Middle River at Middle River	-6.3%	2.4%	2.8%	-39	-11	-11	0.815	0.878	0.880	0.960	0.967	0.968	0.952	0.987	0.987
Turner Cut at Holt	41.6%	-8.8%	-9.1%	-90	-7	-7	1.103	0.568	0.569	0.907	0.816	0.816	0.811	0.900	0.901
Old River near DMC	23.7%	4.0%	3.8%	-30	7	7	0.875	0.892	0.894	0.894	0.901	0.900	0.953	0.973	0.973
Old River at Tracy	10.6%	13.2%	12.7%	-23	23	23	1.247	0.858	0.861	0.916	0.879	0.876	0.940	0.957	0.956
Old River at Hwy 4	-3.3%	-2.3%	-2.0%	-25	-9	-9	0.984	1.035	1.036	0.922	0.928	0.930	0.970	0.978	0.979
SJR at Rough-n-Ready	-1.6%	1.5%	-0.6%	-29	-4	-4	0.831	1.095	1.095	0.928	0.913	0.921	0.956	0.976	0.978
SJR at Garwood	4.6%	0.4%	-1.8%	-34	-12	-11	0.950	1.097	1.096	0.973	0.968	0.978	0.985	0.991	0.993
Old River at Head	-2.3%	-1.7%	-4.0%	-16	14	14	0.939	0.862	0.858	0.956	0.960	0.977	0.988	0.990	0.993
SJR nr Lathrop	14.6%	-9.1%	-11.5%	-20	4	4	0.914	0.970	0.967	0.954	0.955	0.959	0.982	0.986	0.986
Old R at Clifton Court Intake	-50.1%	-1.4%	1.5%	-11	9	9	0.879	0.879	0.879	0.858	0.859	0.859	0.958	0.960	0.960
West Canal at Clifton Ct Intake	-8.7%	1.0%	1.2%	-4	12	12	0.973	0.918	0.919	0.873	0.882	0.883	0.964	0.967	0.967
<b>Average of absolute values</b>	<b>54.2%</b>	<b>16.8%</b>	<b>17.2%</b>	<b>28</b>	<b>12</b>	<b>12</b>	<b>0.940</b>	<b>0.939</b>	<b>0.939</b>	<b>0.941</b>	<b>0.934</b>	<b>0.937</b>	<b>0.957</b>	<b>0.975</b>	<b>0.976</b>

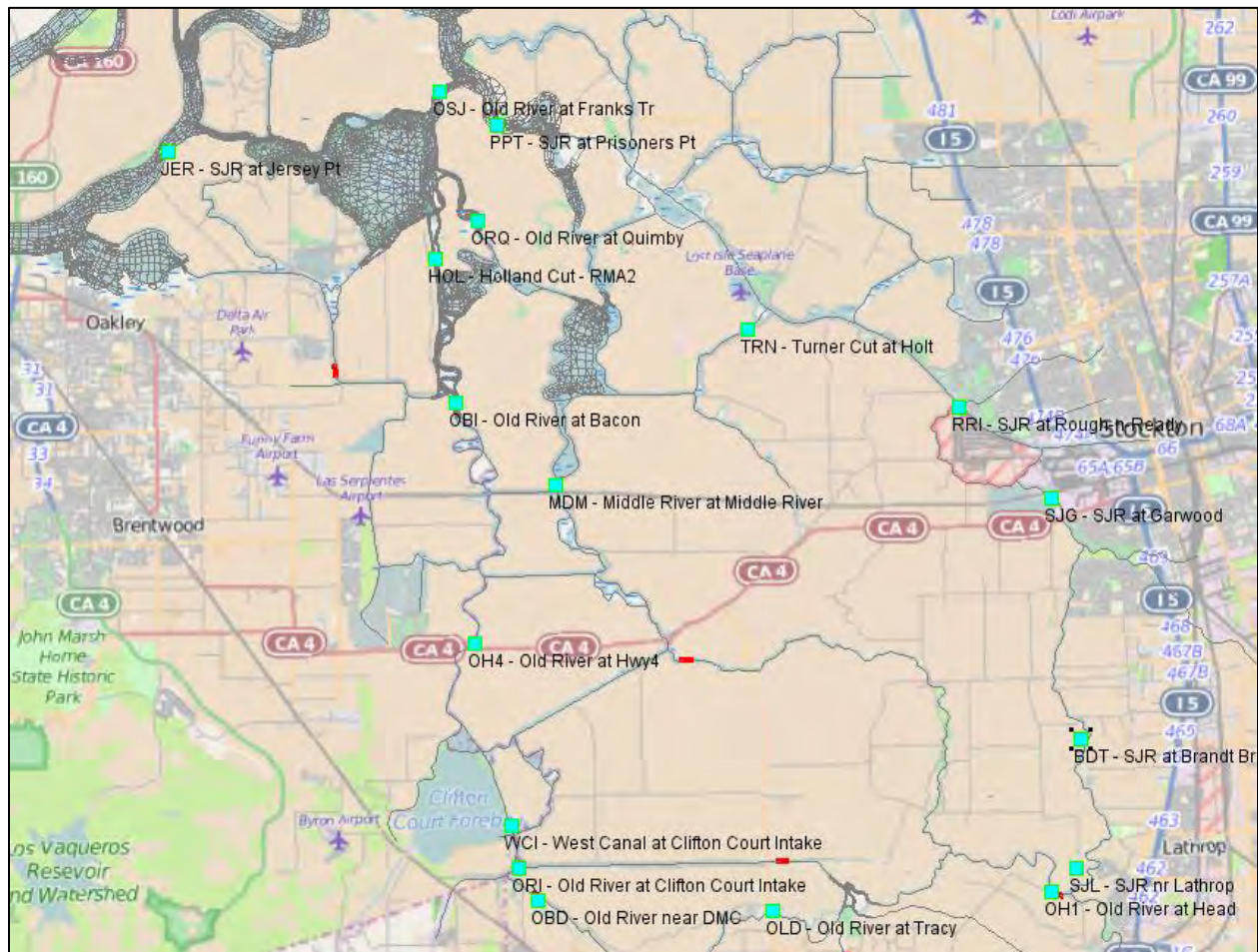


Figure 14 Flow comparison plot locations.

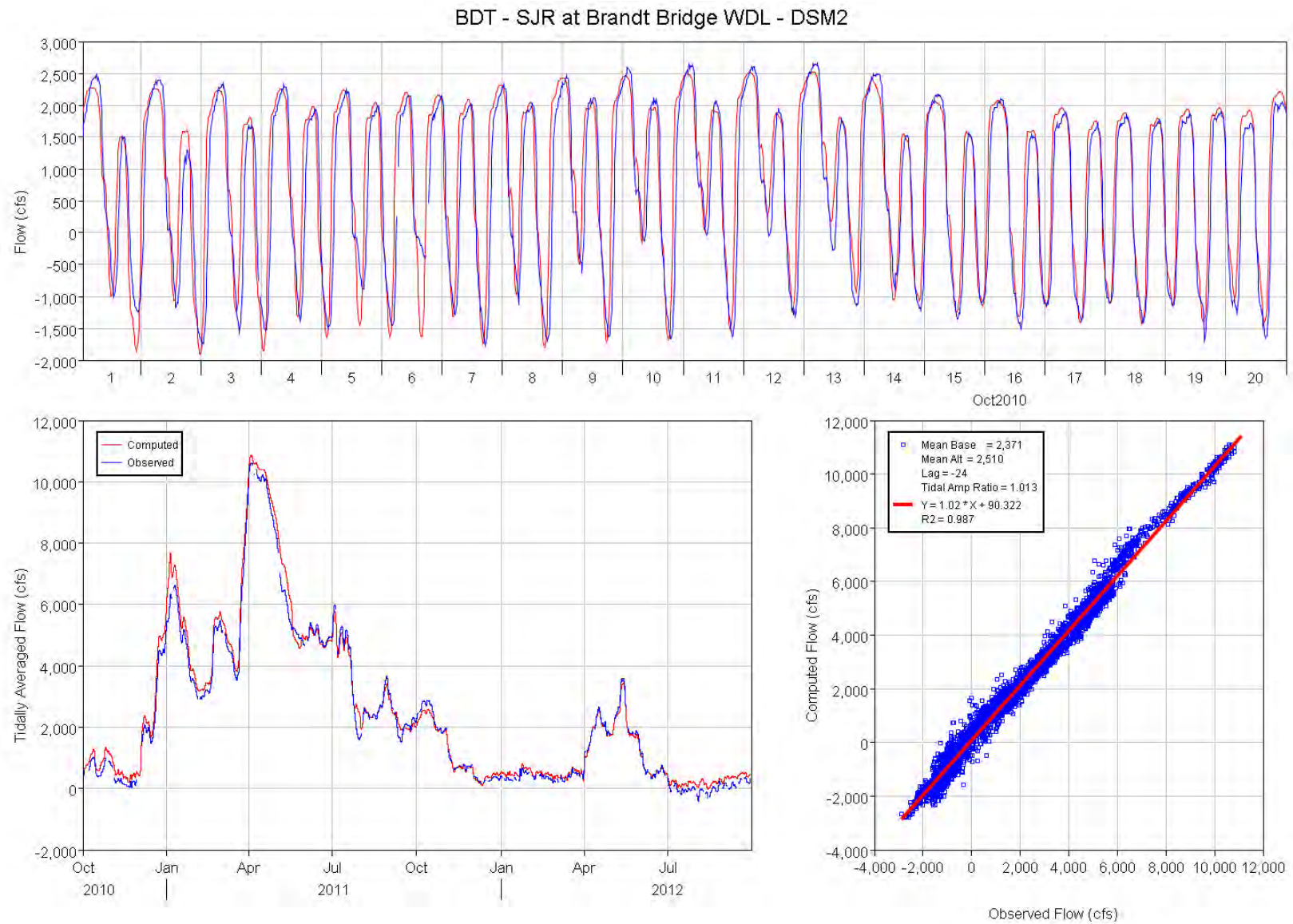


Figure 15 Computed (DSM2) and observed flow comparison plots for San Joaquin River at Brandt Bridge.



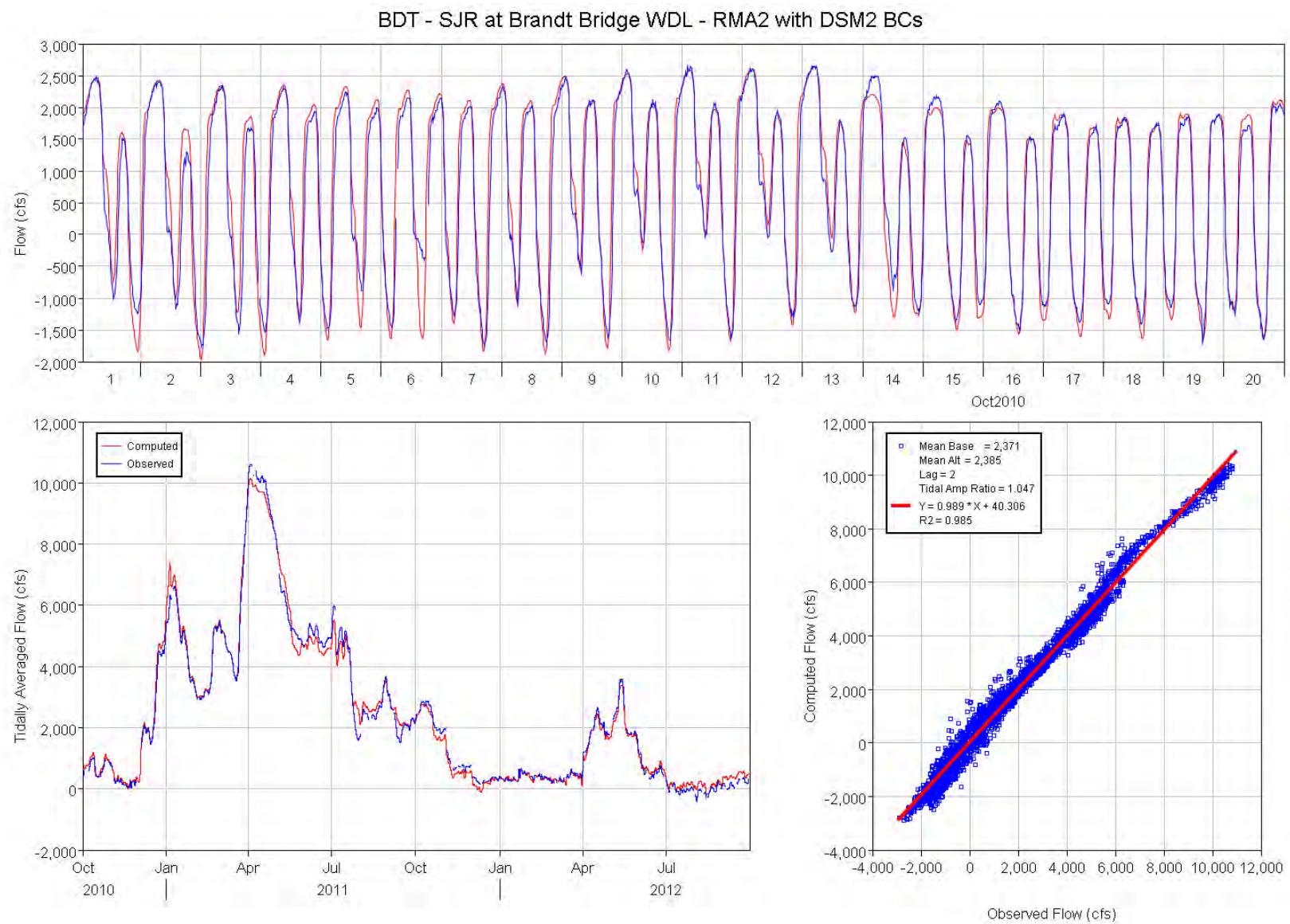


Figure 16 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for San Joaquin River at Brandt Bridge.

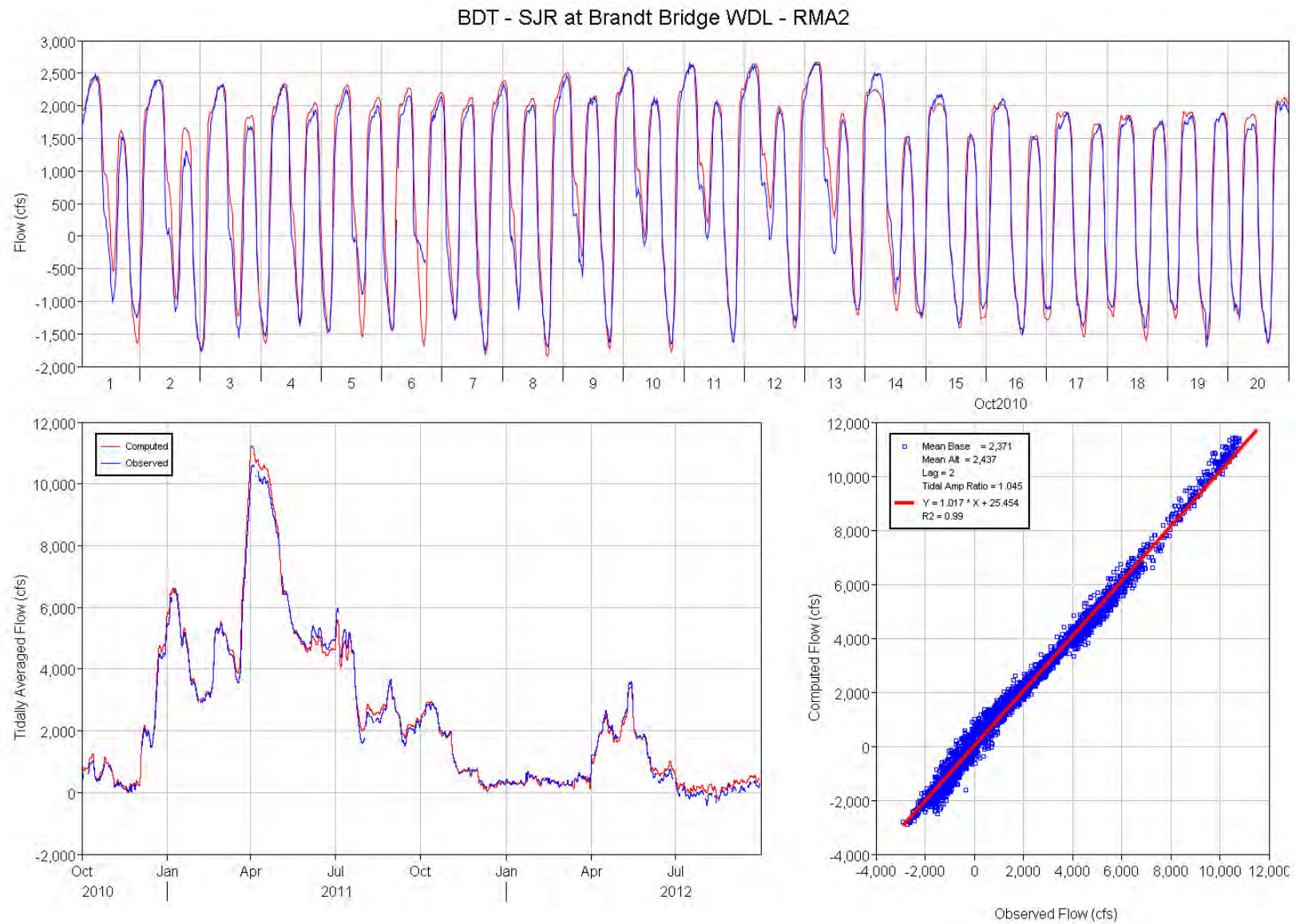


Figure 17 Computed (RMA2) and observed flow comparison plots for San Joaquin River at Brandt Bridge.



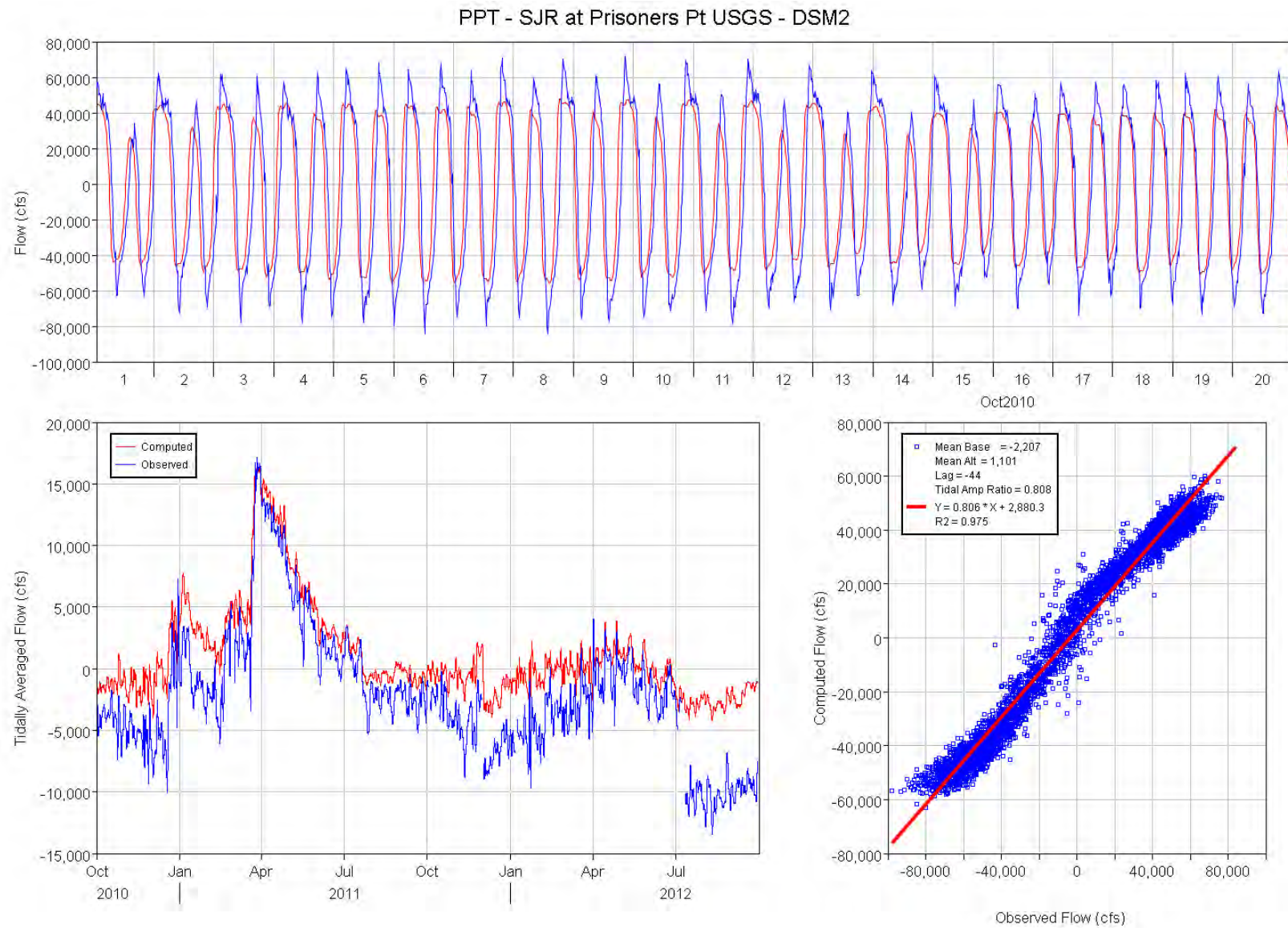


Figure 18 Computed (DSM2) and observed flow comparison plots for Prisoners Point.

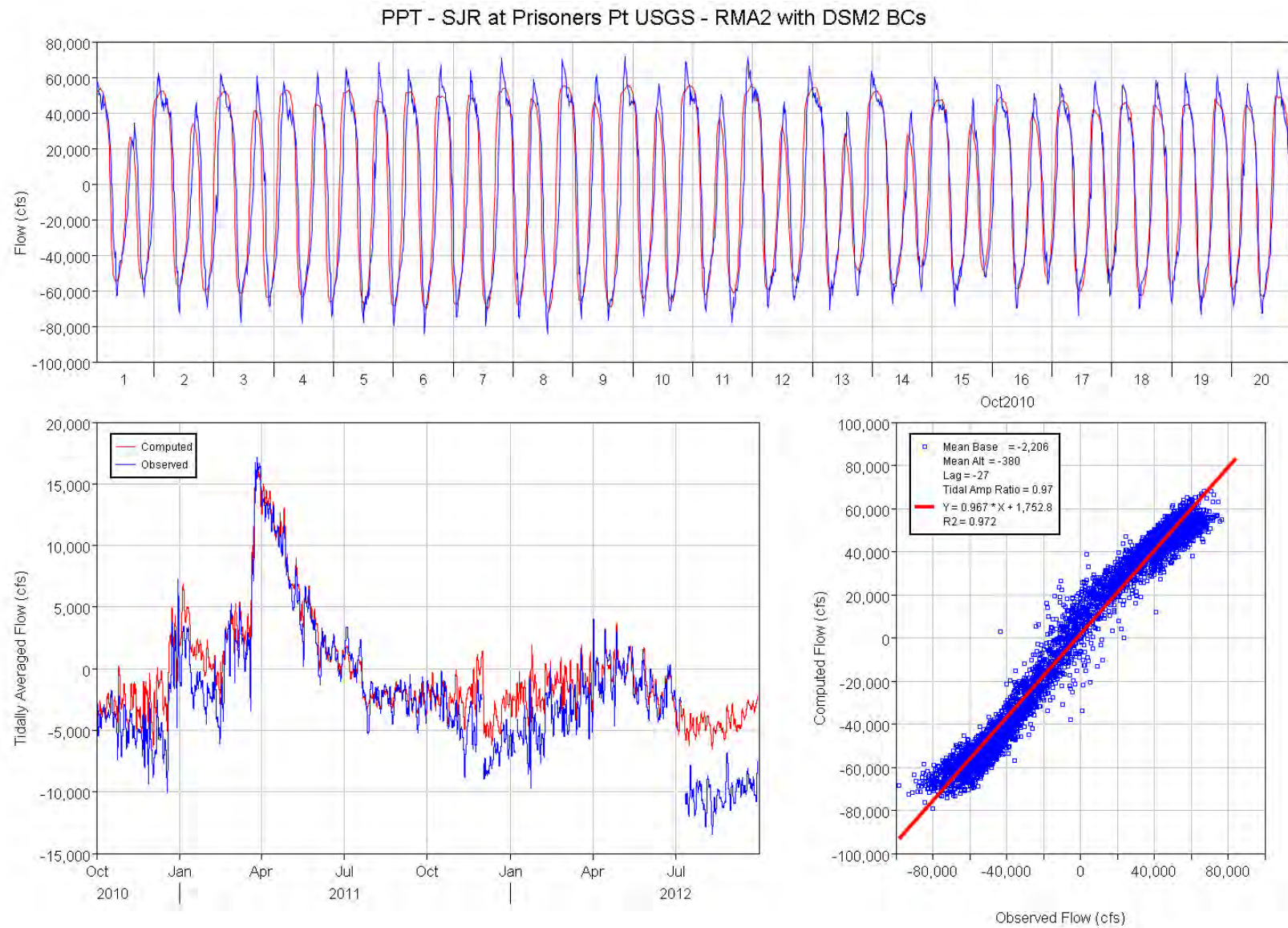


Figure 19 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Prisoners Point.



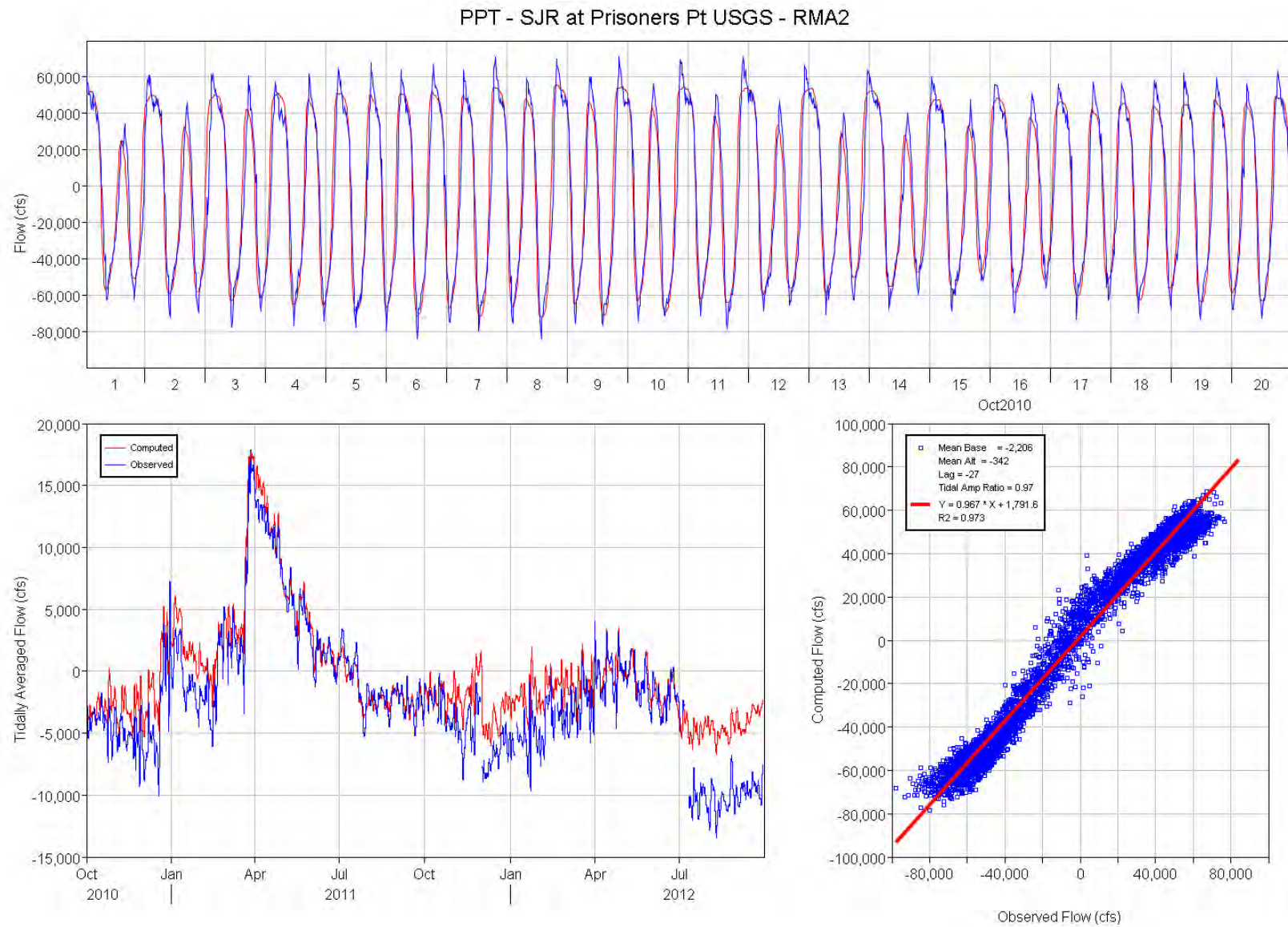


Figure 20 Computed (RMA2) and observed flow comparison plots for Prisoners Point.



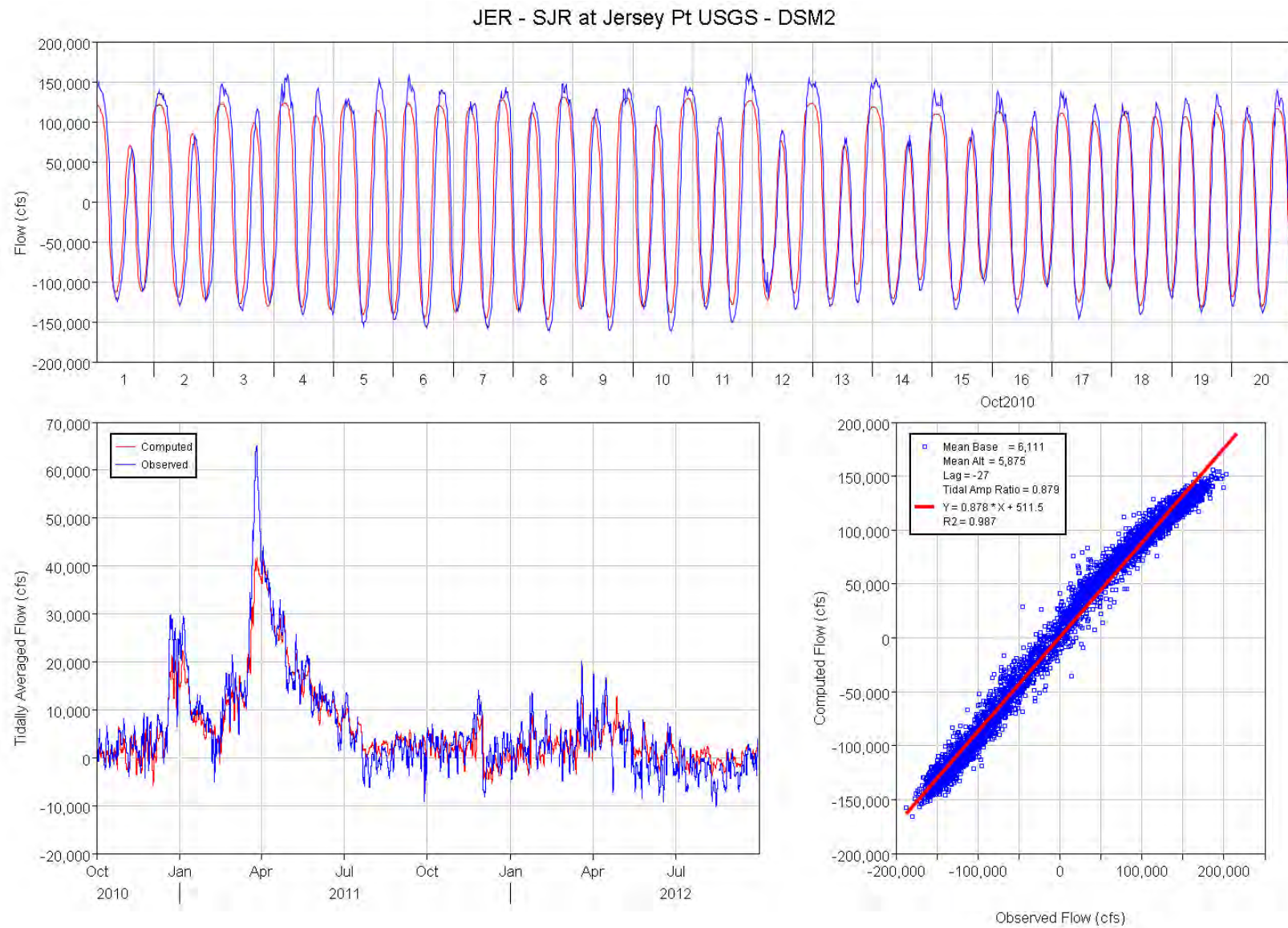


Figure 21 Computed (DSM2) and observed flow comparison plots for Jersey Point.

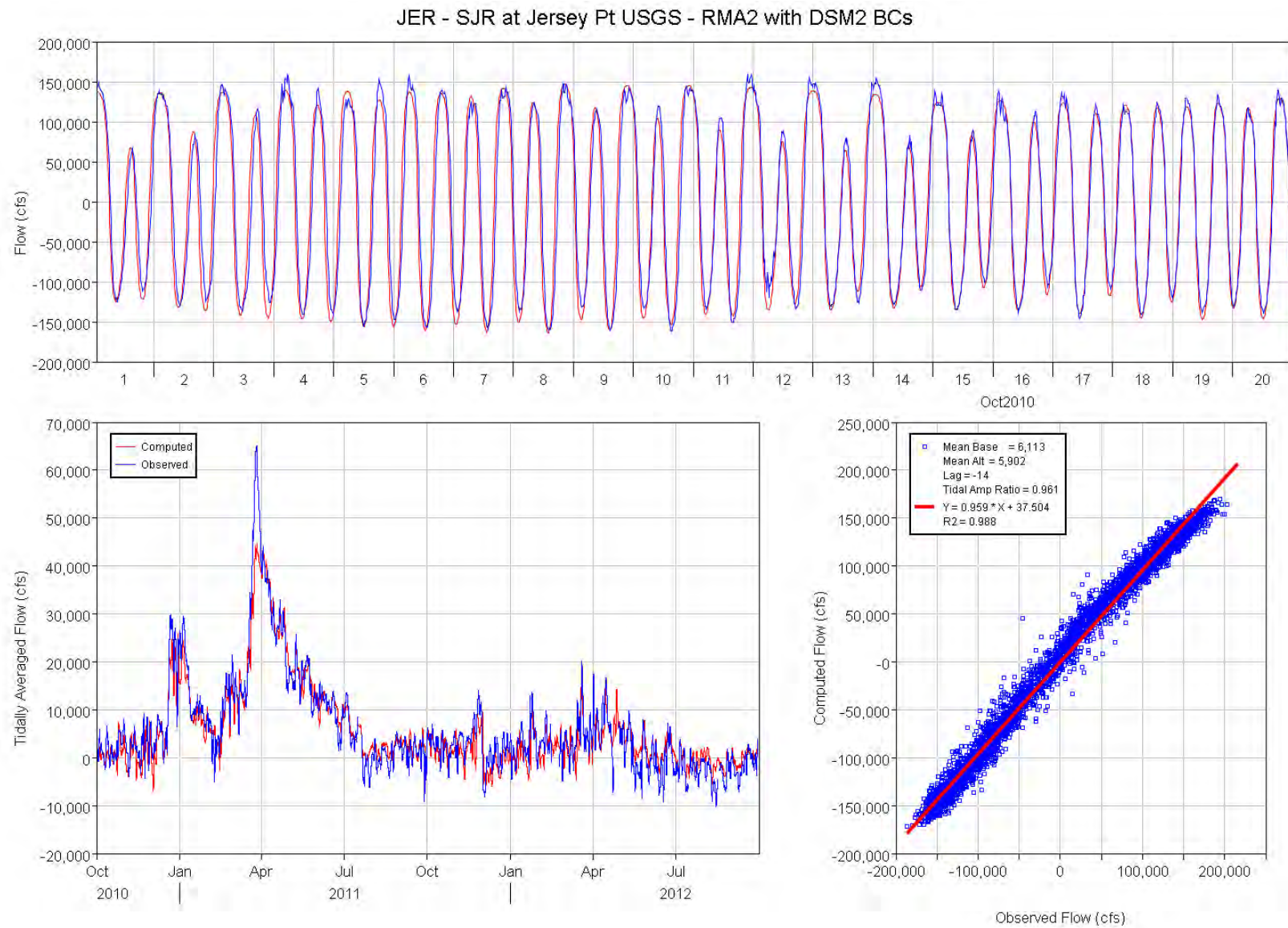


Figure 22 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Jersey Point.



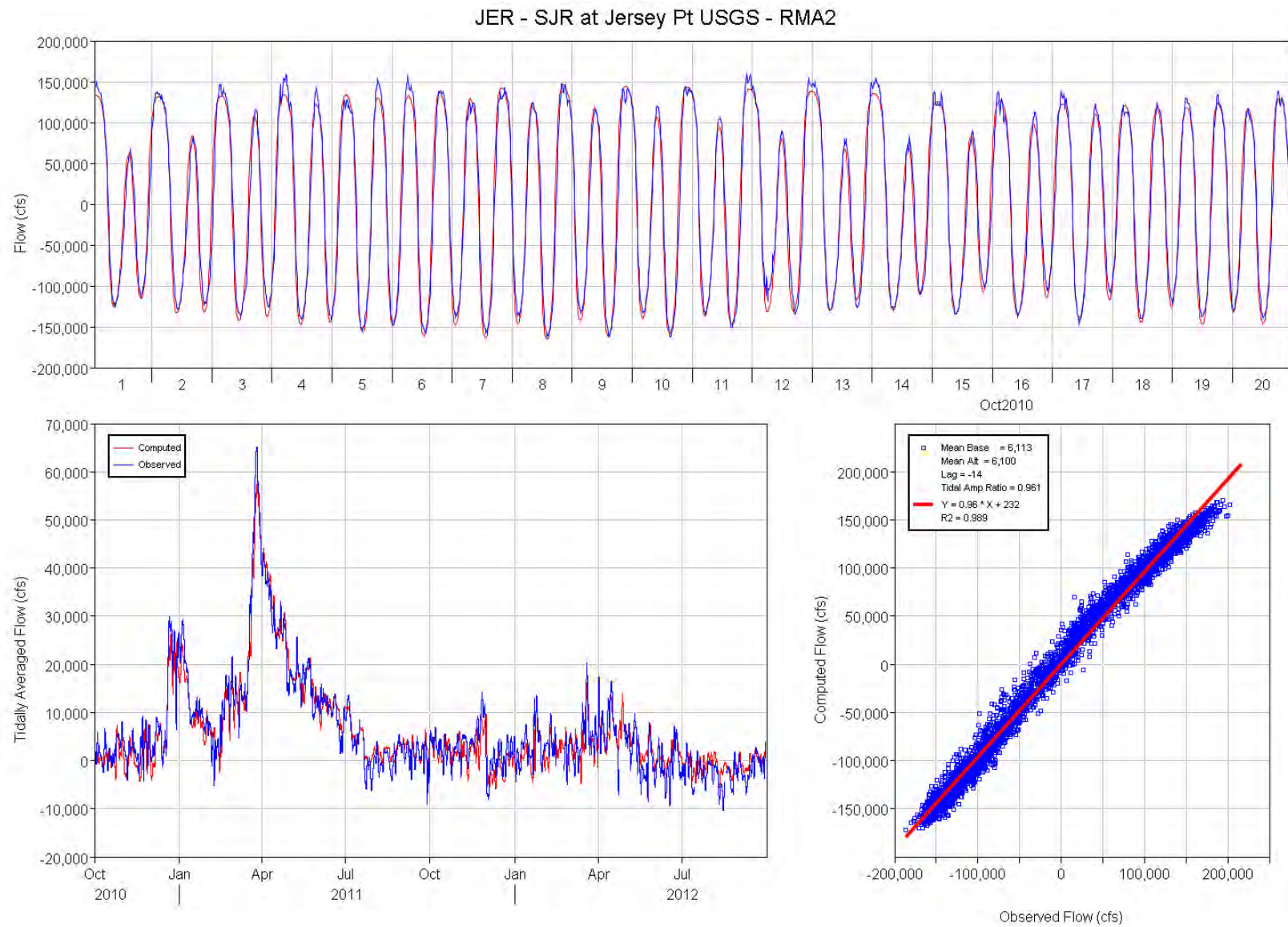


Figure 23 Computed (RMA2) and observed flow comparison plots for Jersey Point (USGS observed data).

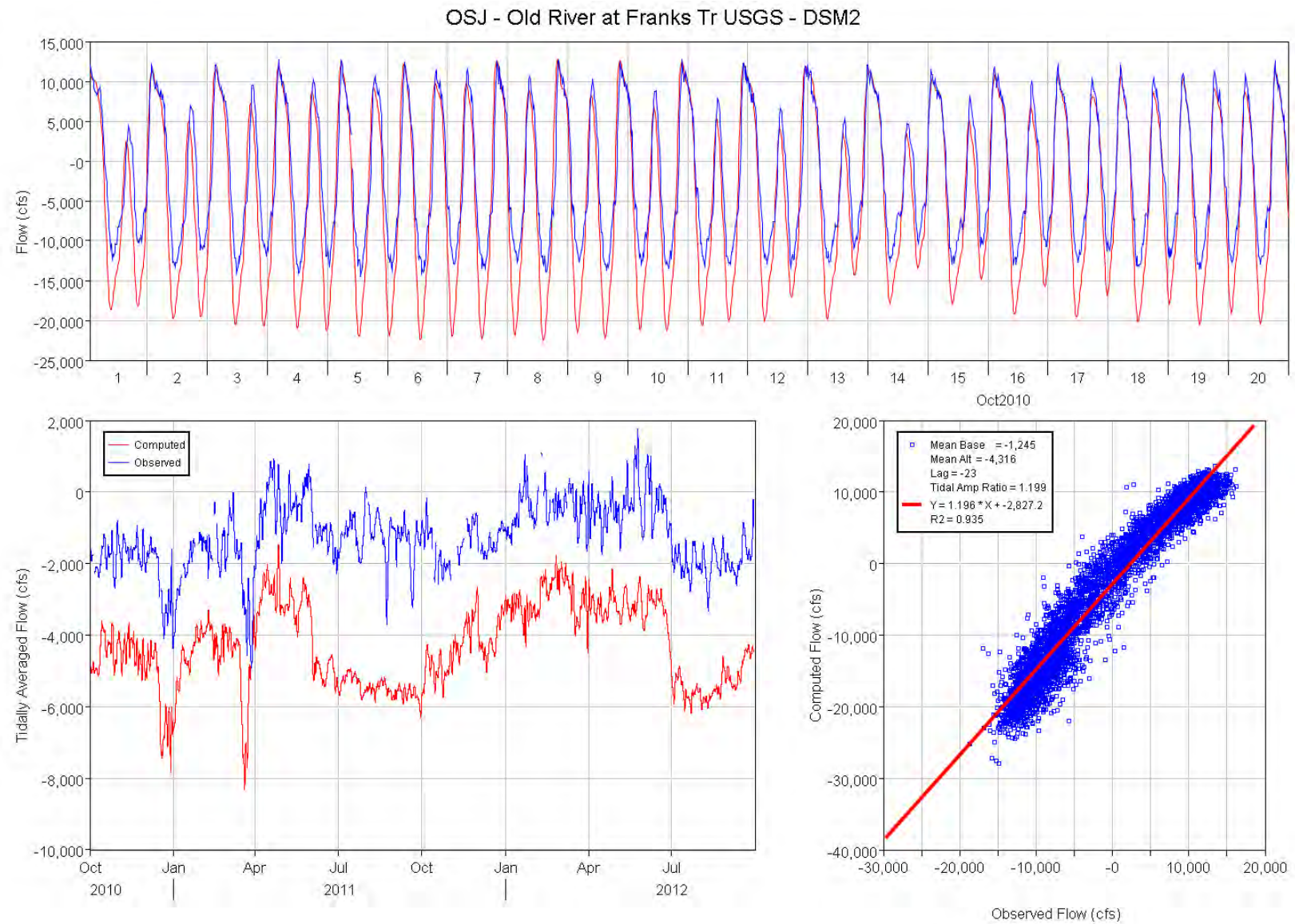


Figure 24 Computed (DSM2) and observed flow comparison plots for Old River at Franks Tract.



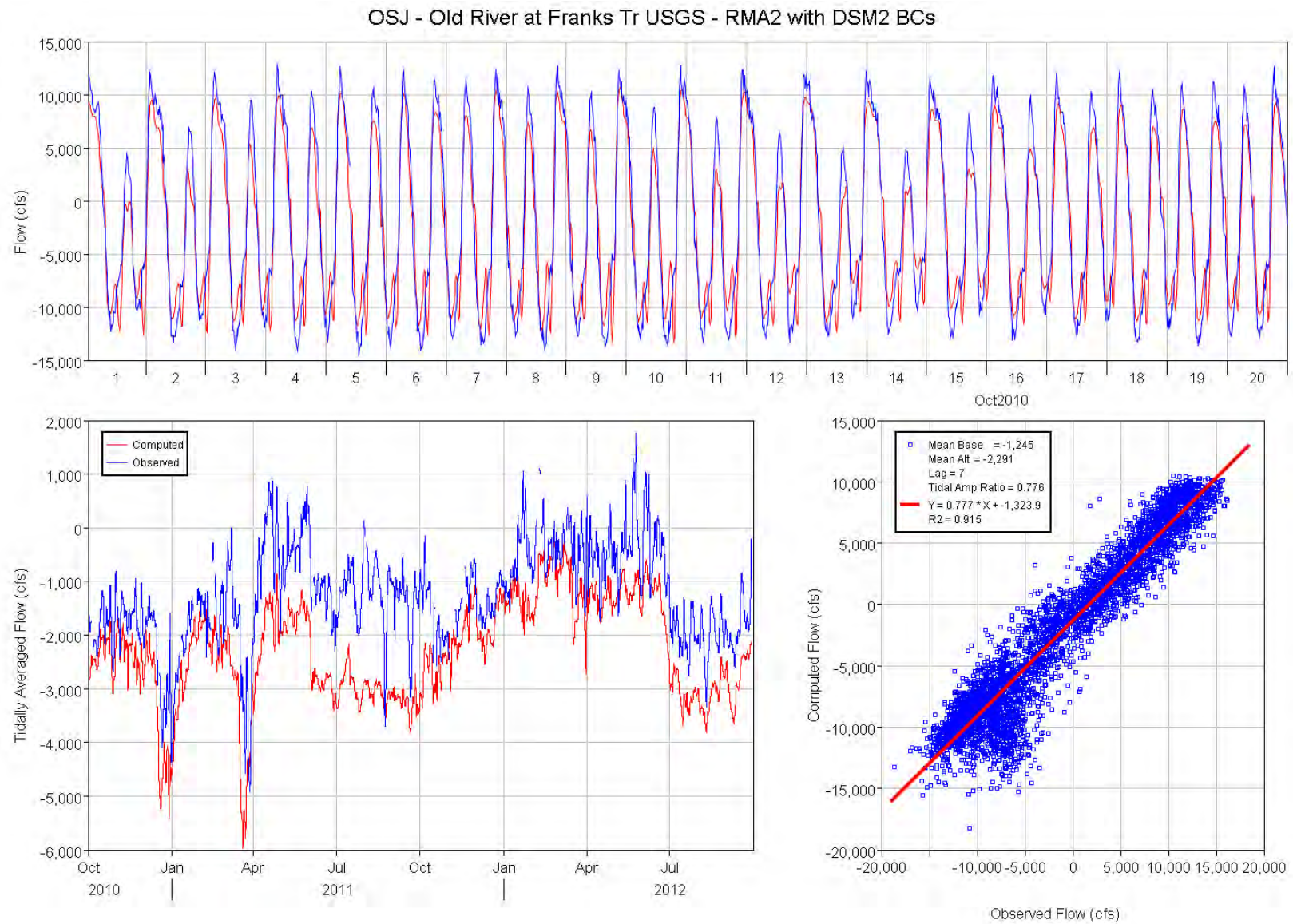


Figure 25 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Franks Tract.

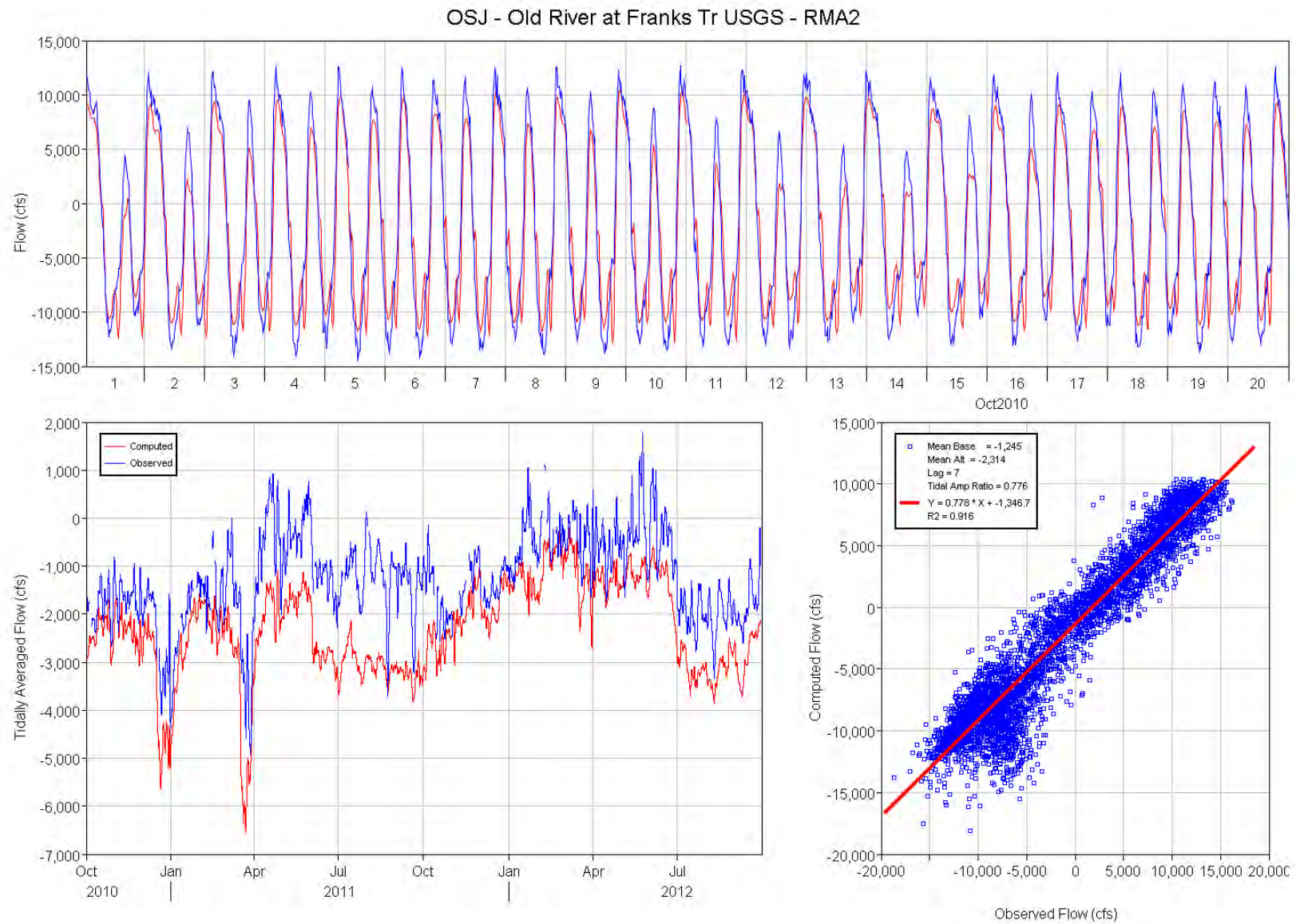


Figure 26 Computed (RMA2) and observed flow comparison plots for Old River at Franks Tract.



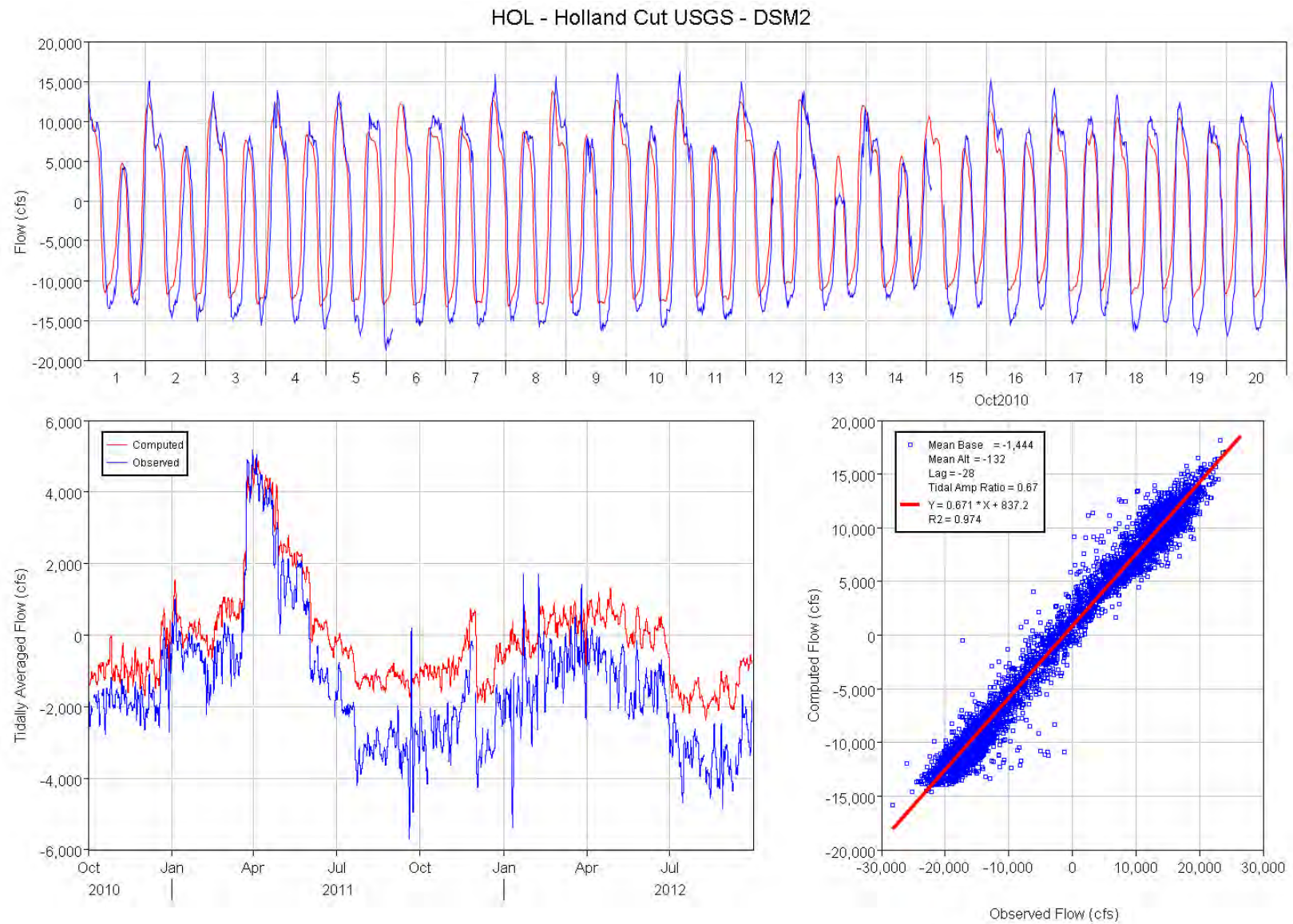


Figure 27 Computed (DSM2) and observed flow comparison plots for Holland Cut.

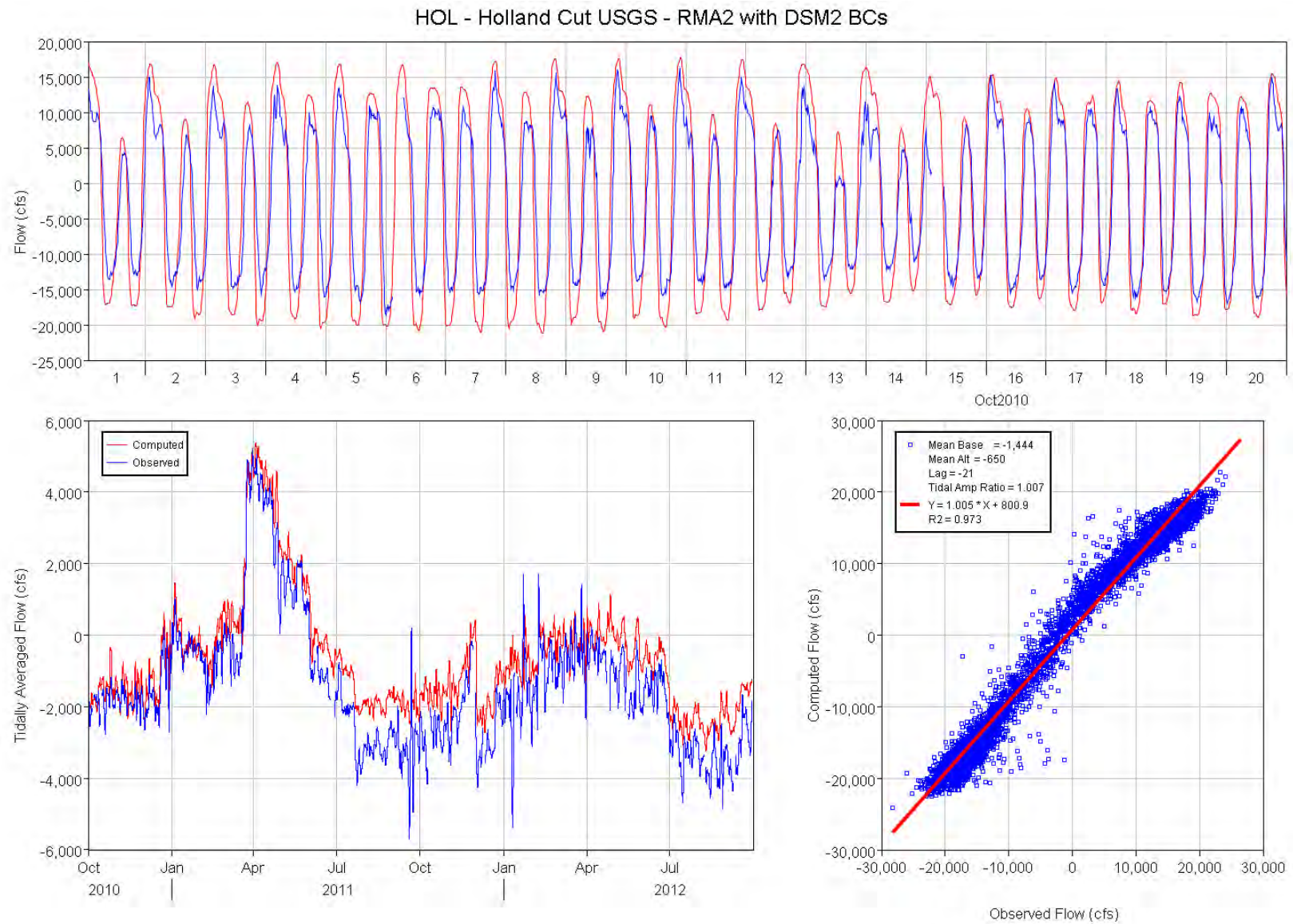


Figure 28 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Holland Cut.



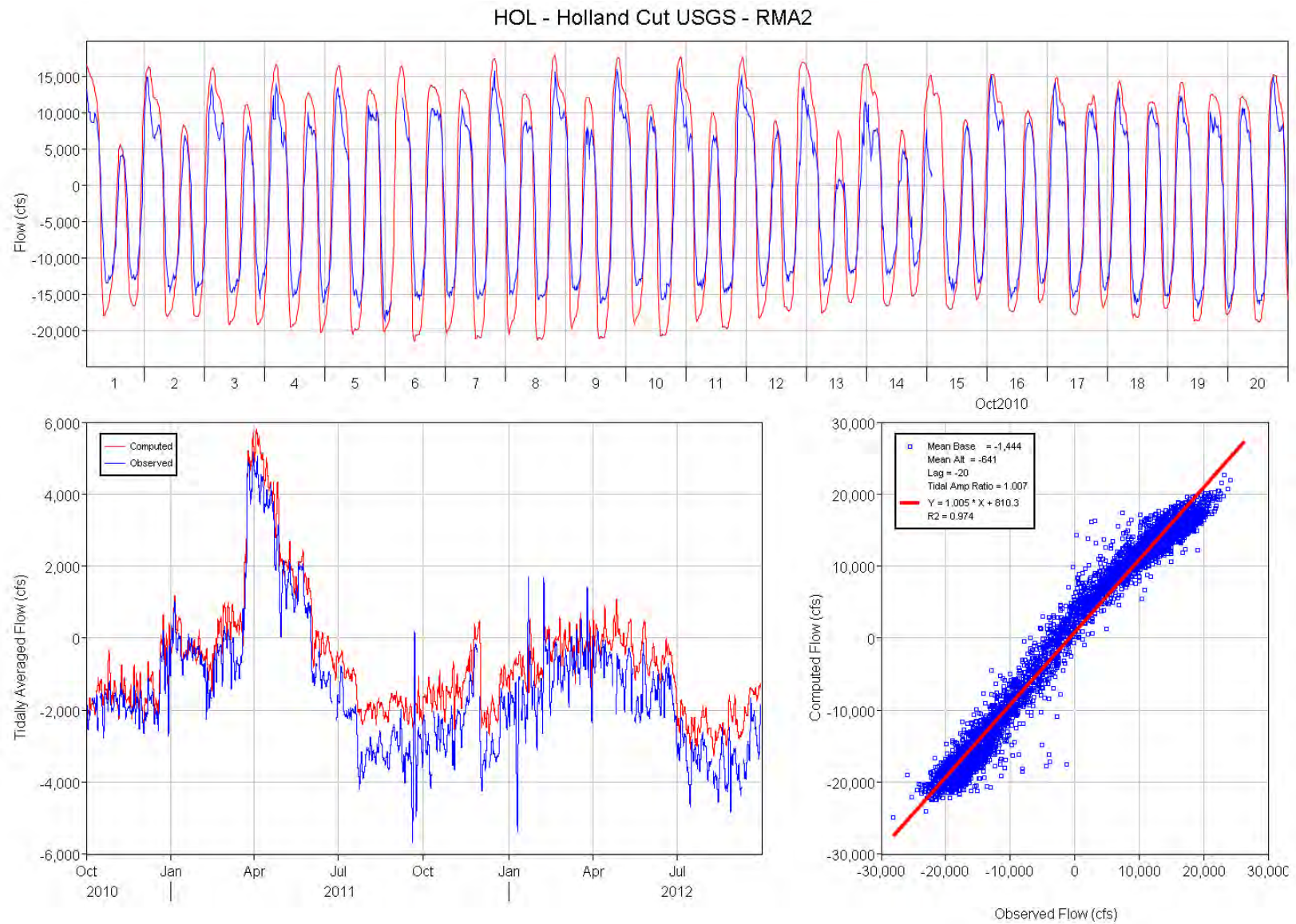


Figure 29 Computed (RMA2) and observed flow comparison plots for Holland Cut.

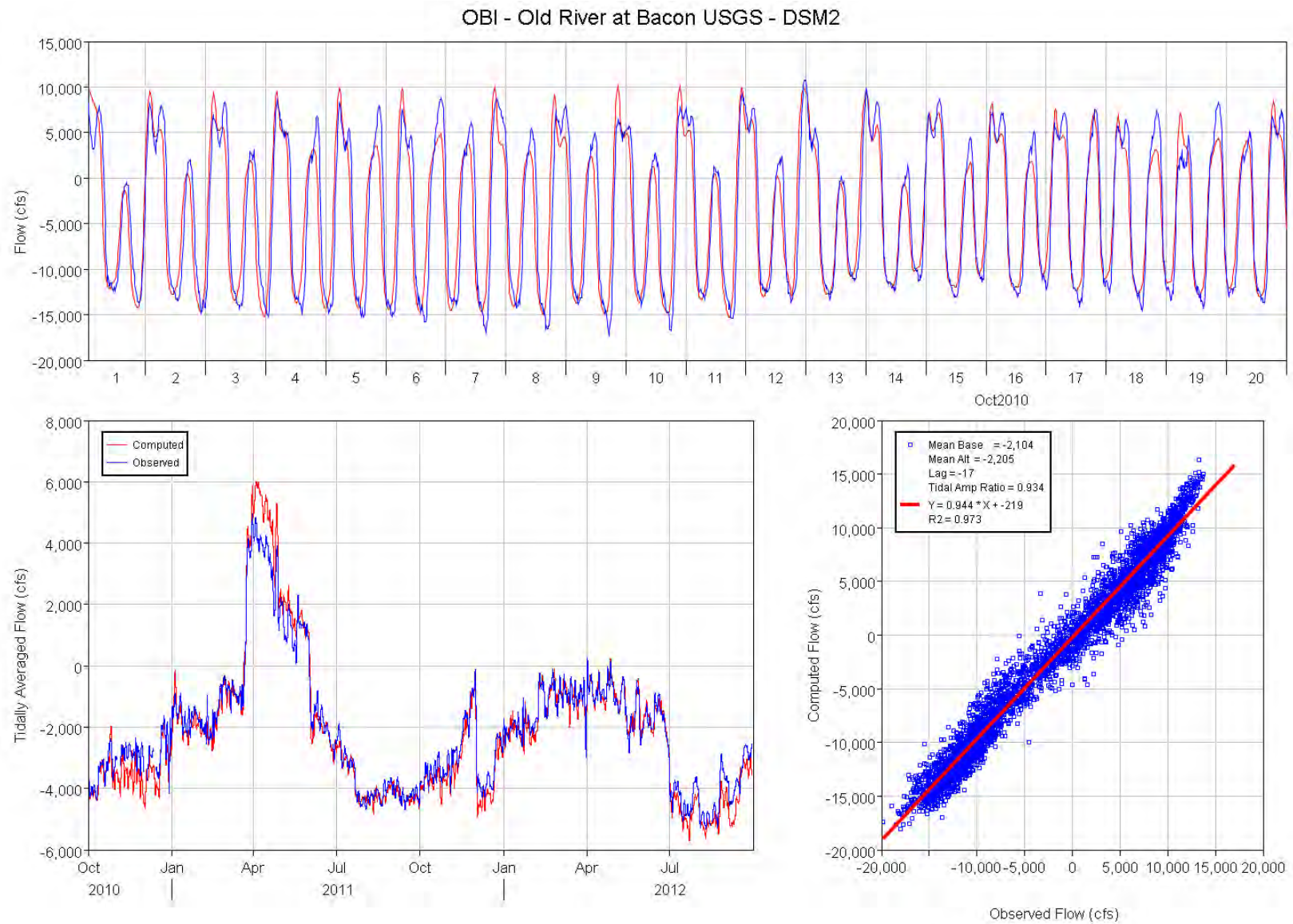


Figure 30 Computed (DSM2) and observed flow comparison plots for Old River at Bacon.



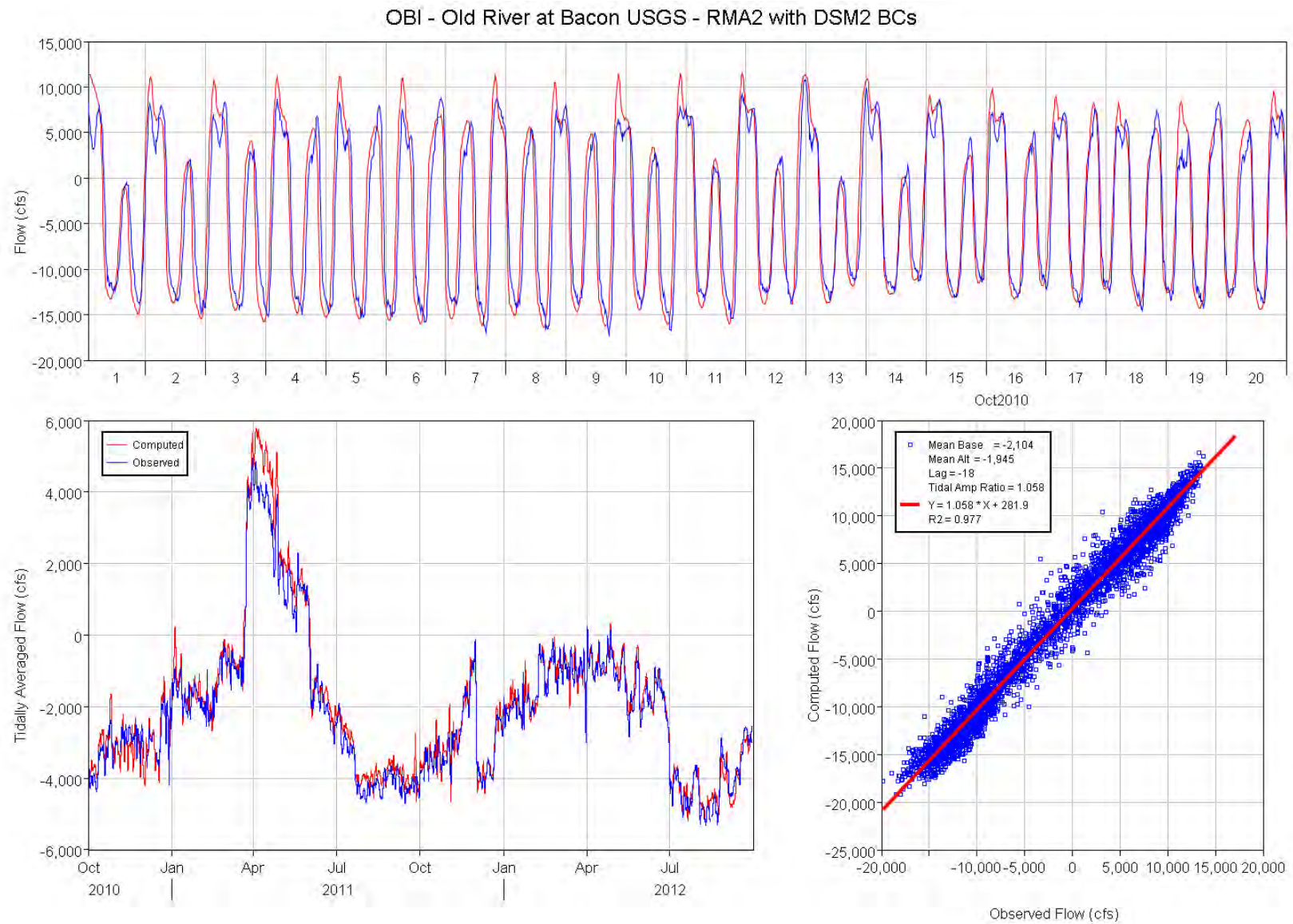


Figure 31 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Bacon.

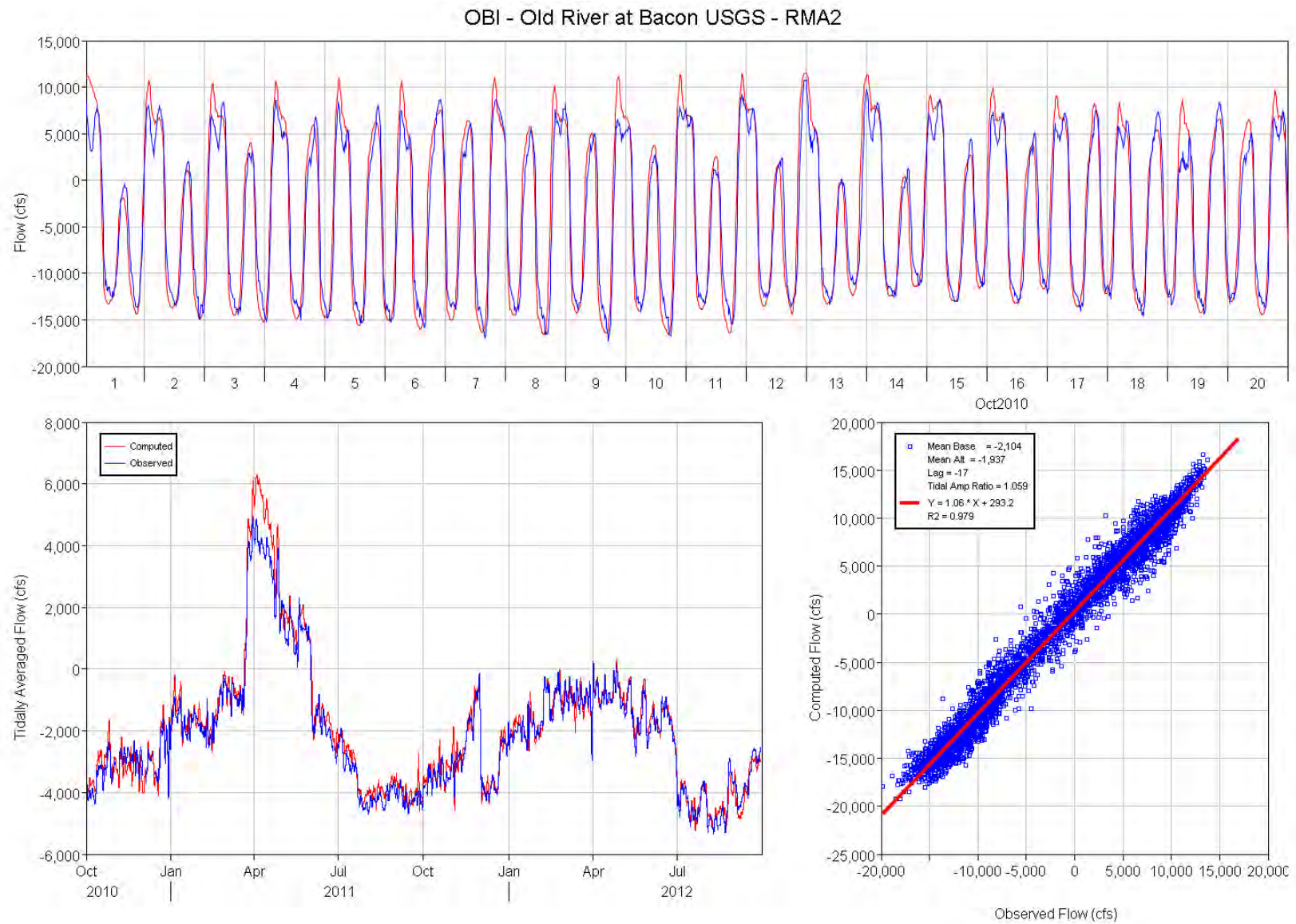


Figure 32 Computed (RMA2) and observed flow comparison plots for Old River at Bacon.



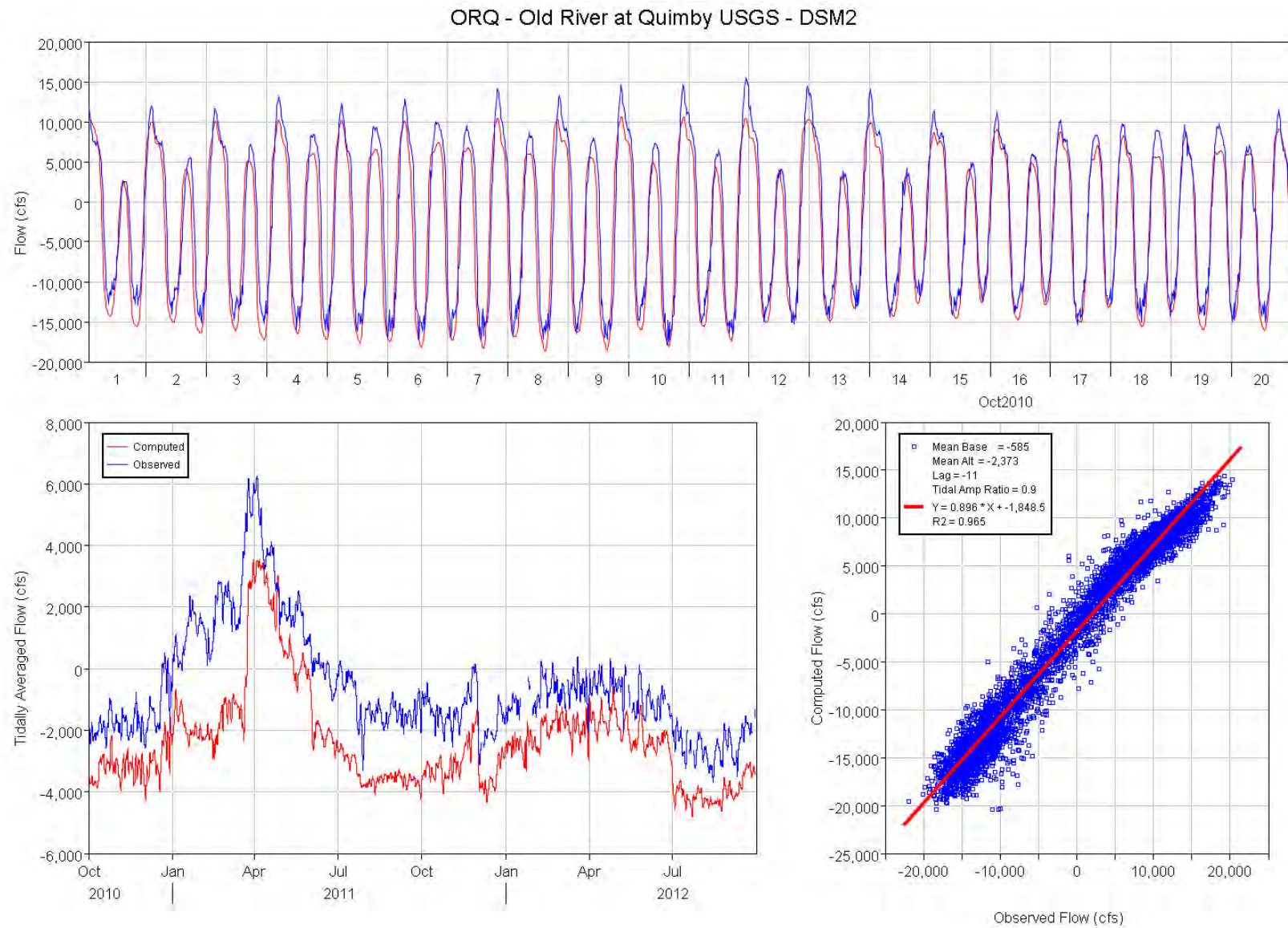


Figure 33 Computed (DSM2) and observed flow comparison plots for Old River at Quimby.

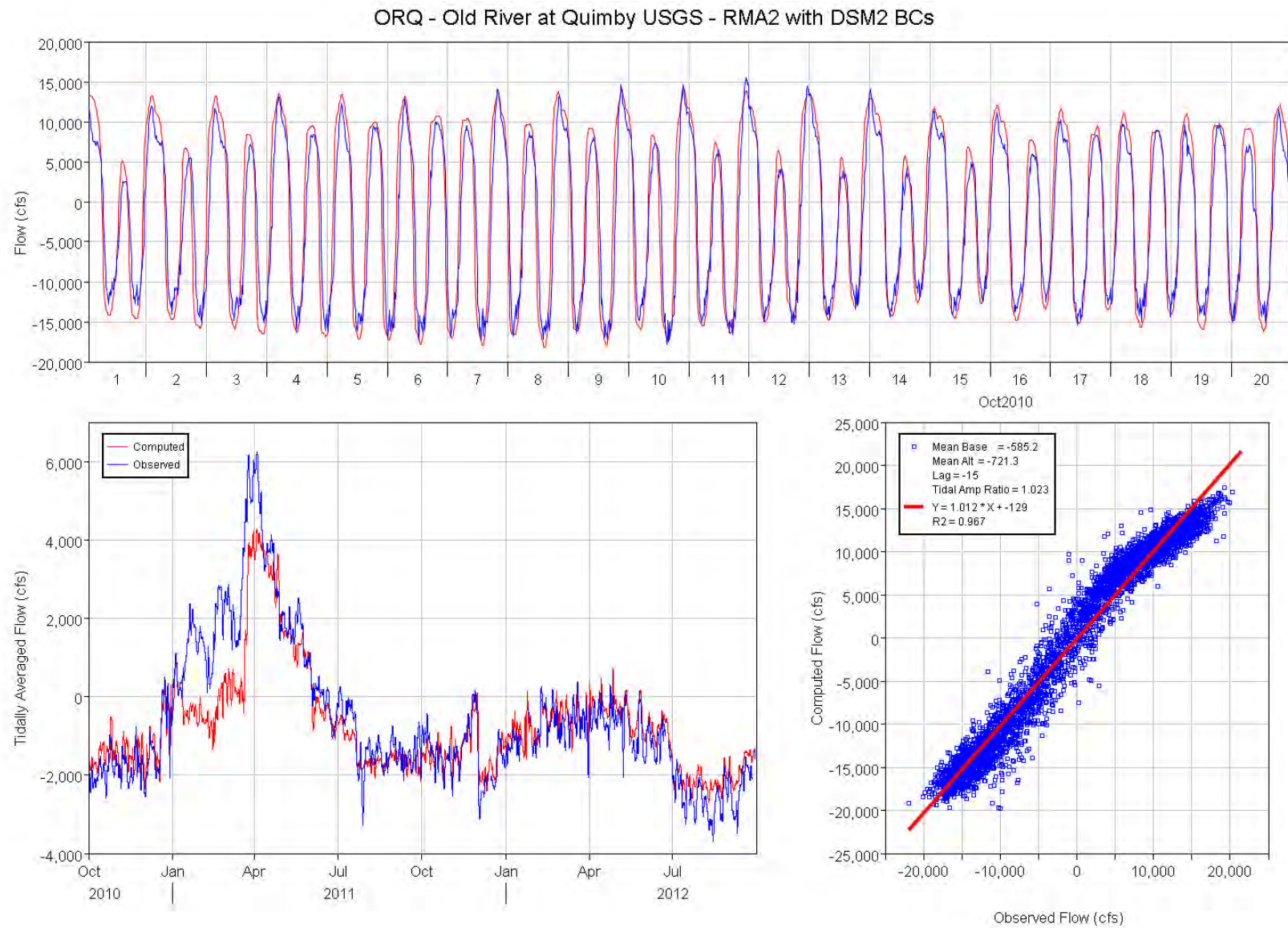


Figure 34 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Quimby.



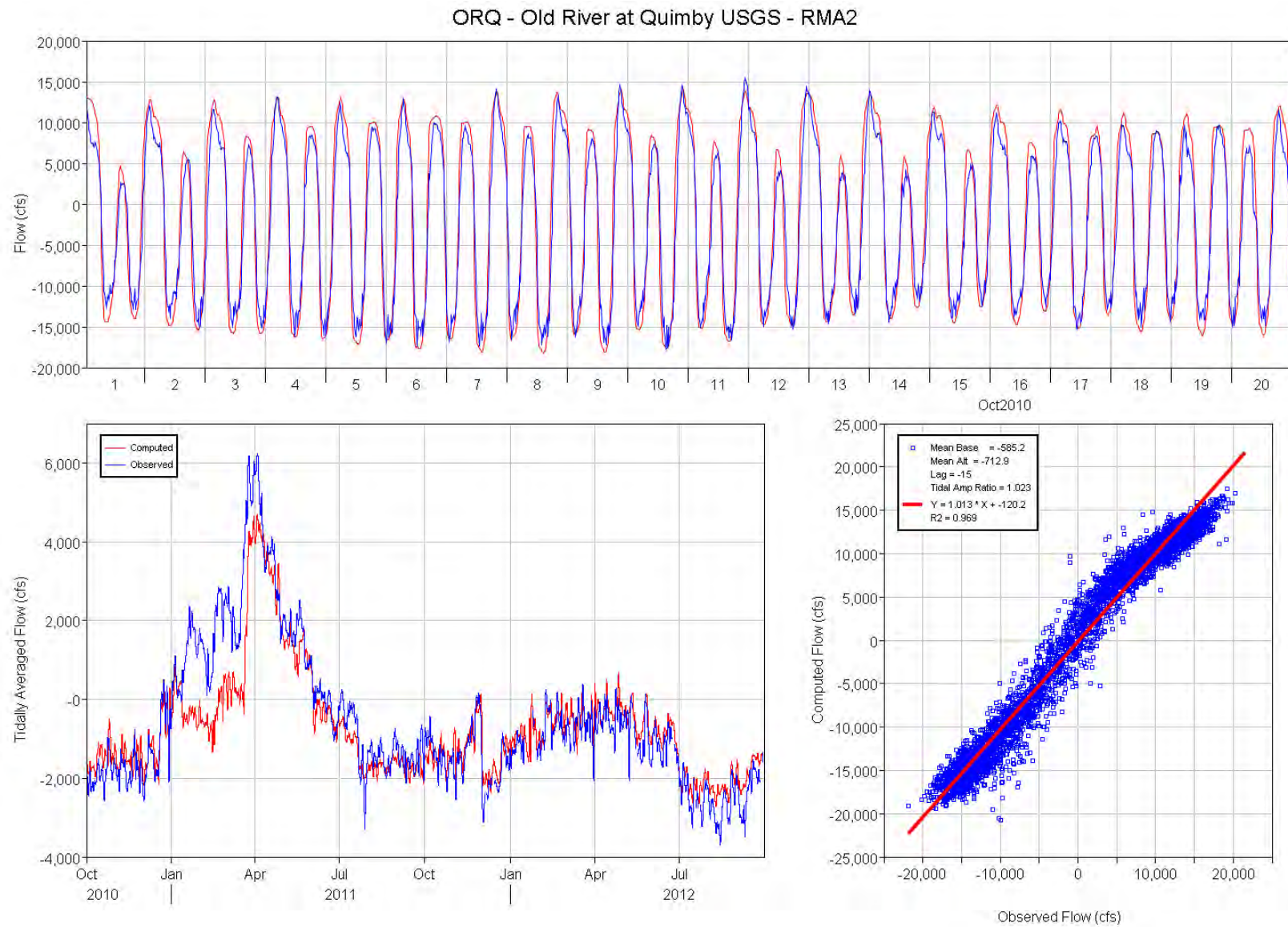


Figure 35 Computed (RMA2) and observed flow comparison plots for Old River at Quimby.

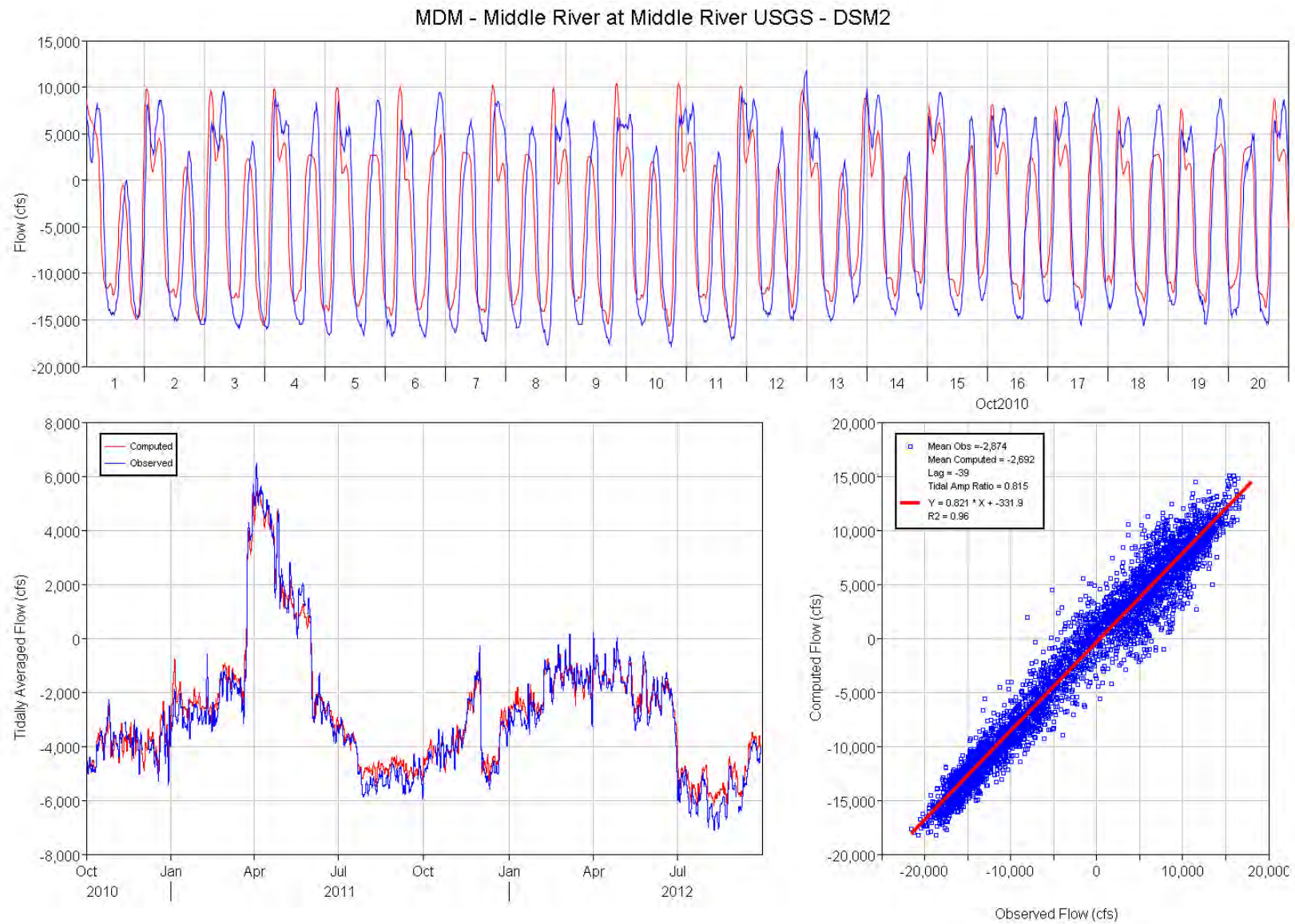


Figure 36 Computed (DSM2) and observed flow comparison plots for Middle River at Middle River.



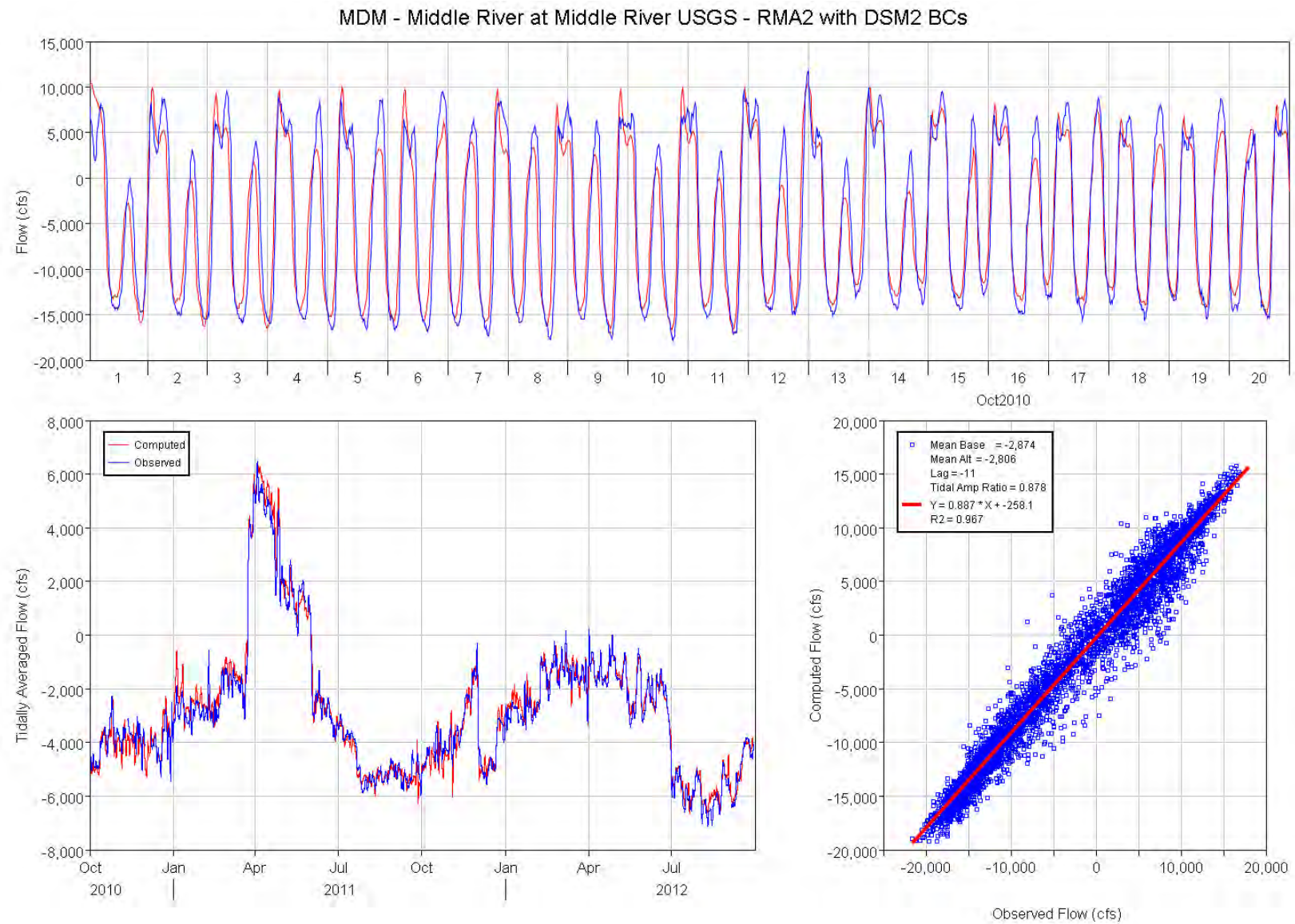


Figure 37 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Middle River at Middle River.

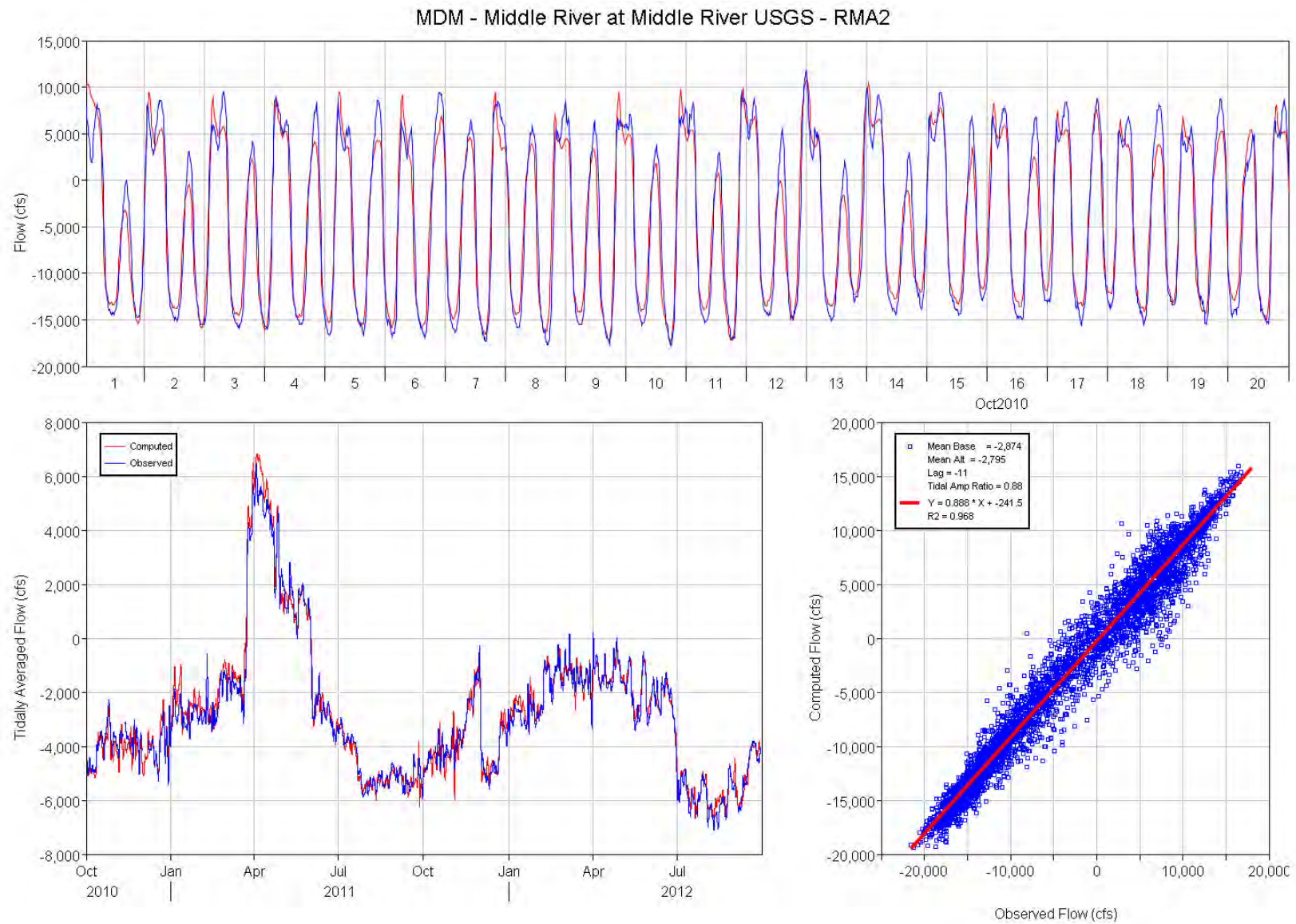


Figure 38 Computed (RMA2) and observed flow comparison plots for Middle River at Middle River.



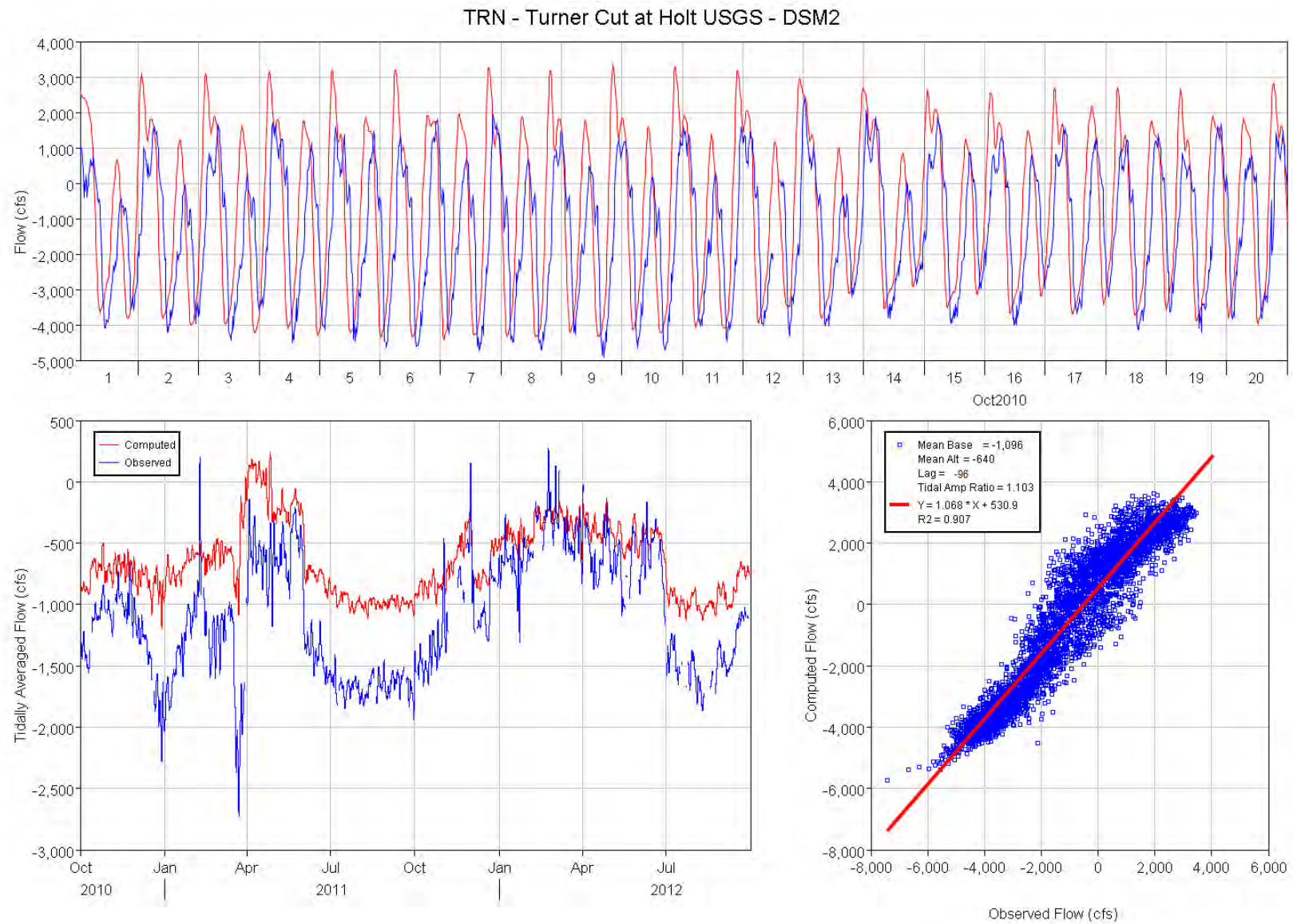


Figure 39 Computed (DSM2) and observed flow comparison plots for Turner Cut at Holt.

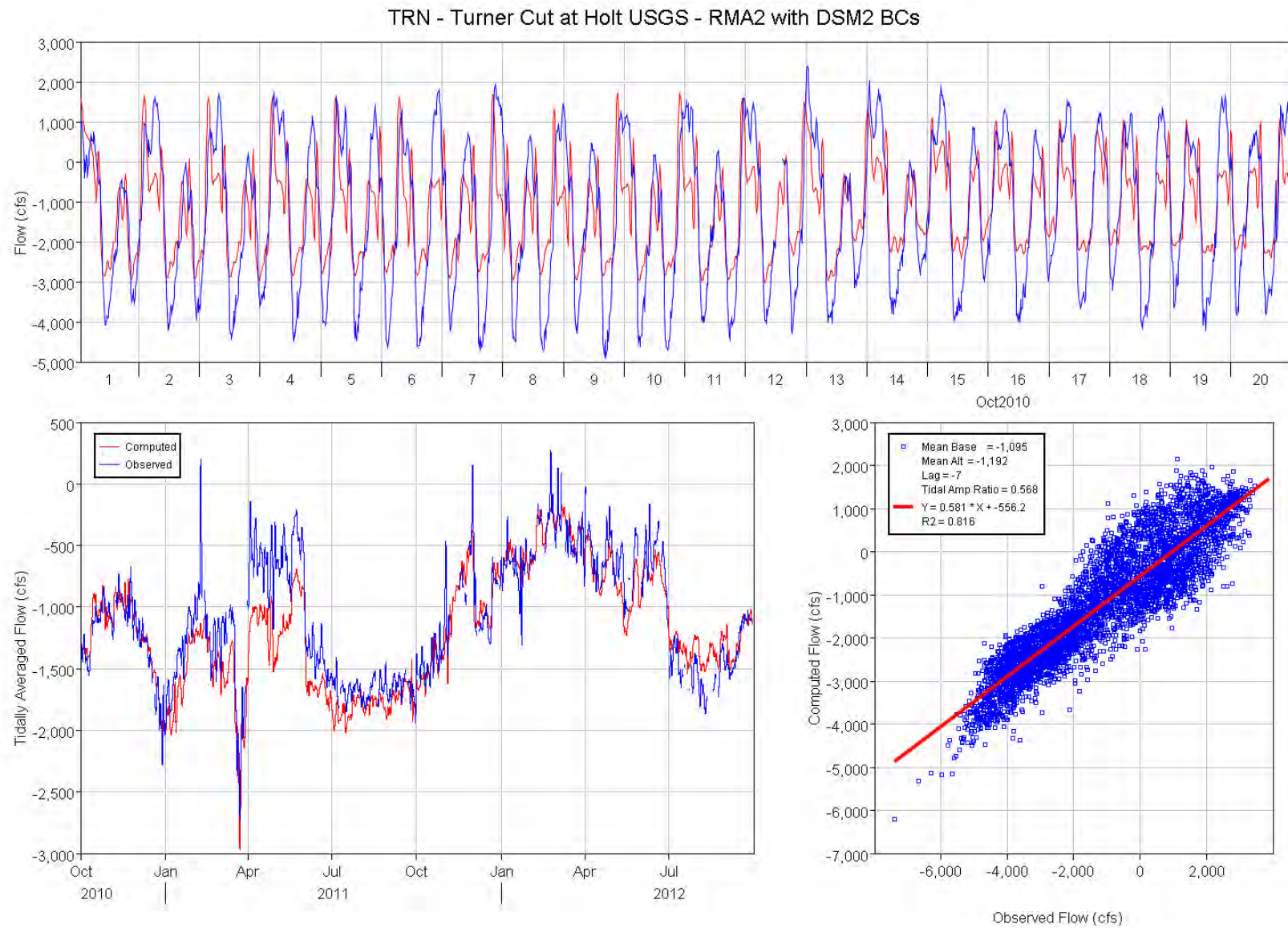


Figure 40 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Turner Cut at Holt.



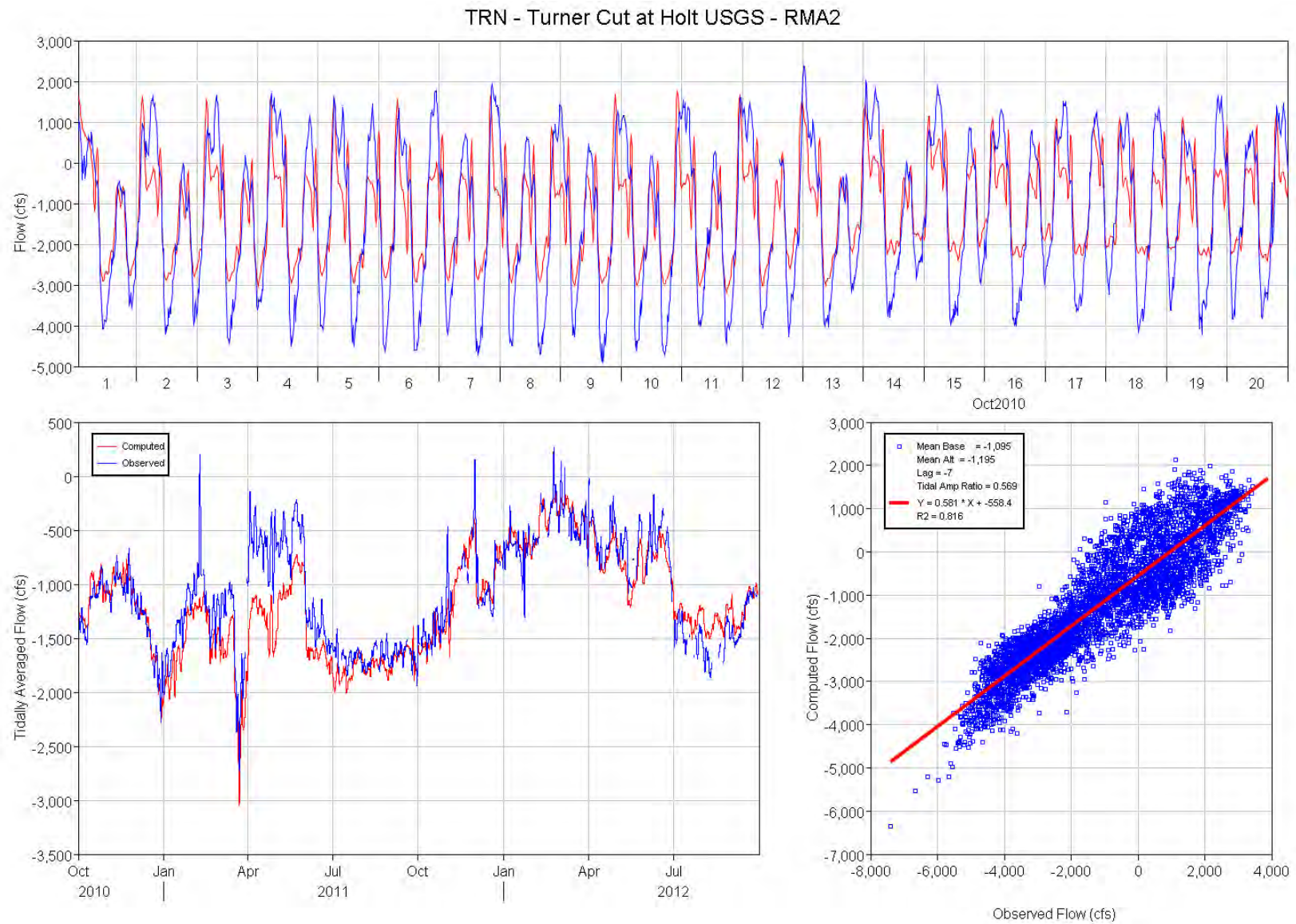


Figure 41 Computed (RMA2) and observed flow comparison plots for Turner Cut at Holt.

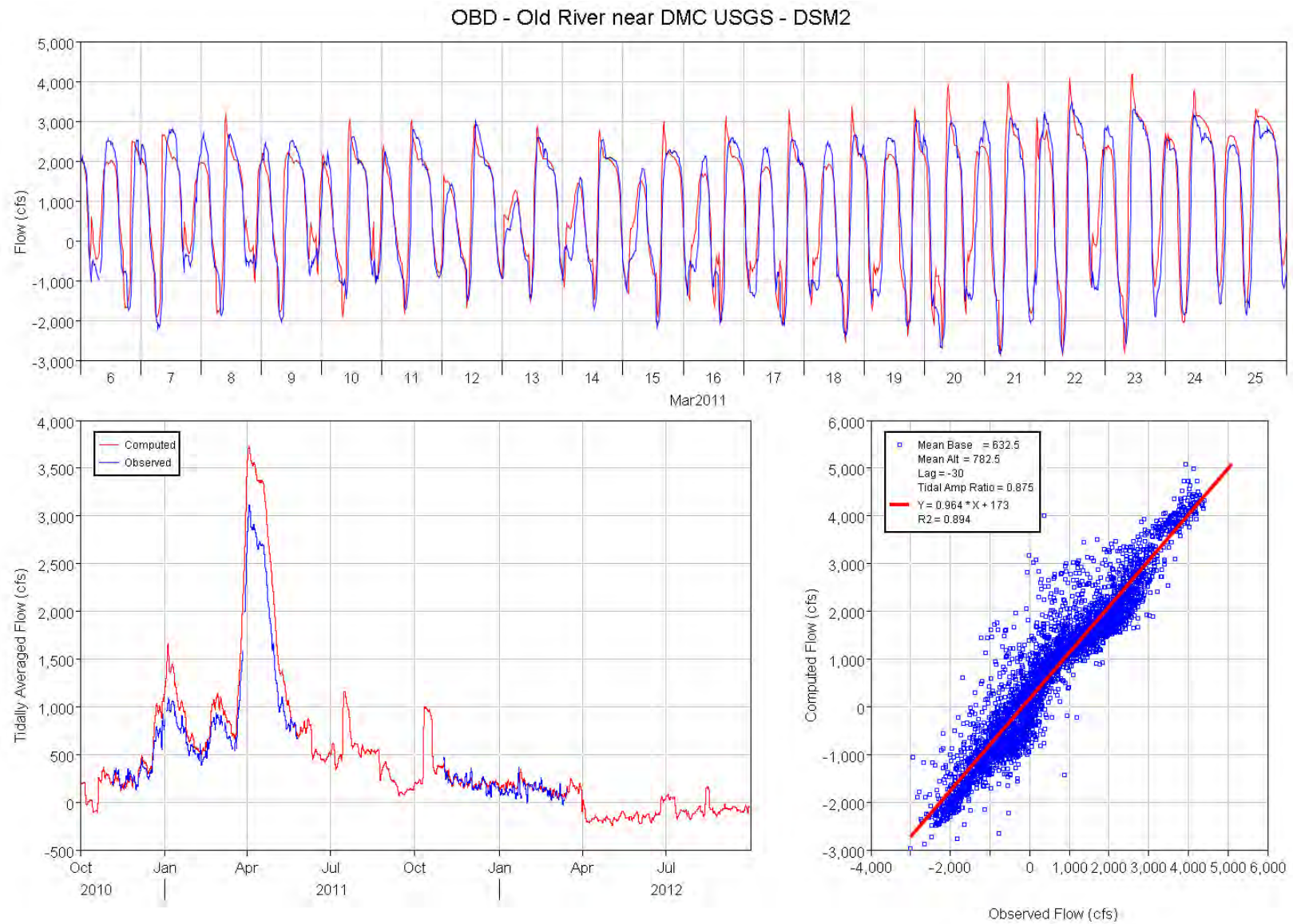


Figure 42 Computed (DSM2) and observed flow comparison plots for Old River near DMC.



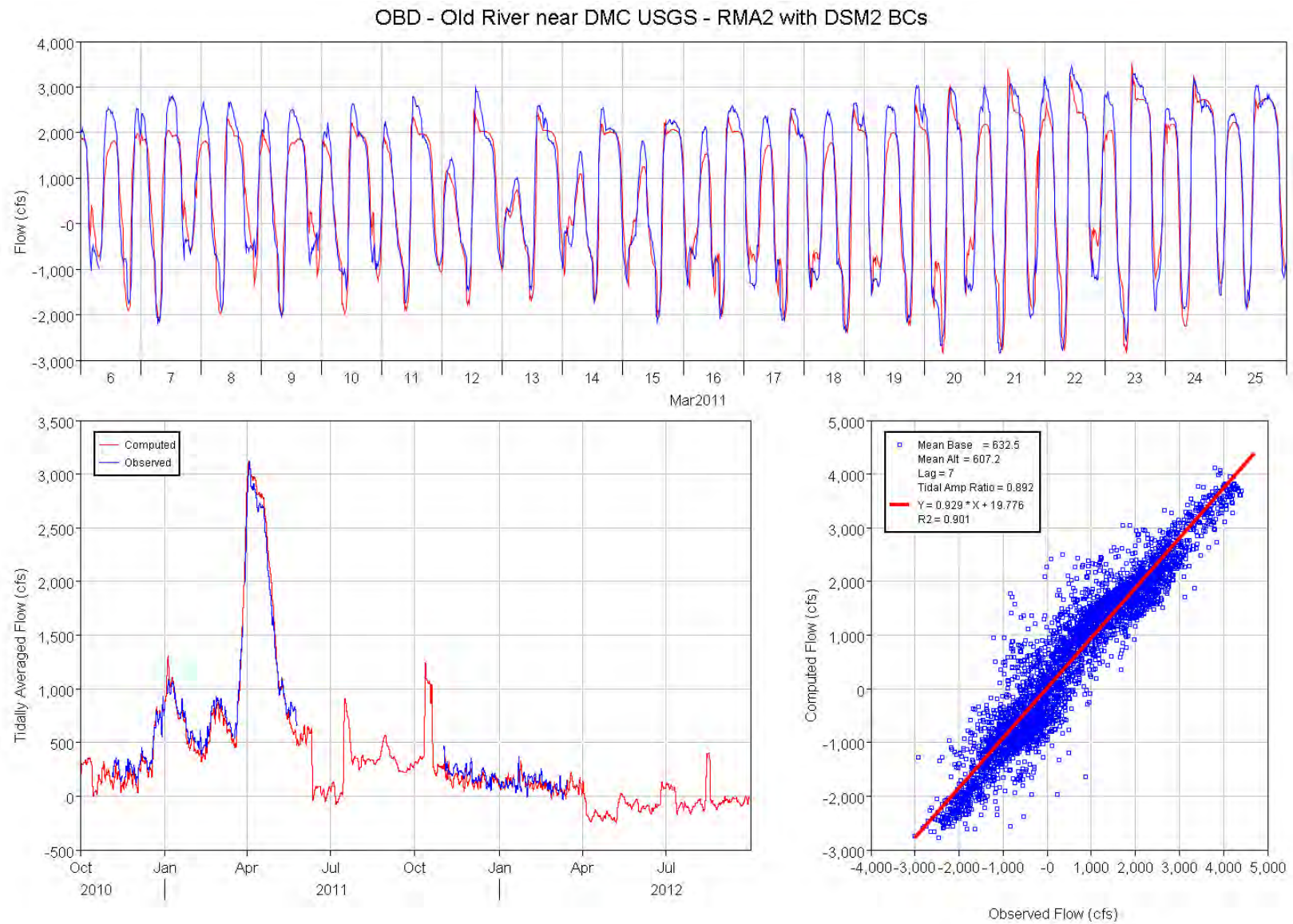


Figure 43 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River near DMC.

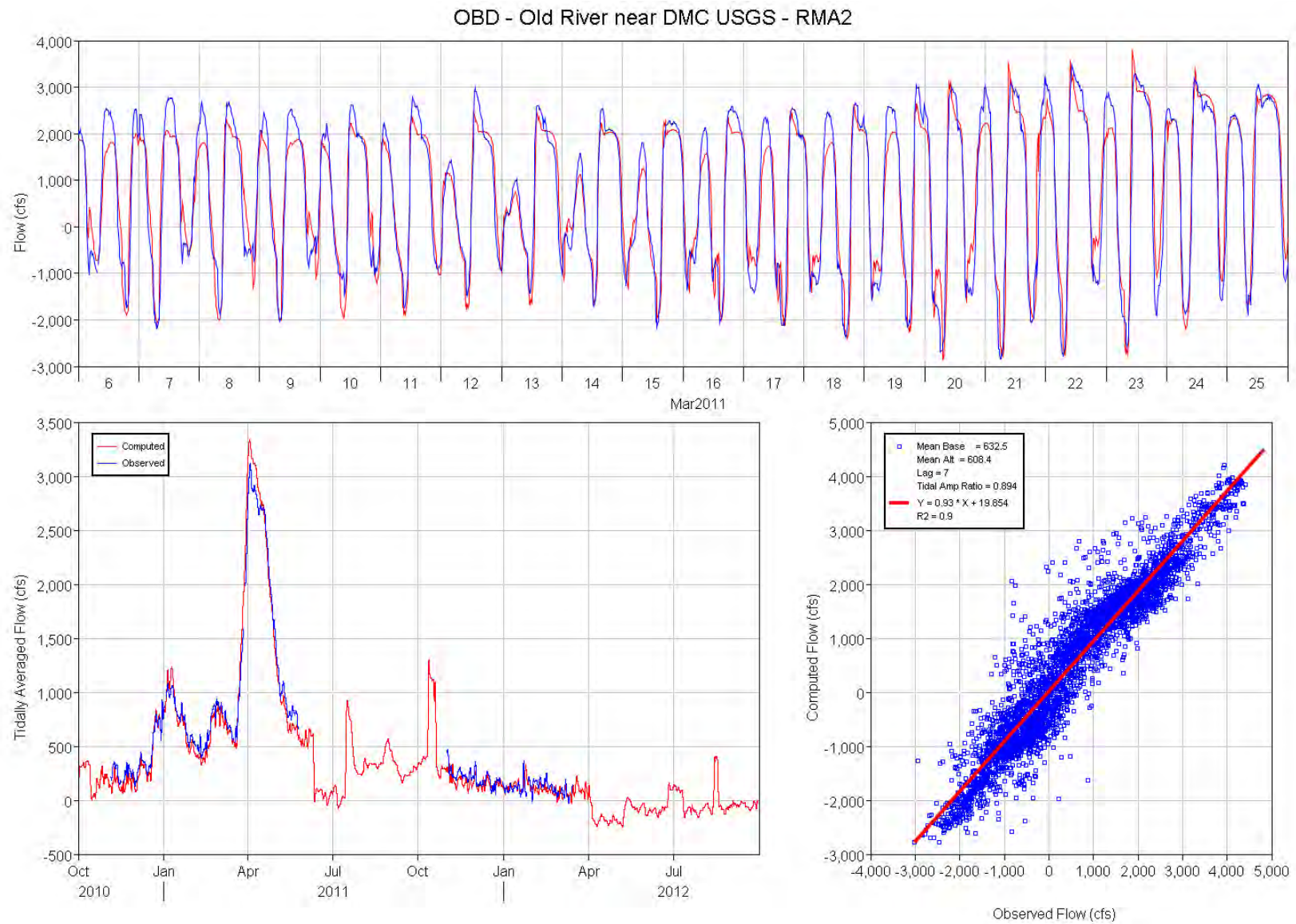


Figure 44 Computed (RMA2) and observed flow comparison plots for Old River near DMC.



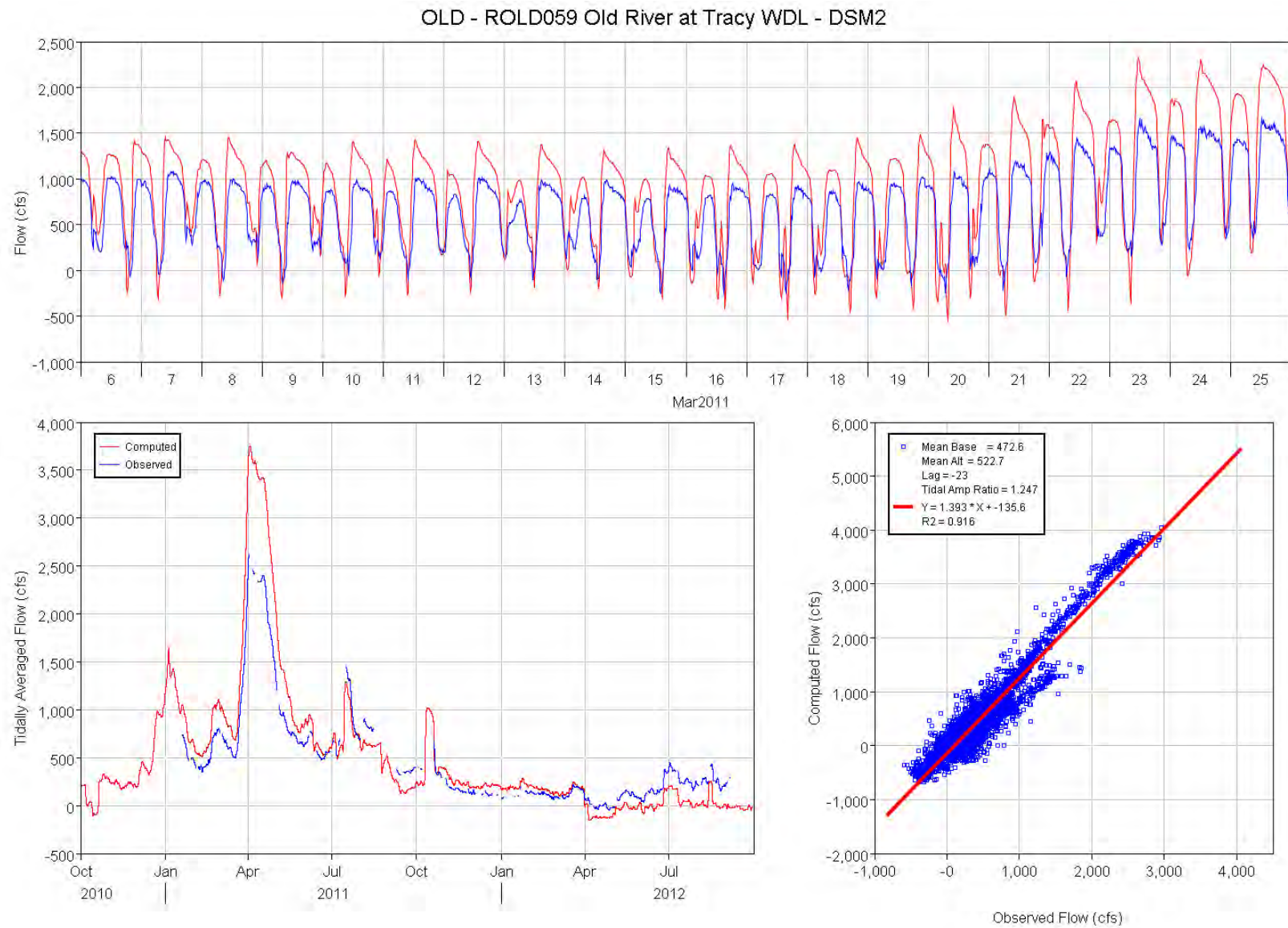


Figure 45 Computed (DSM2) and observed flow comparison plots for Old River at Tracy.

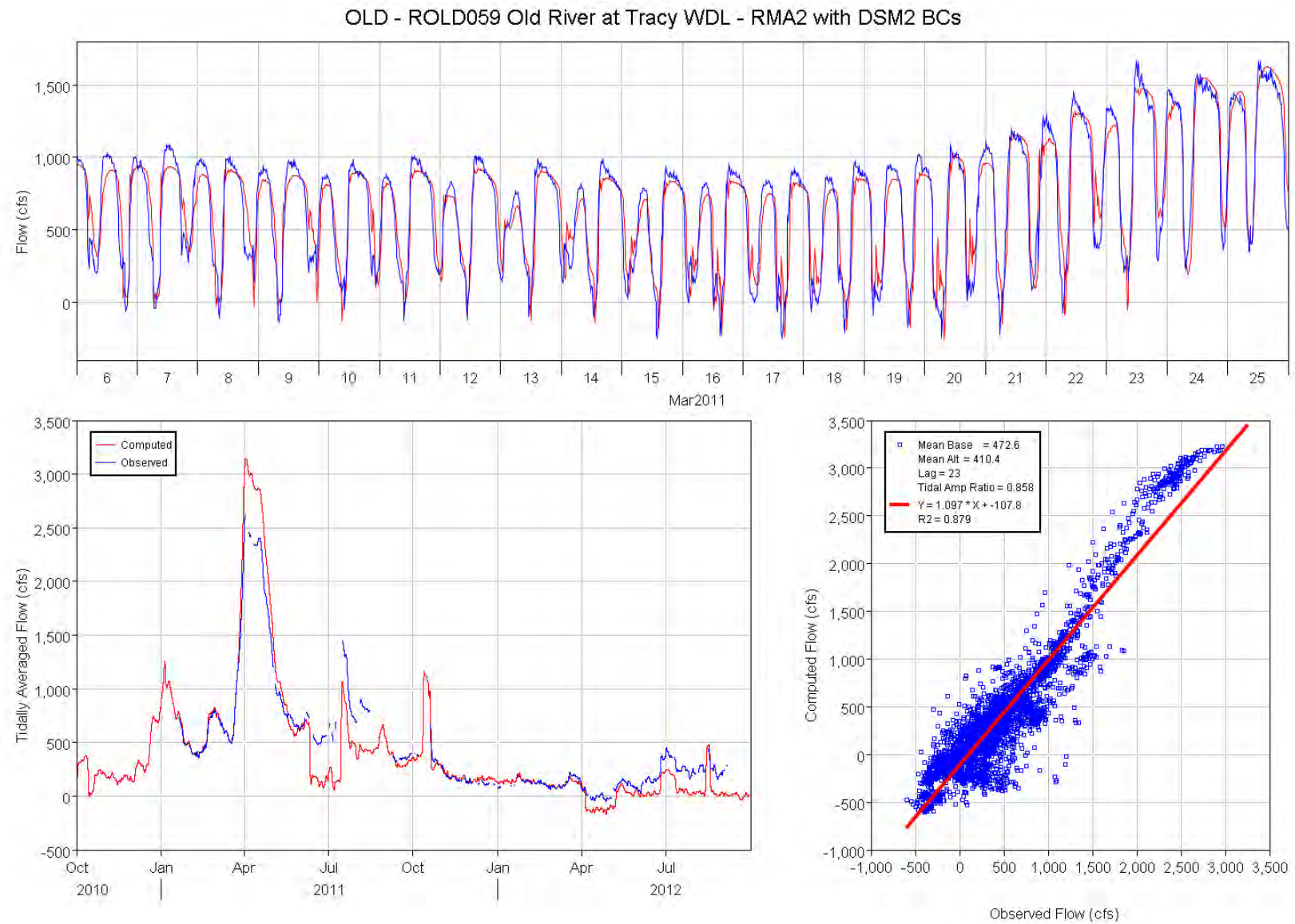


Figure 46 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Tracy.

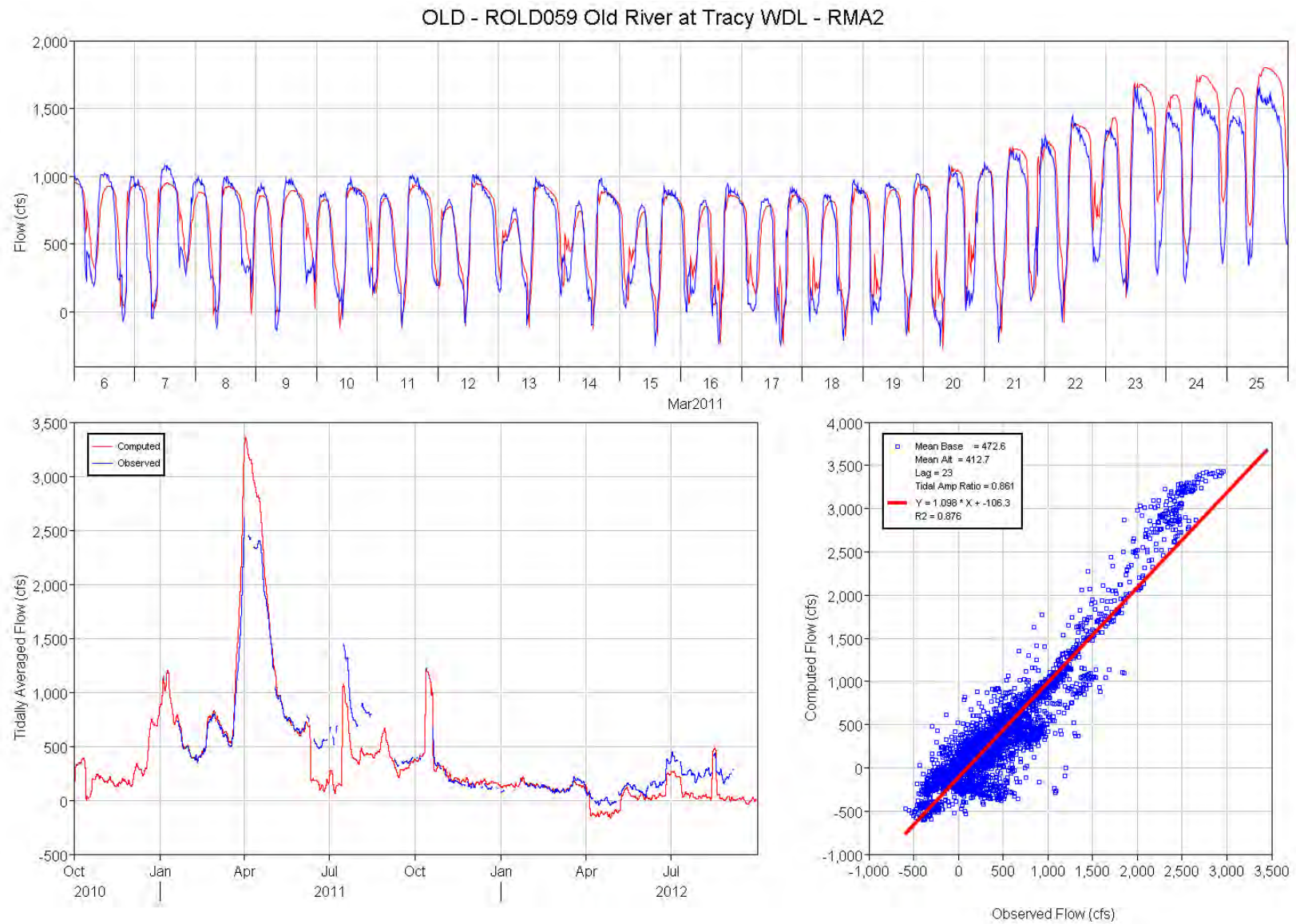


Figure 47 Computed (RMA2) and observed flow comparison plots for Old River at Tracy.



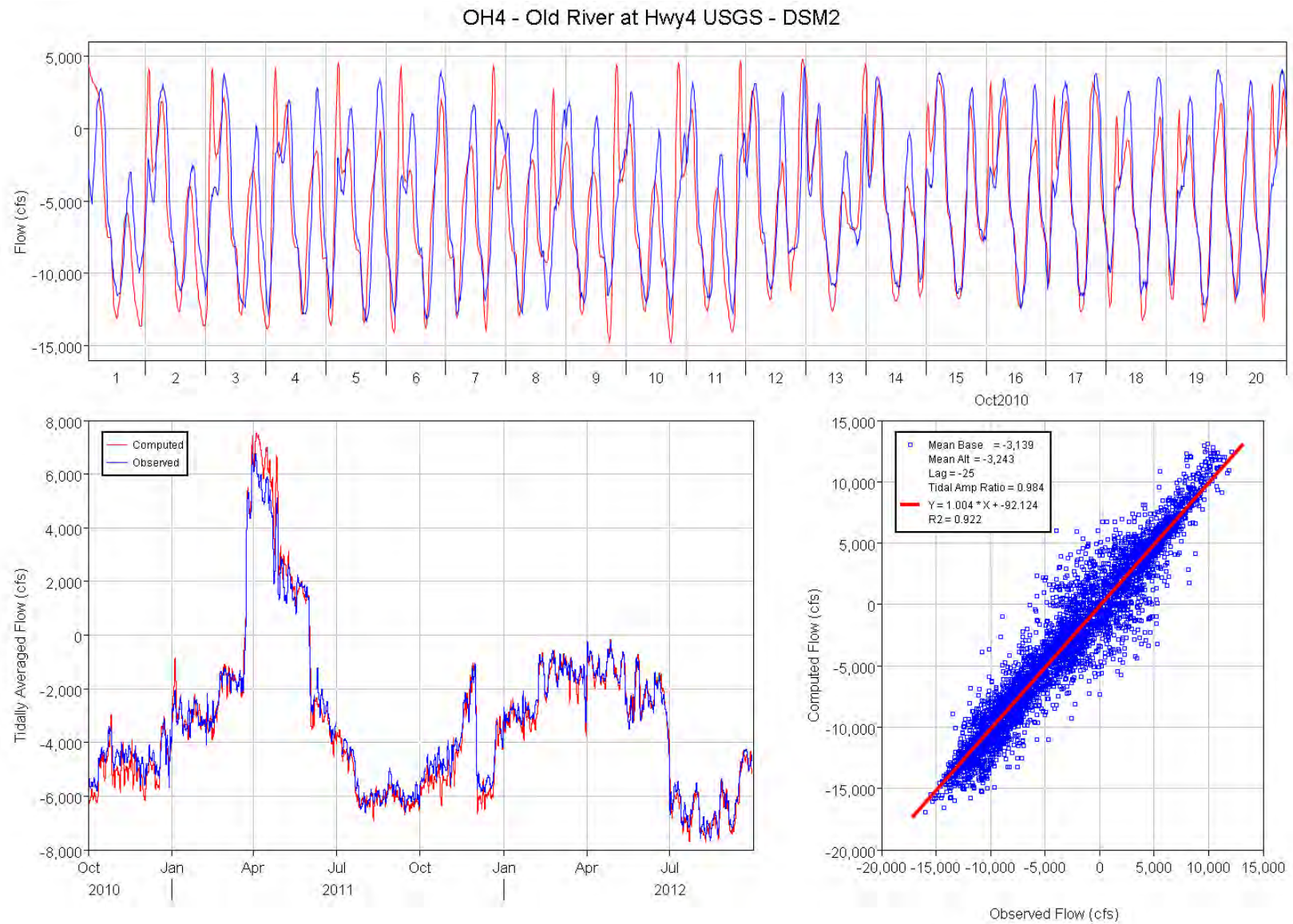


Figure 48 Computed (DSM2) and observed flow comparison plots for Old River at Hwy 4.

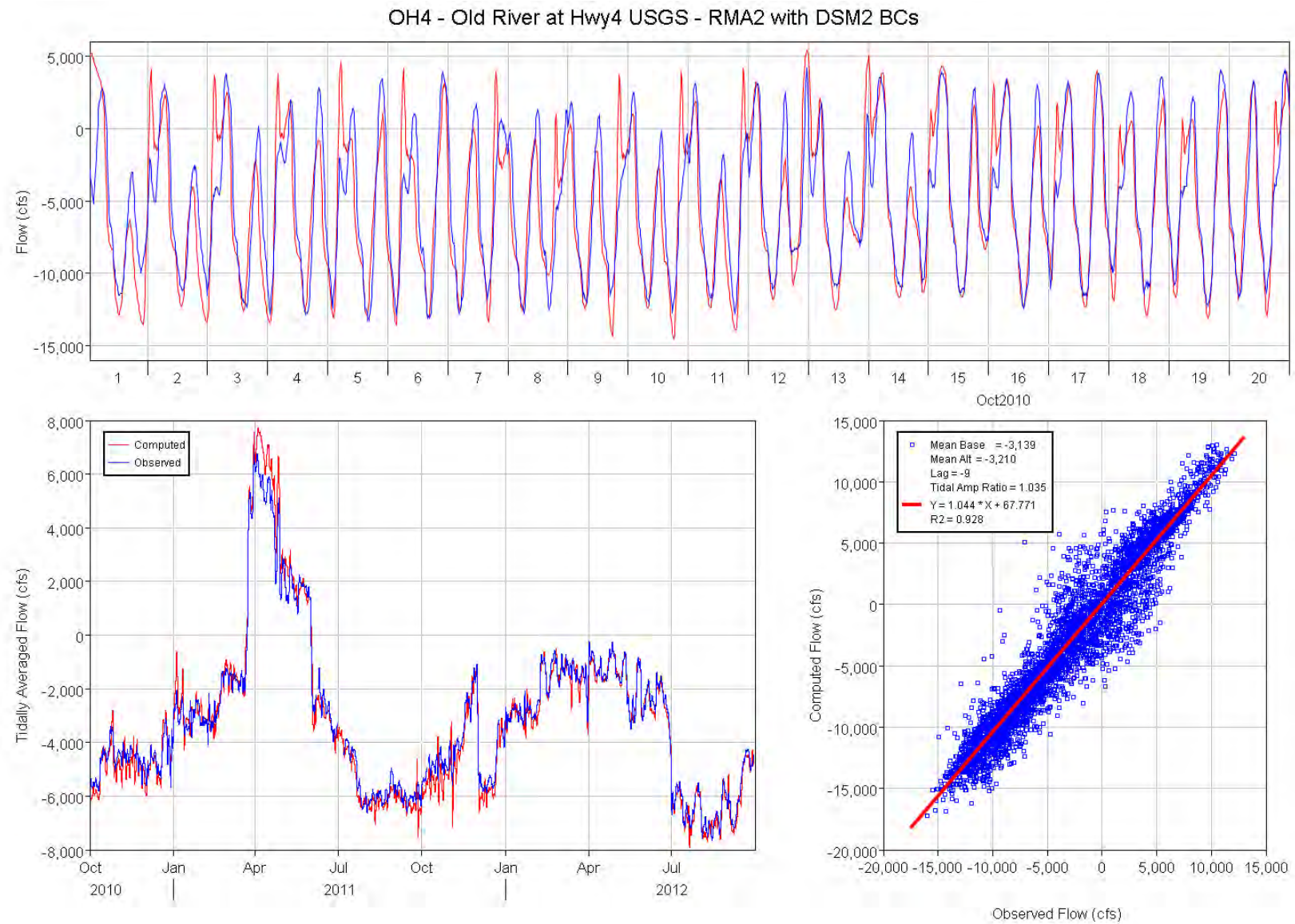


Figure 49 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Hwy 4.



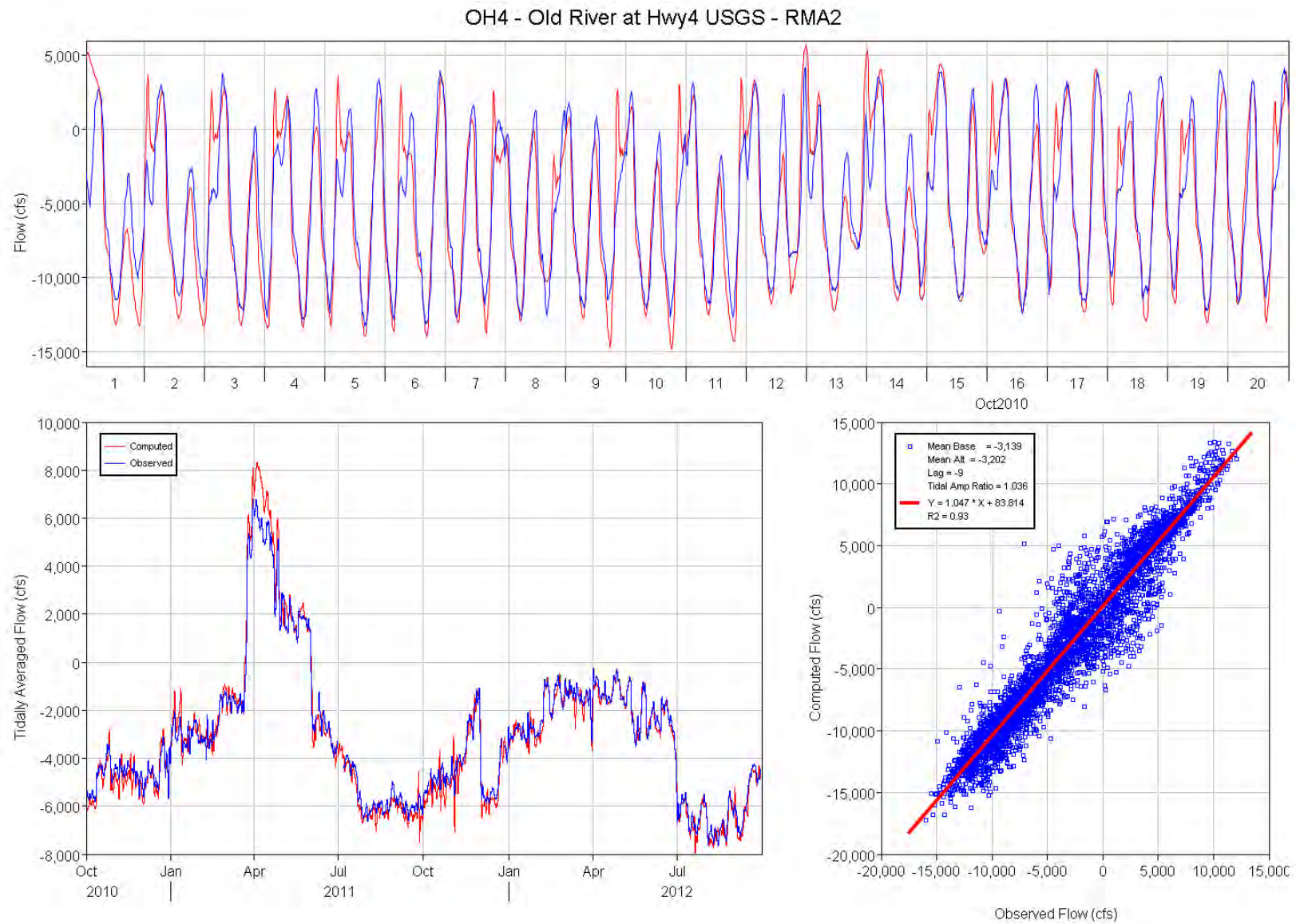


Figure 50 Computed (RMA2) and observed flow comparison plots for Old River at Hwy 4.



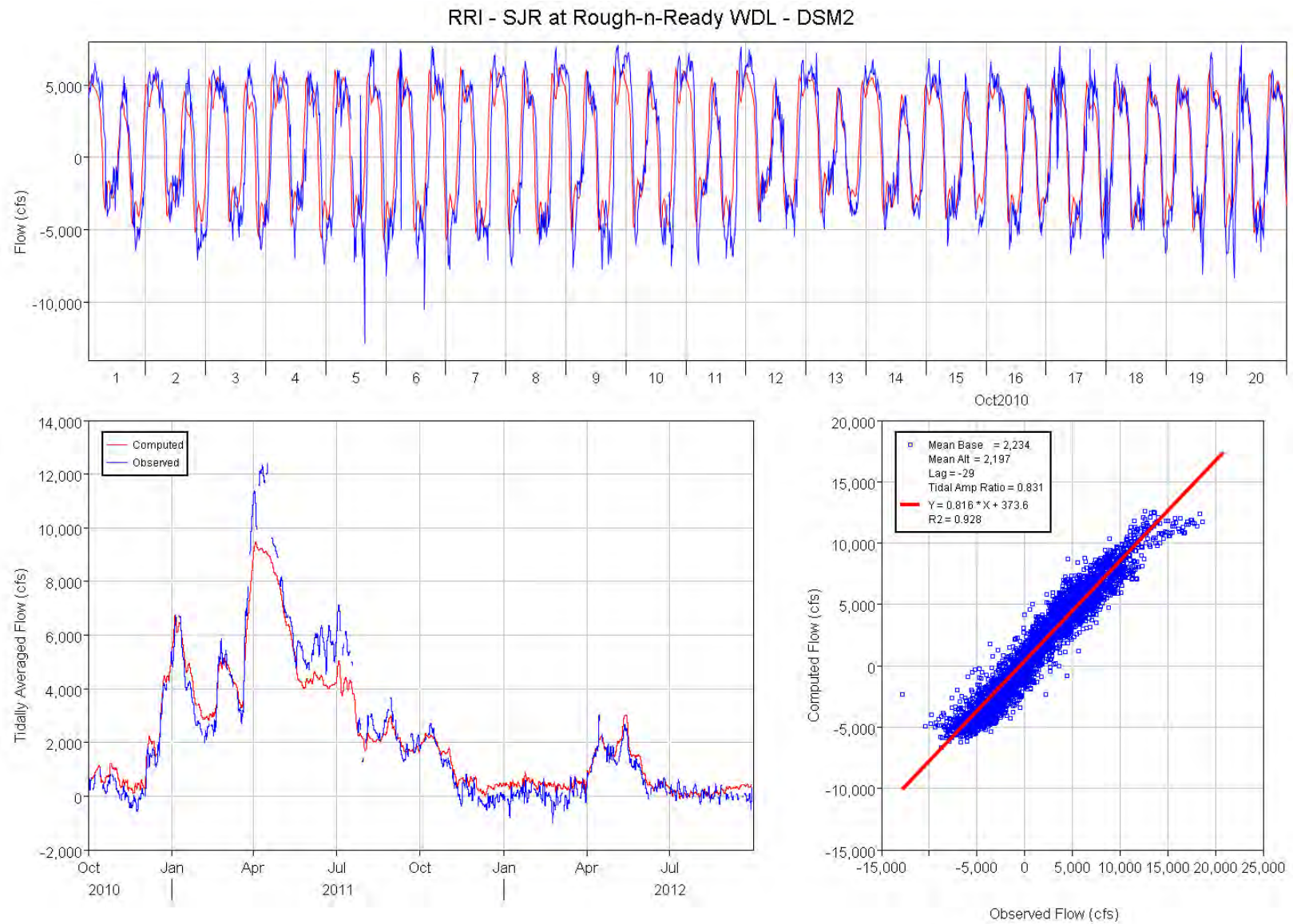


Figure 51 Computed (DSM2) and observed flow comparison plots for SJR at Rough-n-Ready.

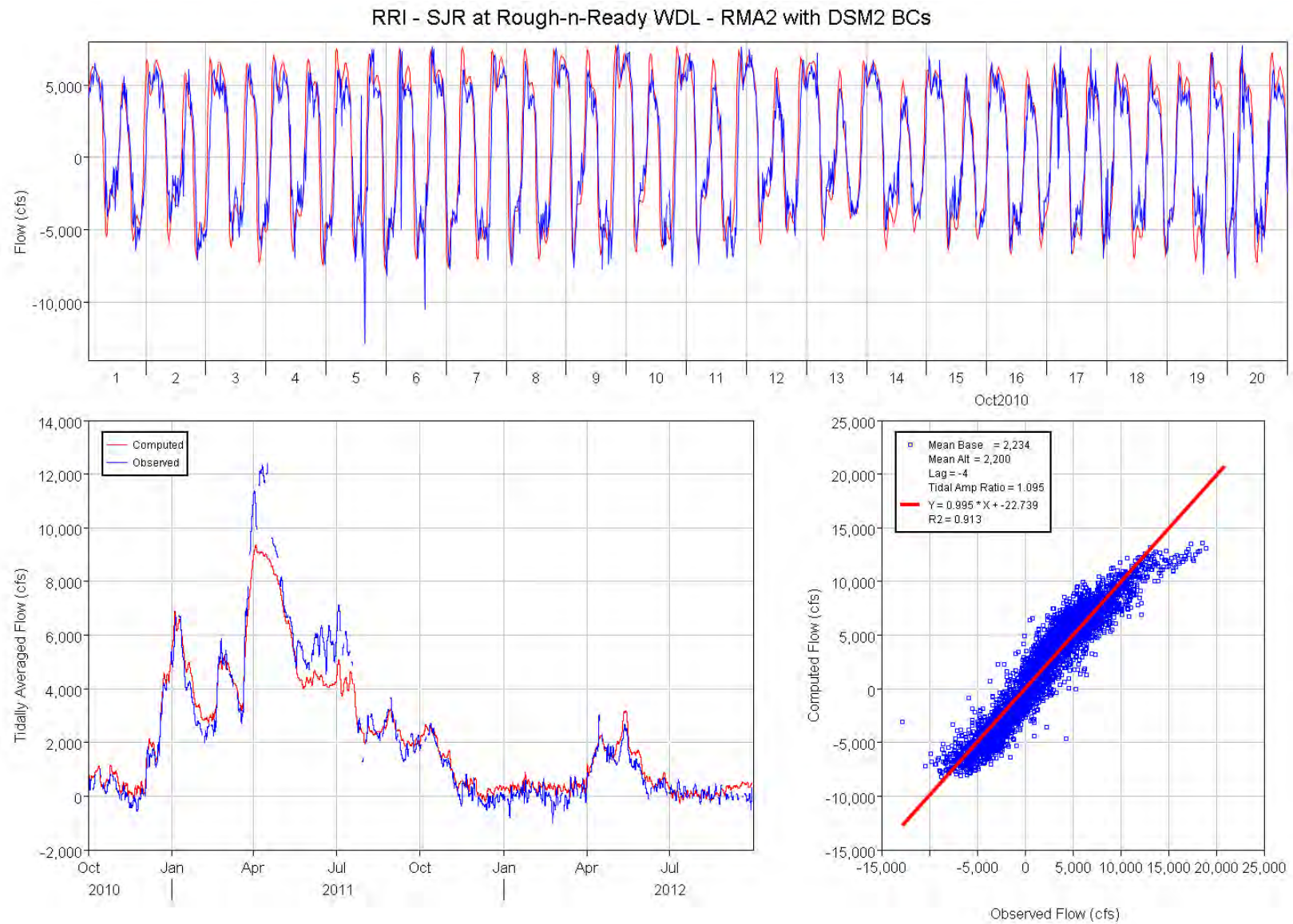


Figure 52 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for SJR at Rough-n-Ready.

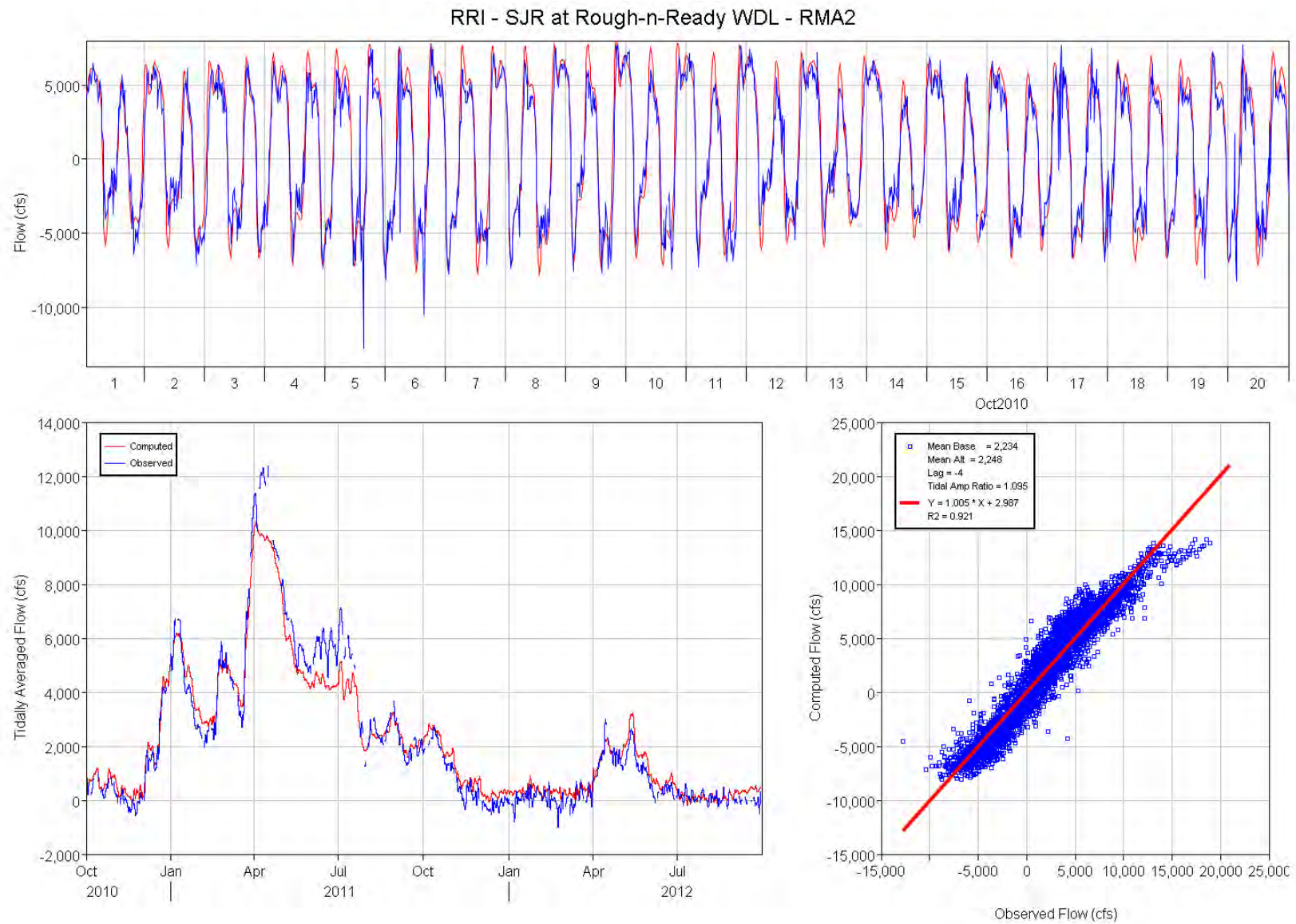


Figure 53 Computed (RMA2) and observed flow comparison plots for SJR at Rough-n-Ready.



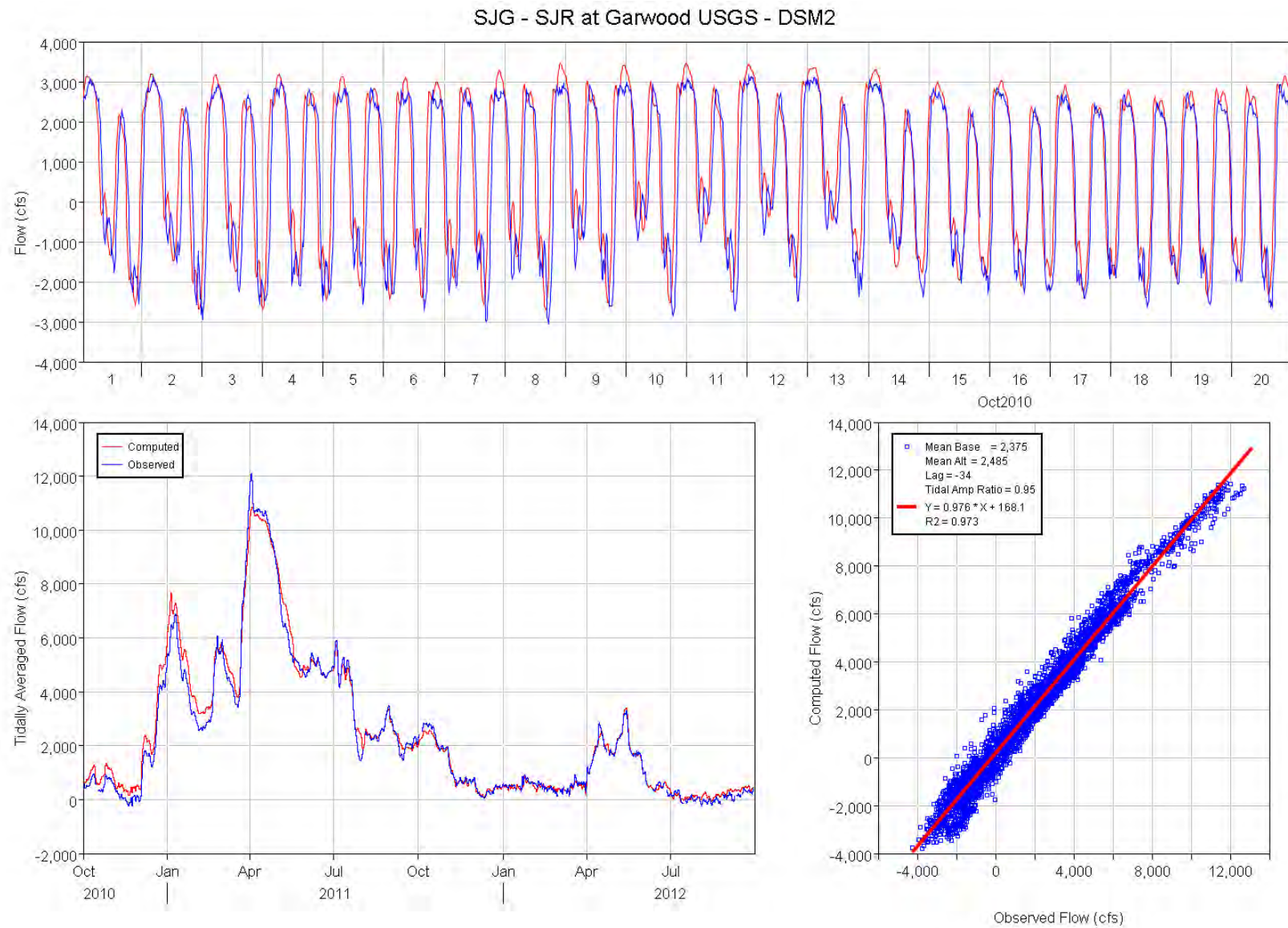


Figure 54 Computed (DSM2) and observed flow comparison plots for SJR at Garwood.



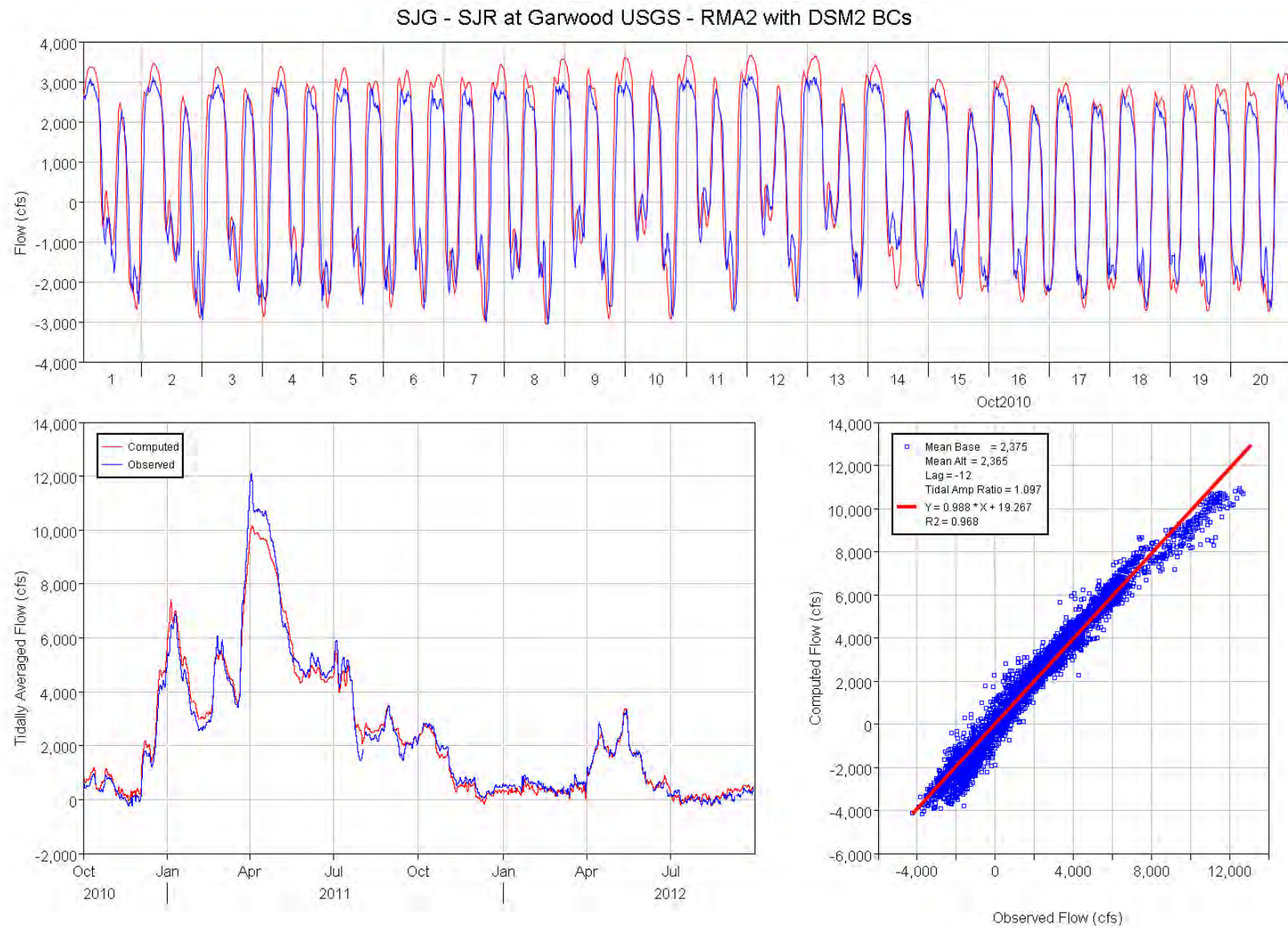


Figure 55 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for SJR at Garwood.

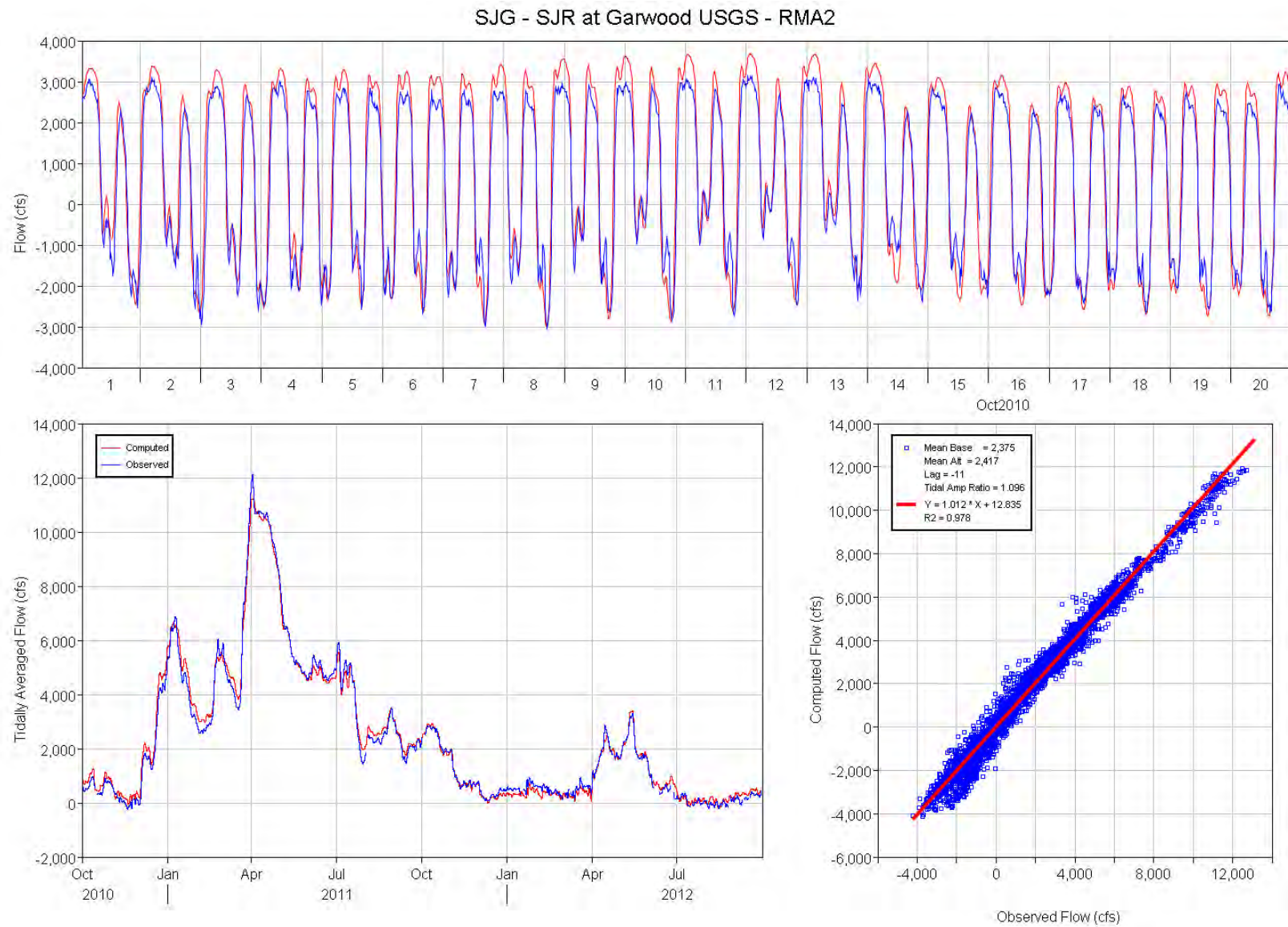


Figure 56 Computed (RMA2) and observed flow comparison plots for SJR at Garwood.

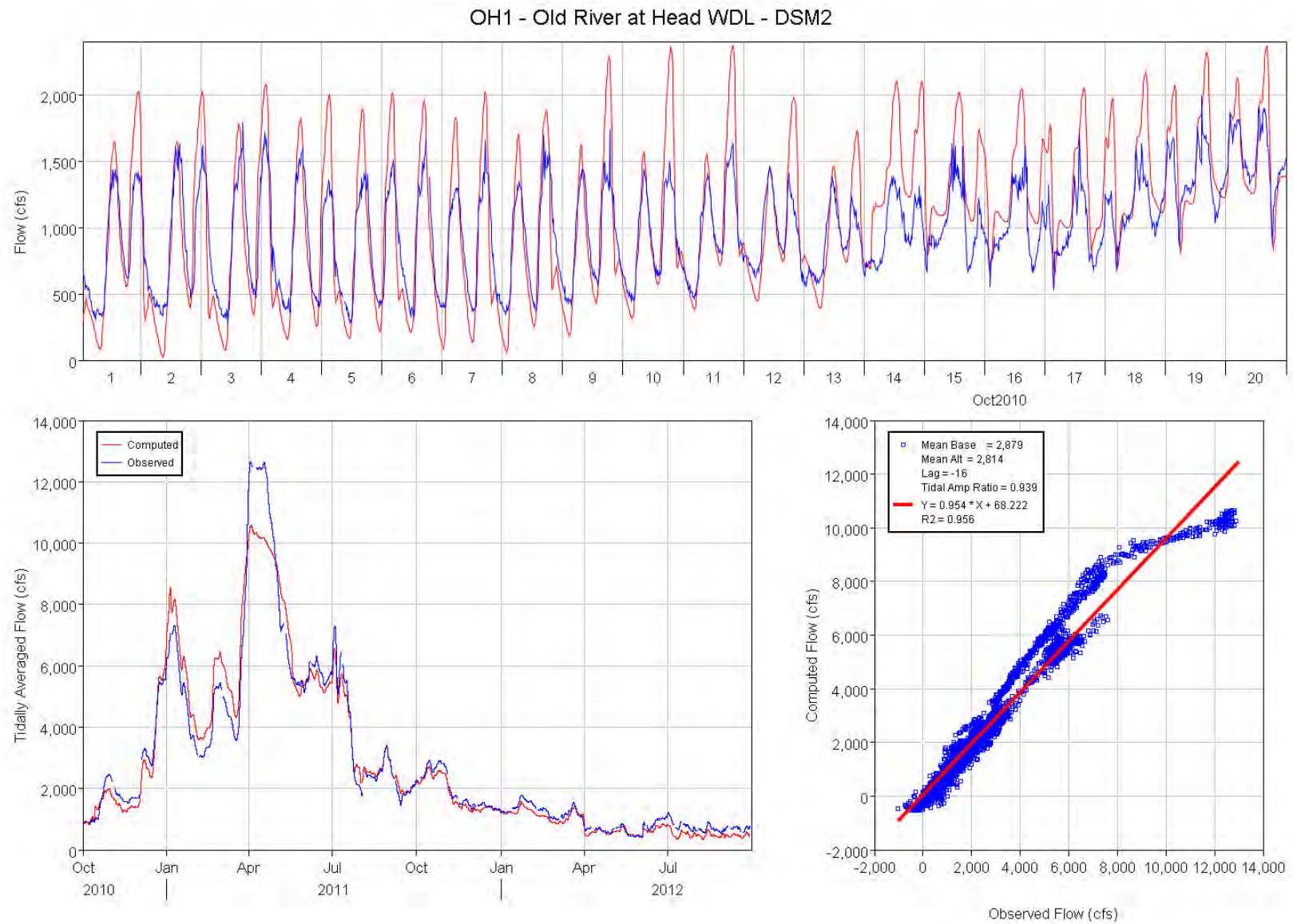


Figure 57 Computed (DSM2) and observed flow comparison plots for Old River at Head.



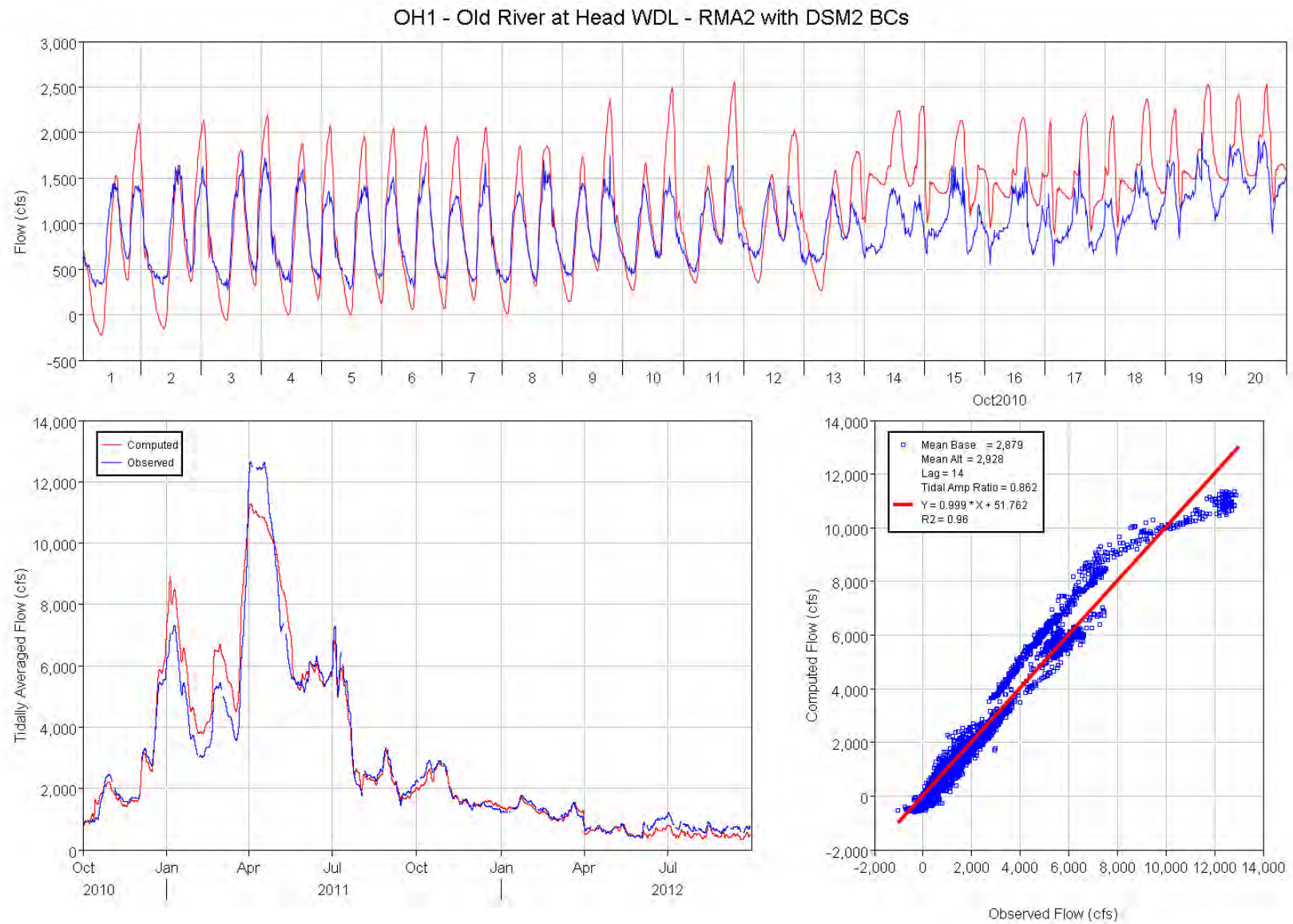


Figure 58 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Head.



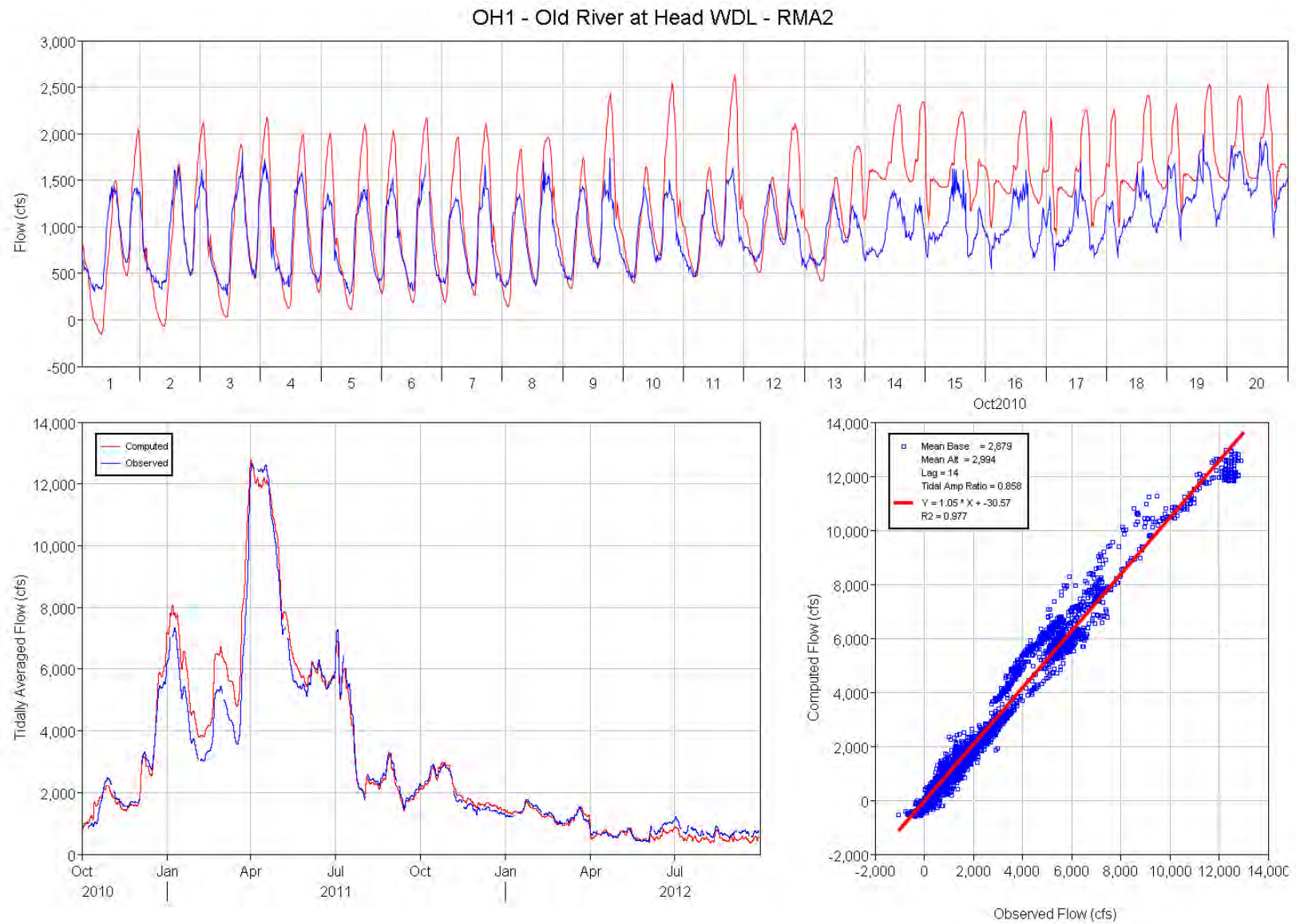


Figure 59 Computed (RMA2) and observed flow comparison plots for Old River at Head.

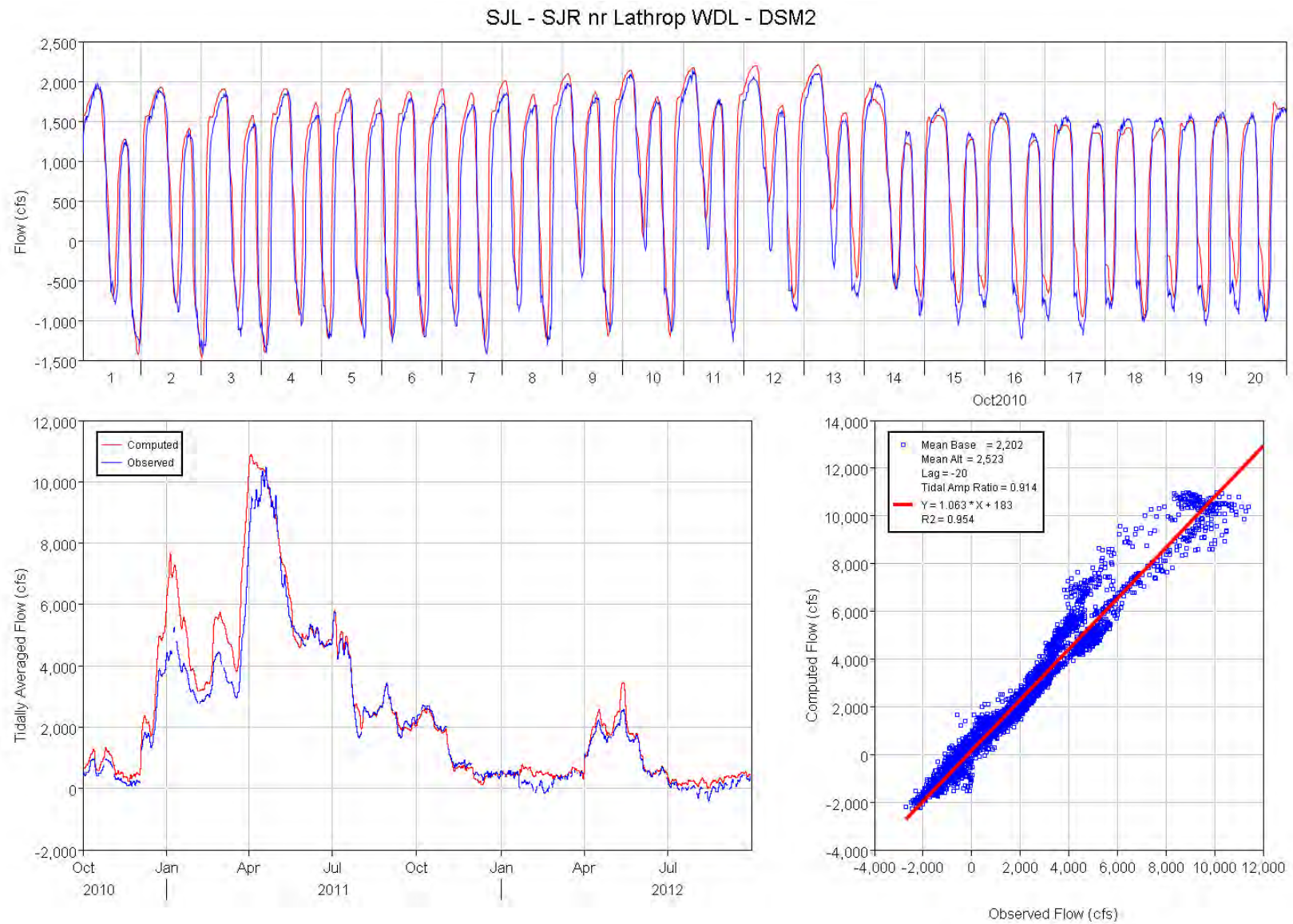


Figure 60 Computed (DSM2) and observed flow comparison plots for SJR near Lathrop.

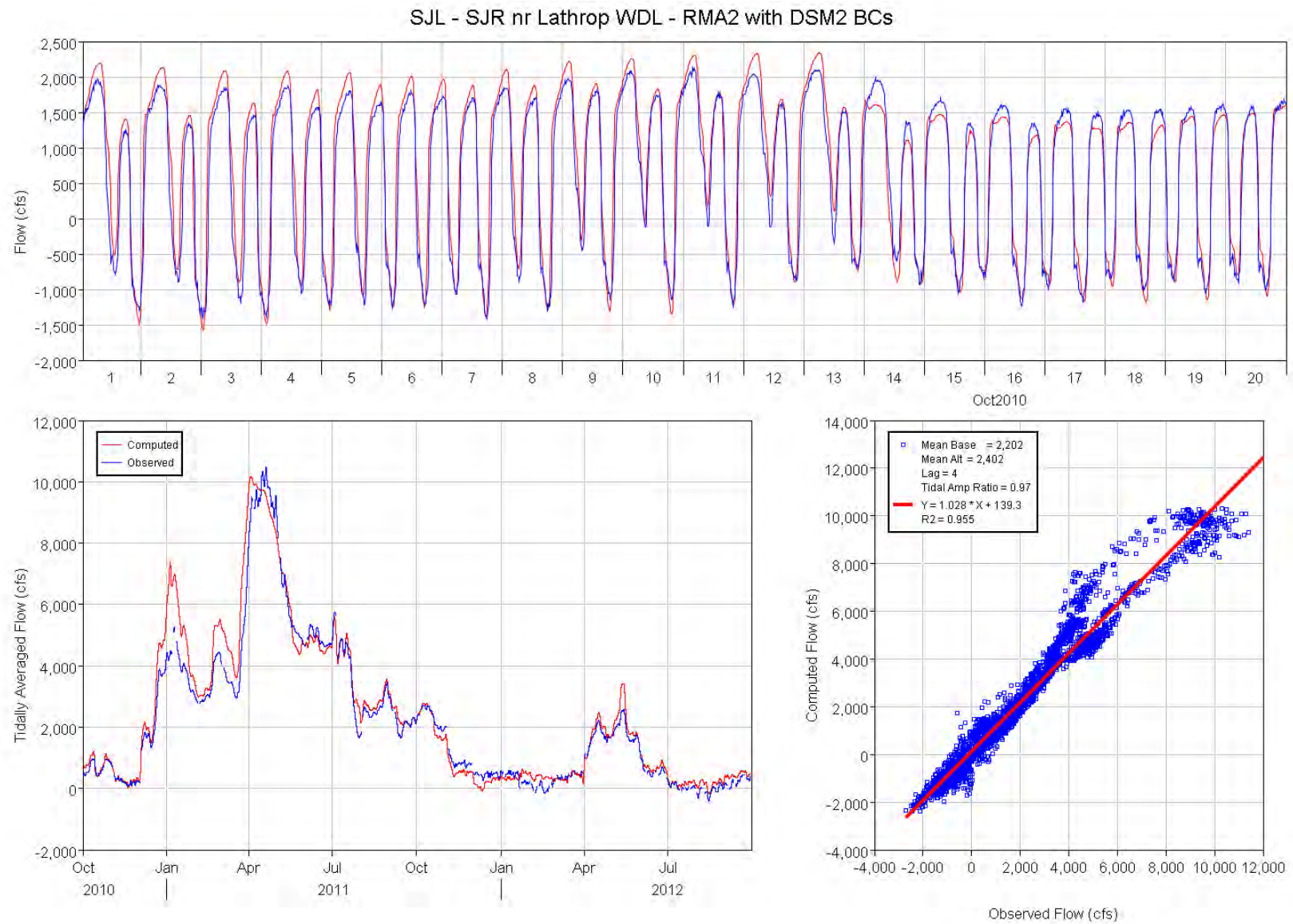


Figure 61 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for SJR near Lathrop.



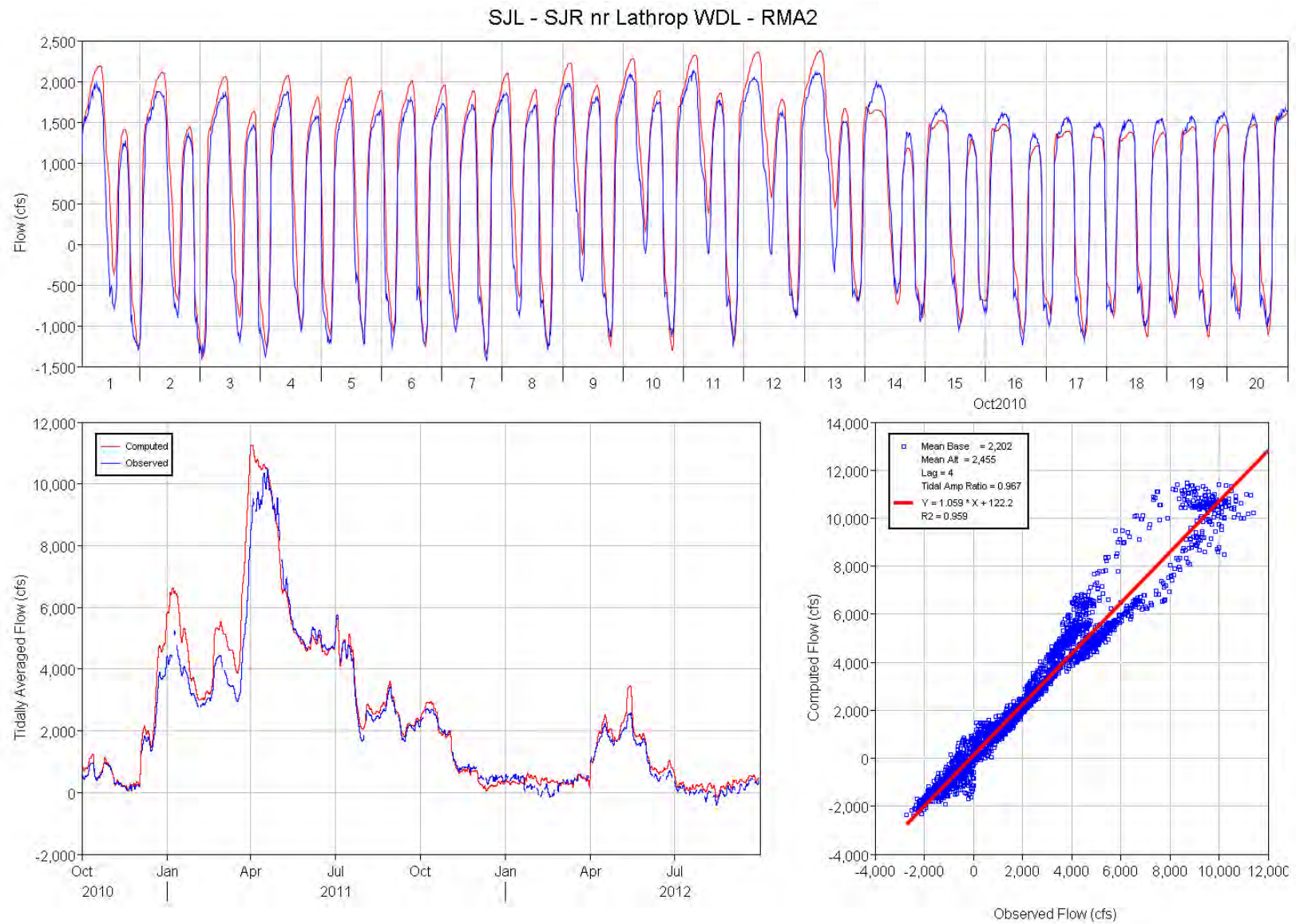


Figure 62 Computed (RMA2) and observed flow comparison plots for SJR near Lathrop.

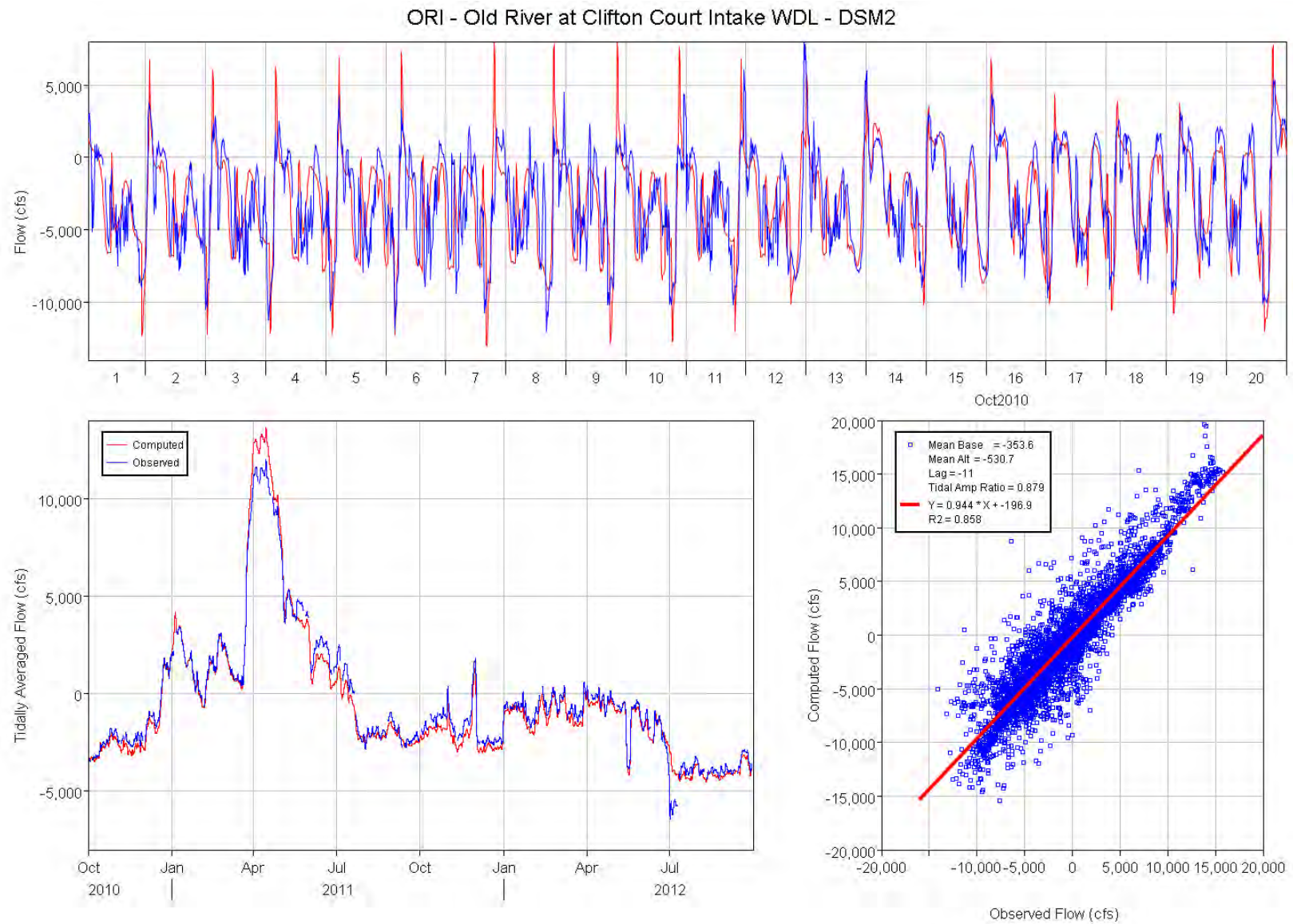


Figure 63 Computed (DSM2) and observed flow comparison plots for Old River at Clifton Court Intake.

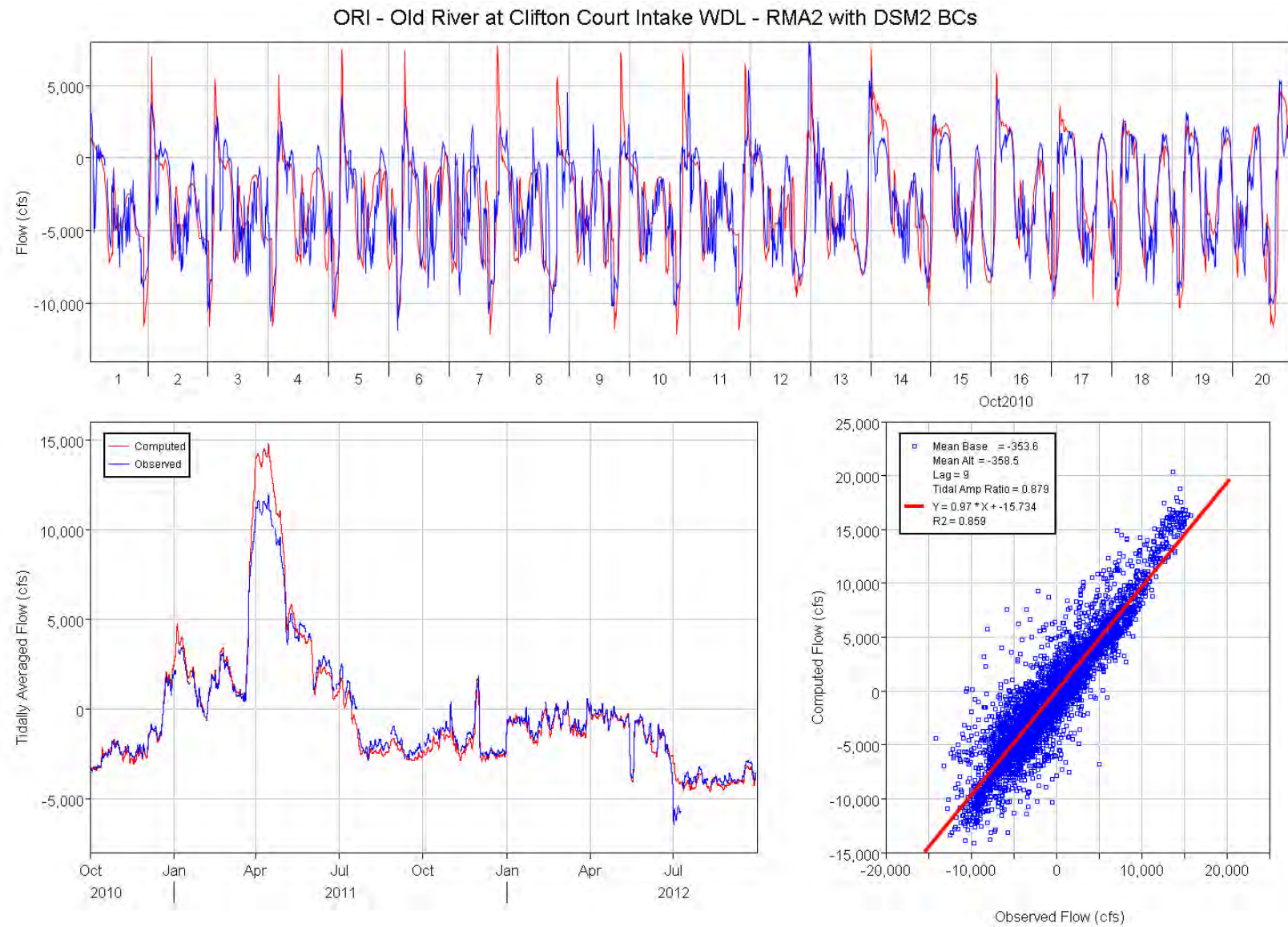


Figure 64 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River at Clifton Court Intake.



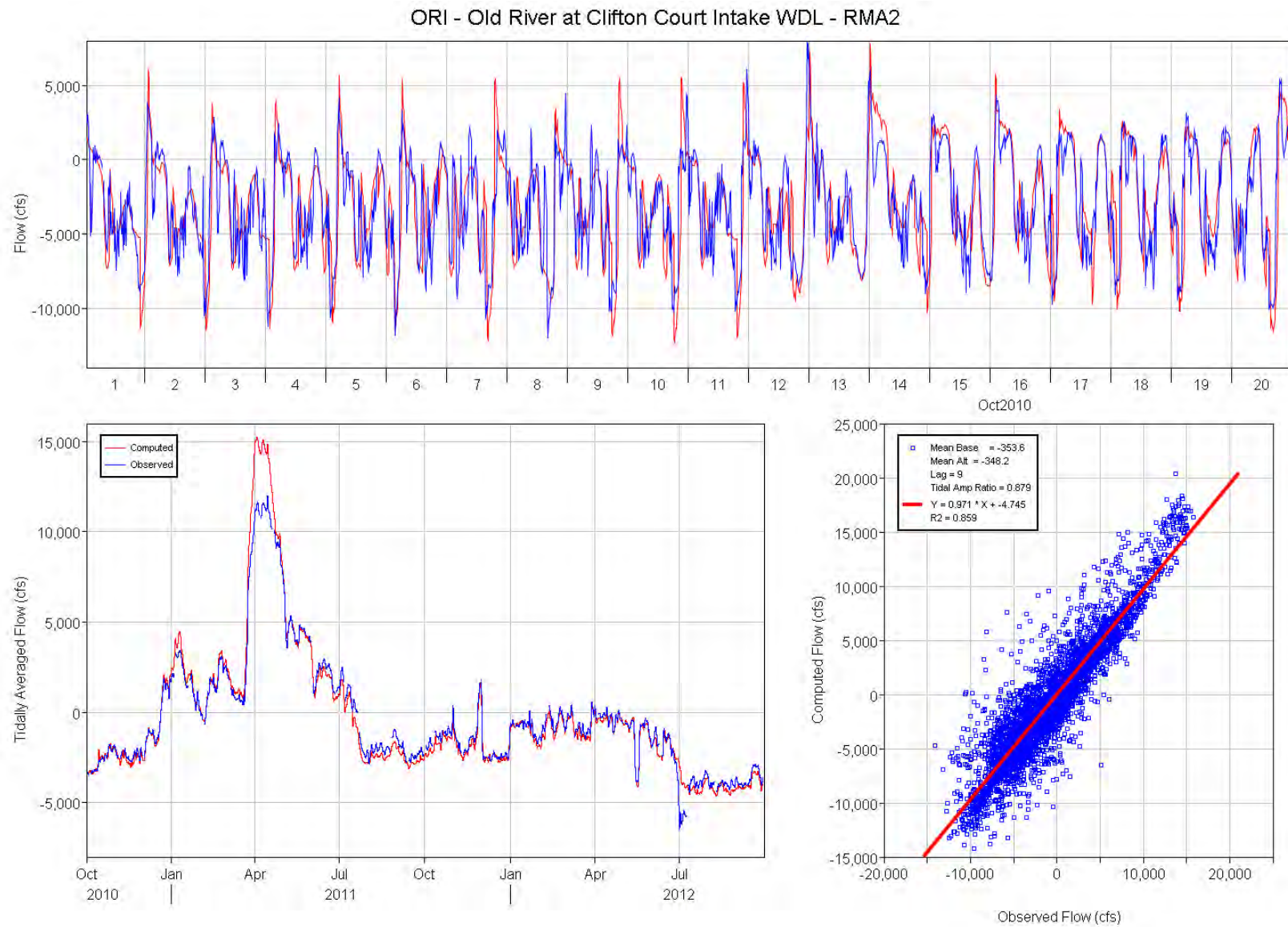


Figure 65 Computed (RMA2) and observed flow comparison plots for Old River at Clifton Court Intake.

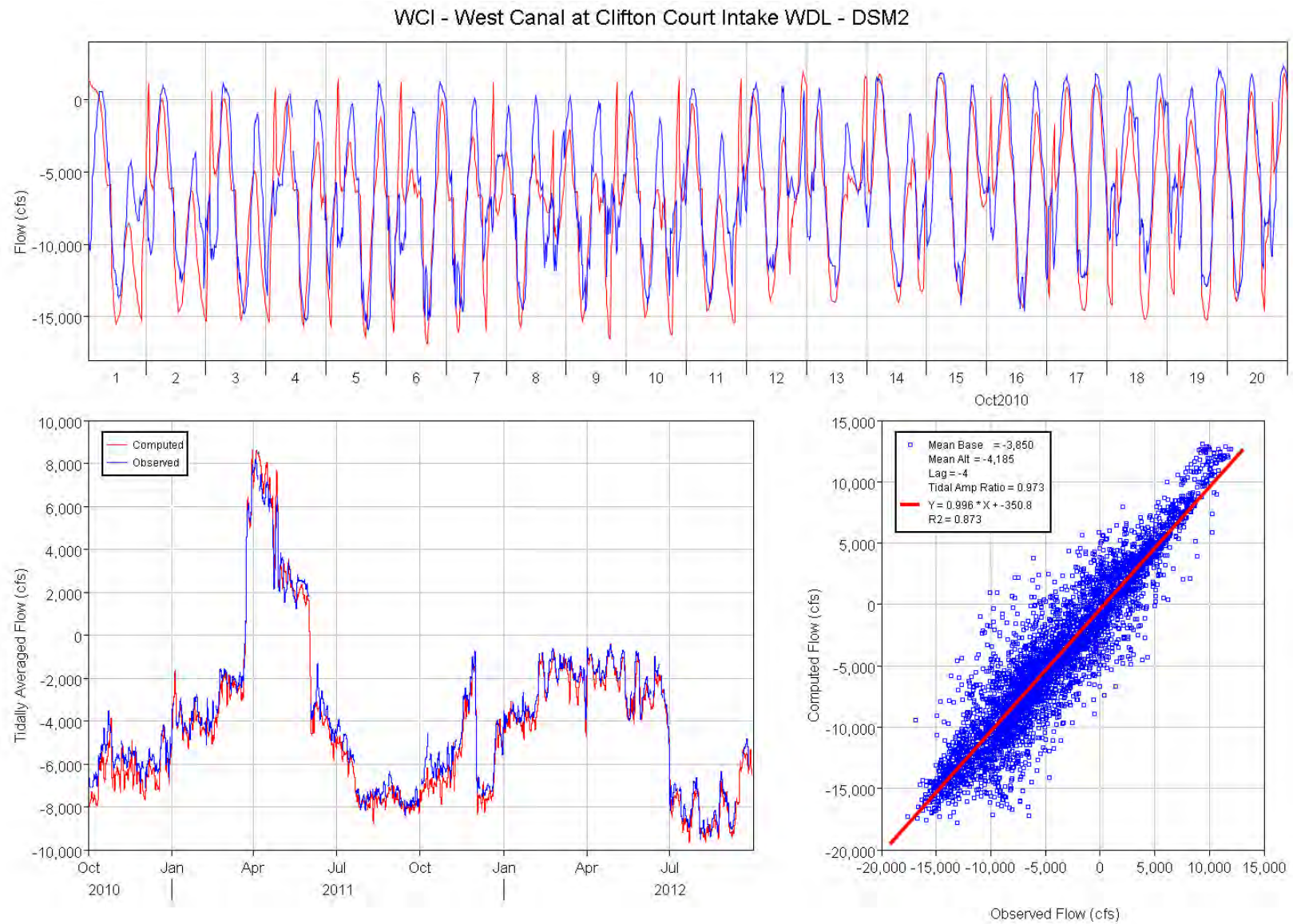


Figure 66 Computed (DSM2) and observed flow comparison plots for West Canal at Clifton Court Intake.



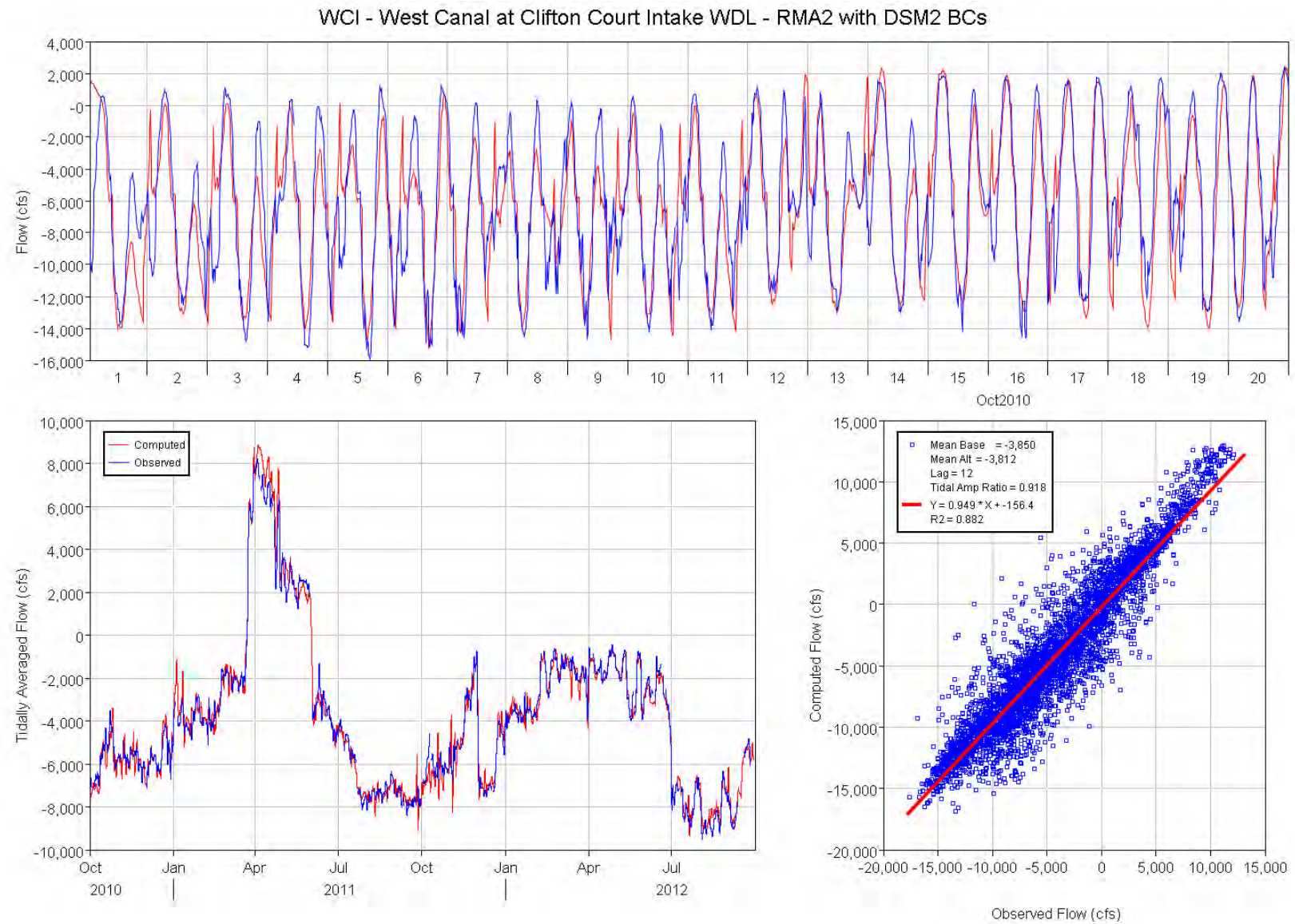


Figure 67 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for West Canal at Clifton Court Intake.



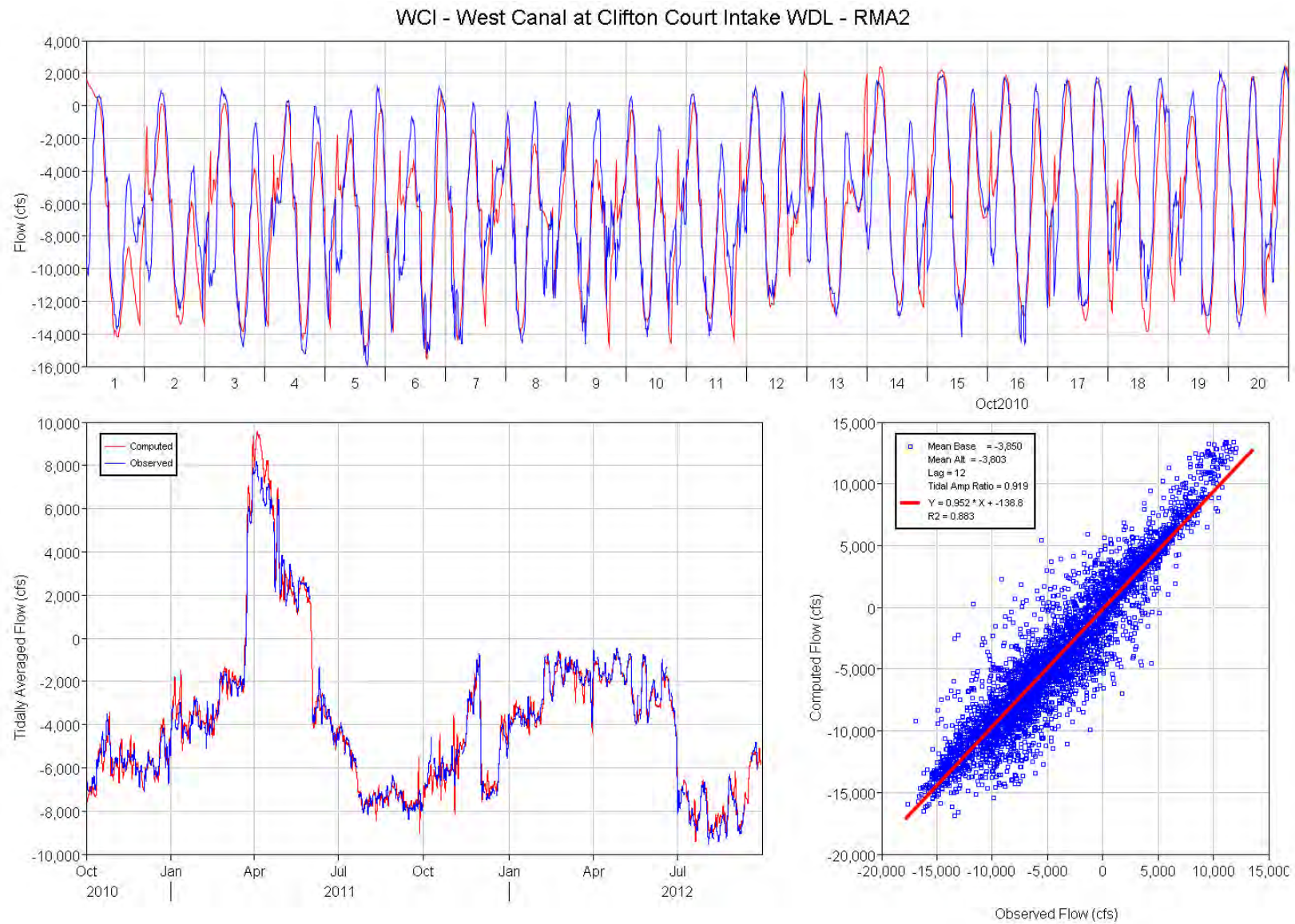


Figure 68 Computed (RMA2) and observed flow comparison plots for West Canal at Clifton Court Intake.

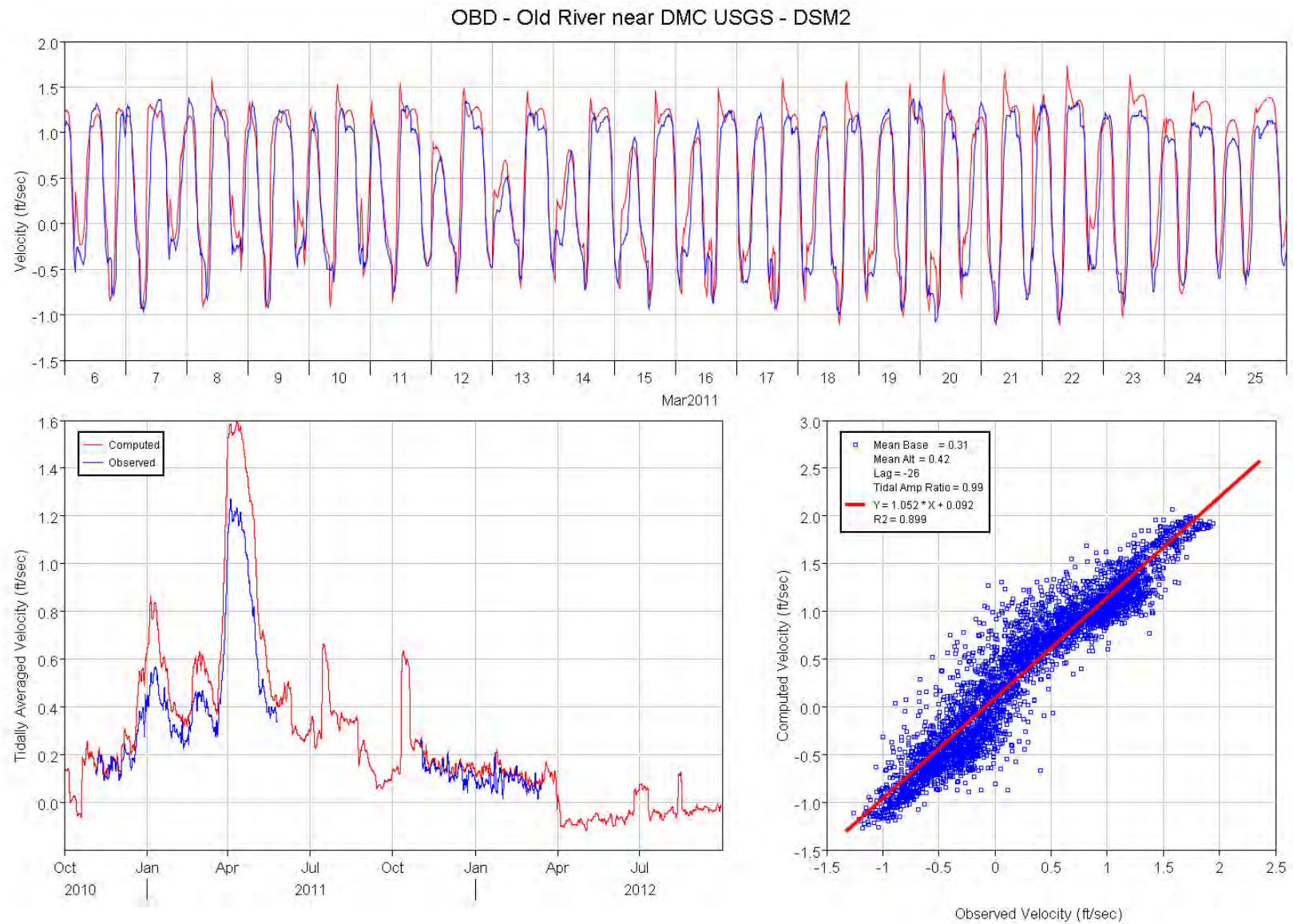


Figure 69 Computed (DSM2) and observed flow comparison plots for Old River near DMC.



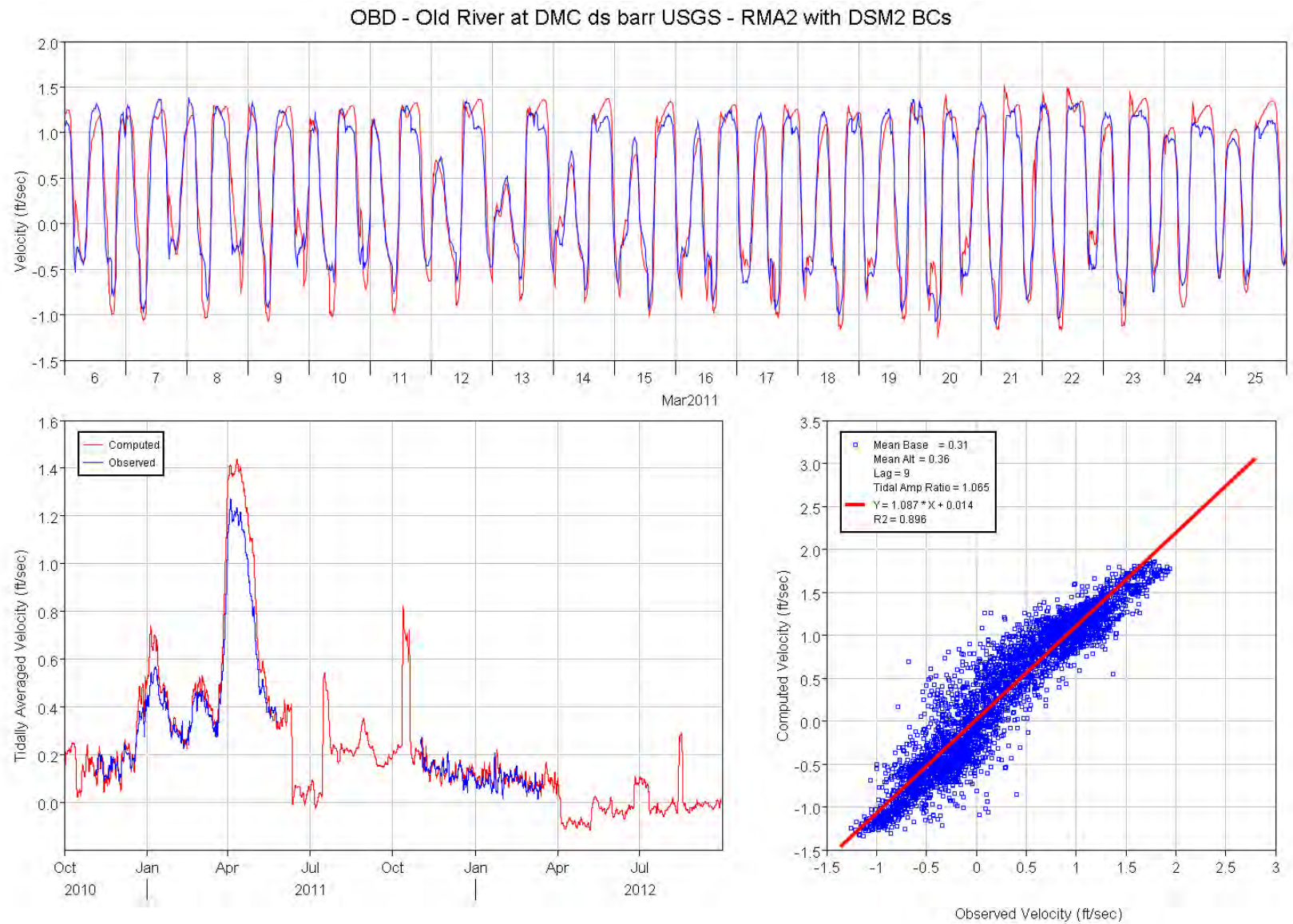


Figure 70 Computed (RMA2 with DSM2 BCs) and observed flow comparison plots for Old River near DMC.



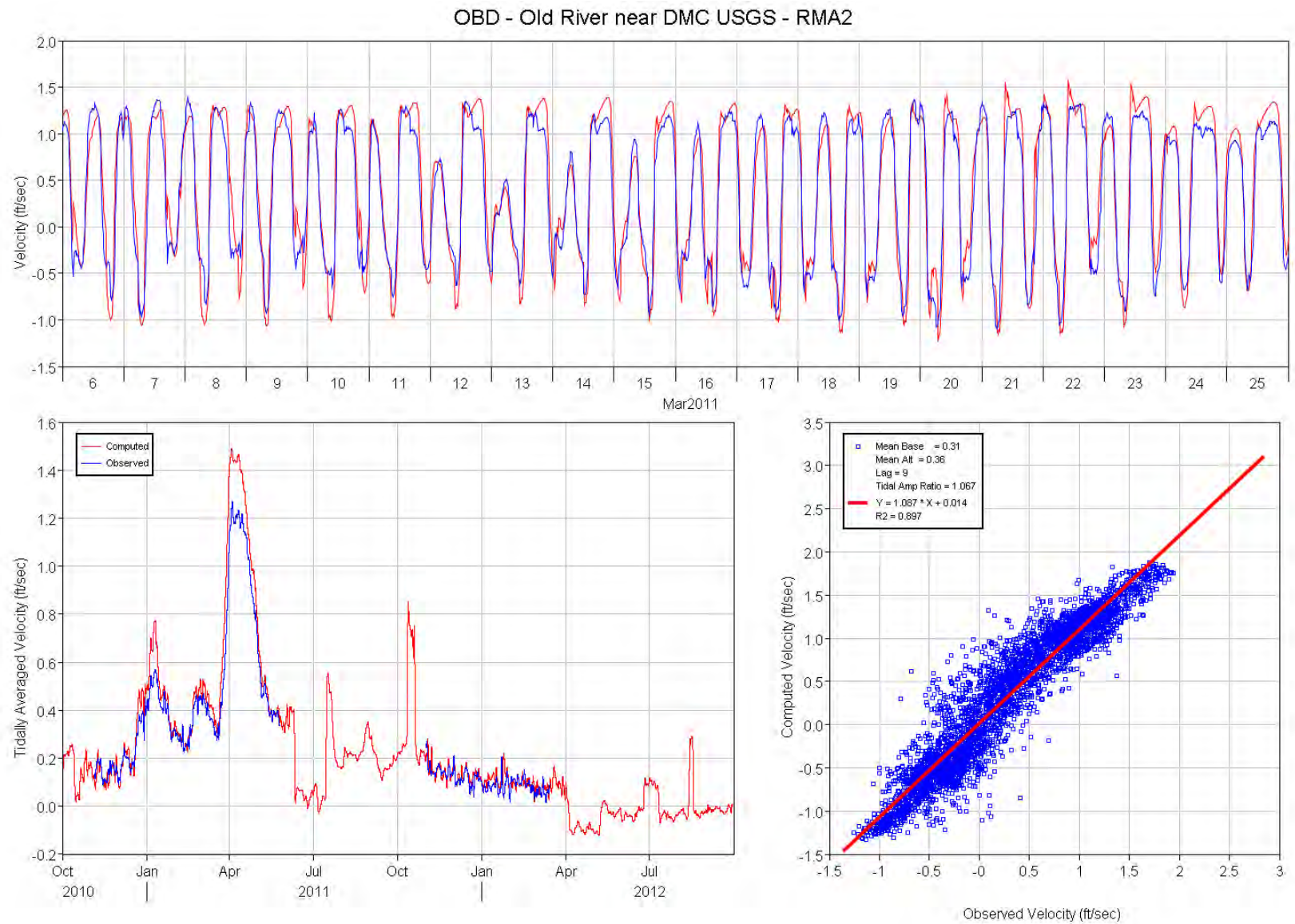


Figure 71 Computed (RMA2) and observed flow comparison plots for Old River near DMC.

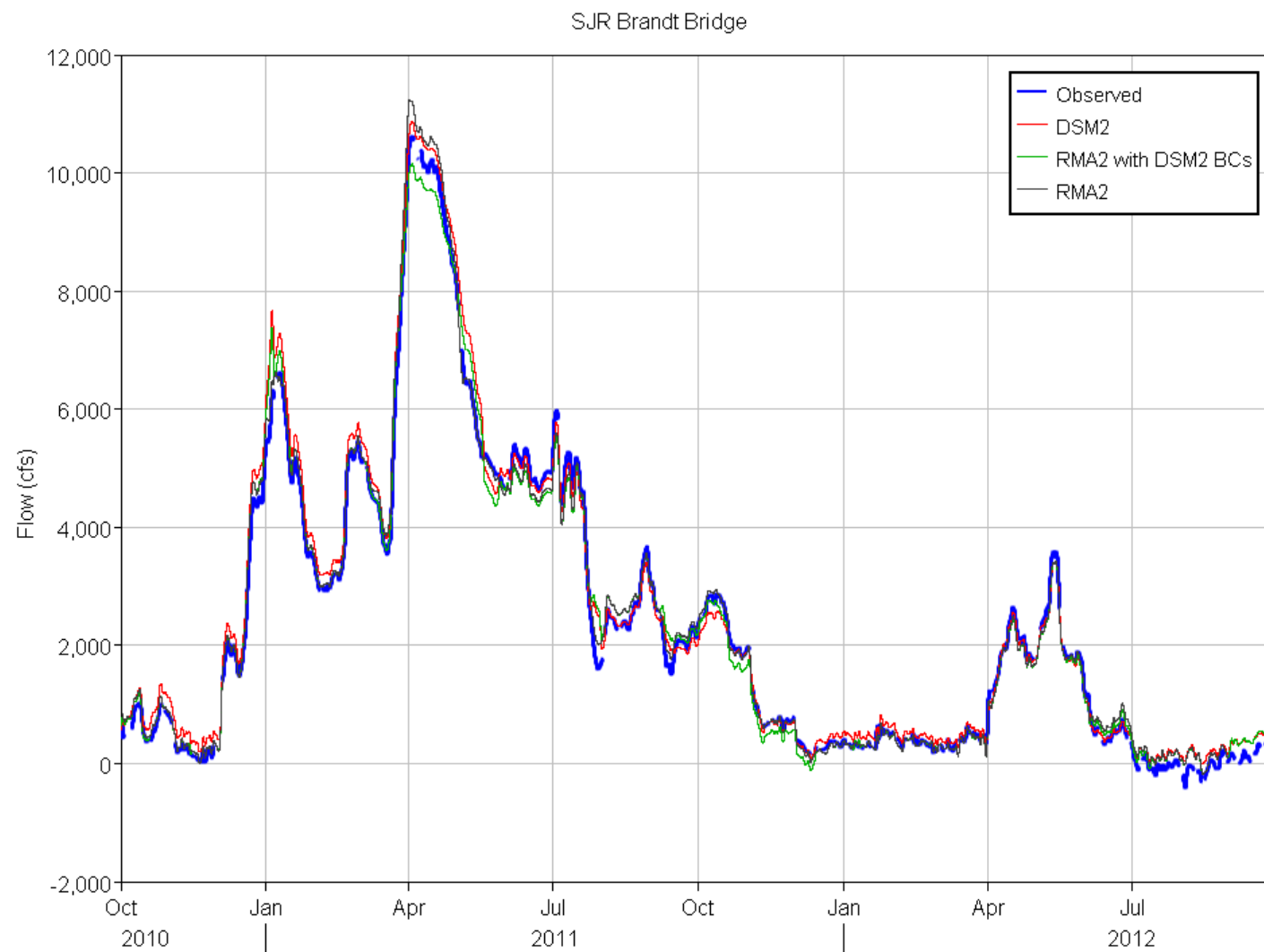


Figure 72 Tidally averaged observed and computed flows for SJR at Brandt Bridge.

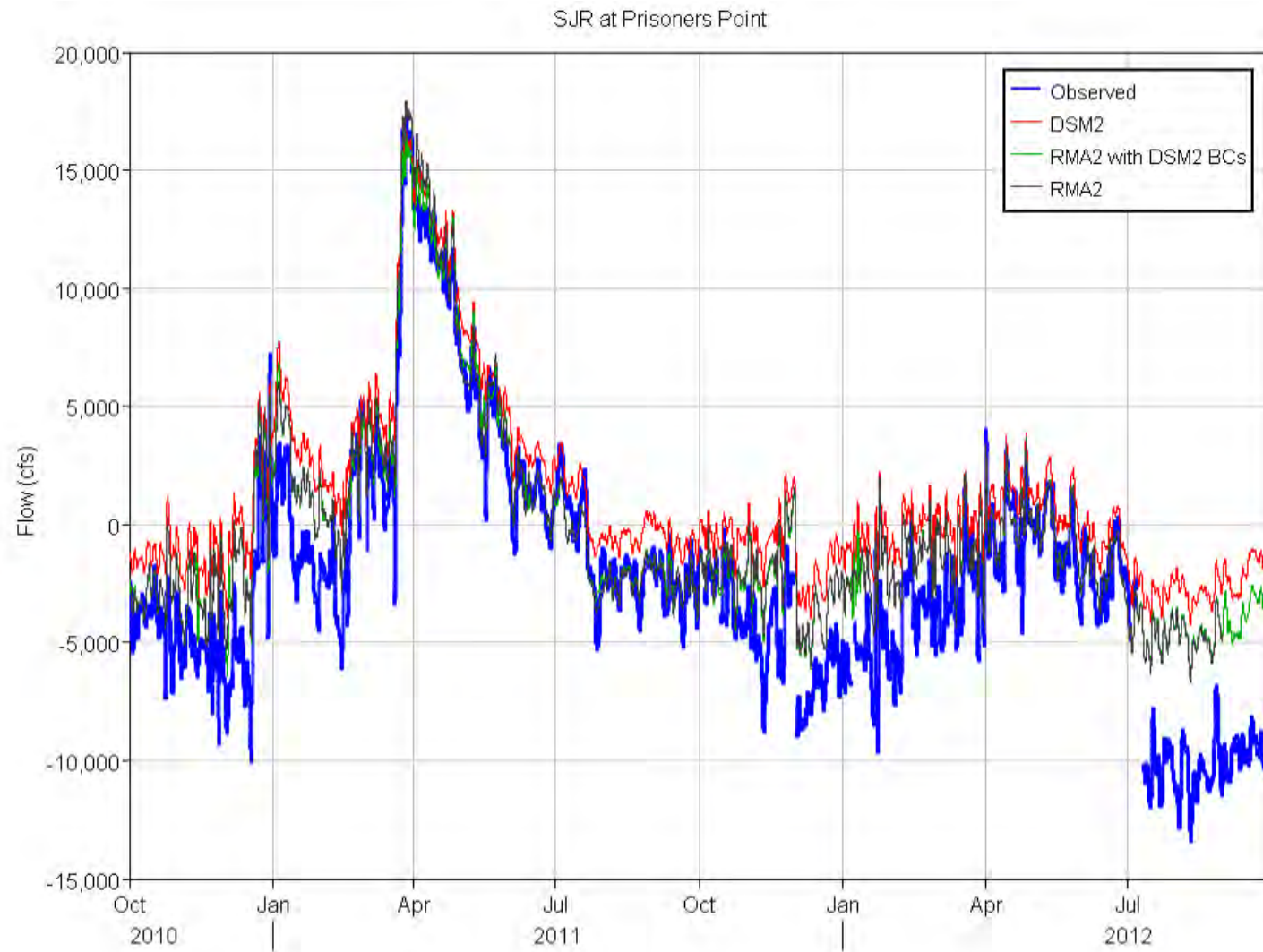


Figure 73 Tidally averaged observed and computed flows for SJR Prisoner Point.



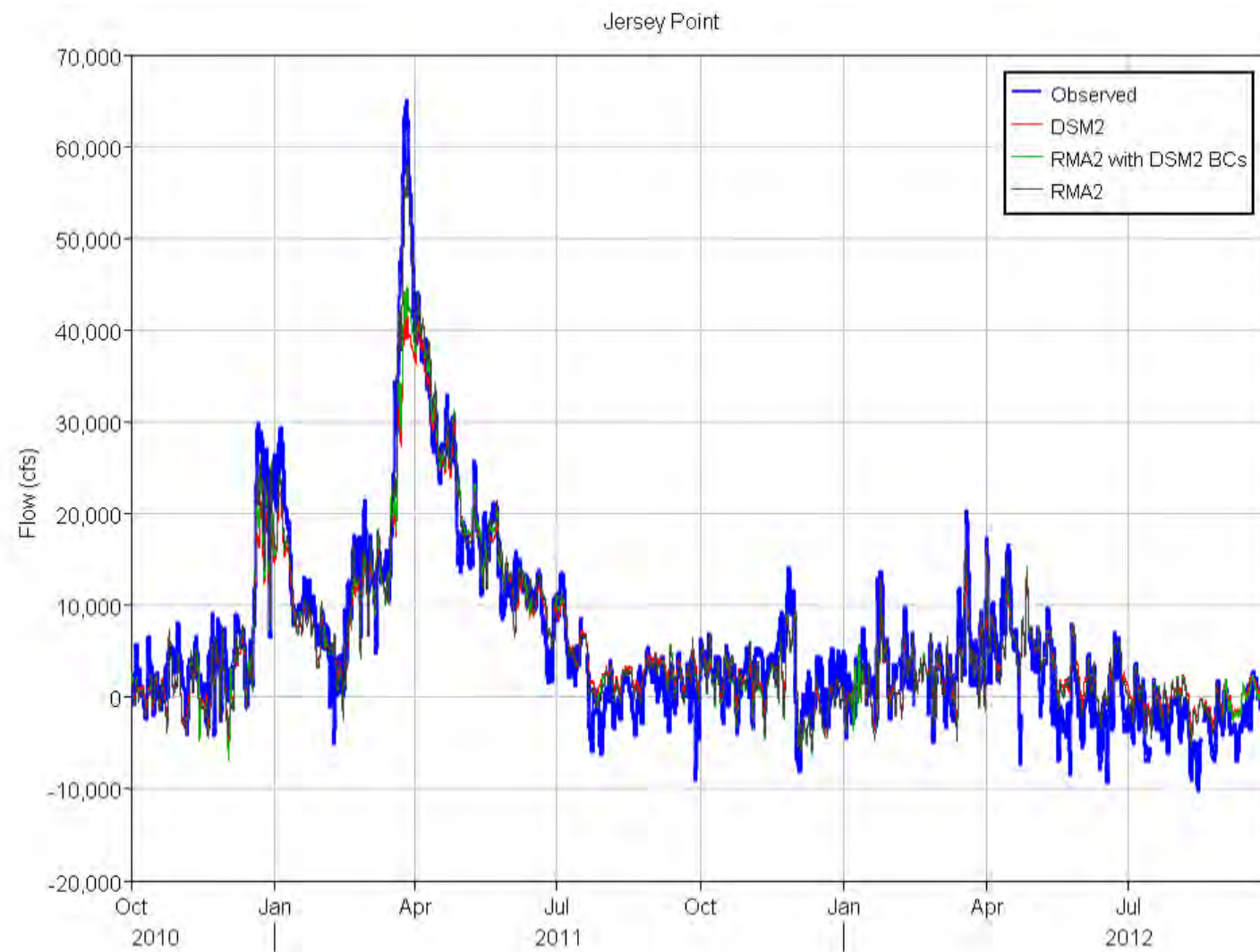


Figure 74 Tidally averaged observed and computed flows for Jersey Point.

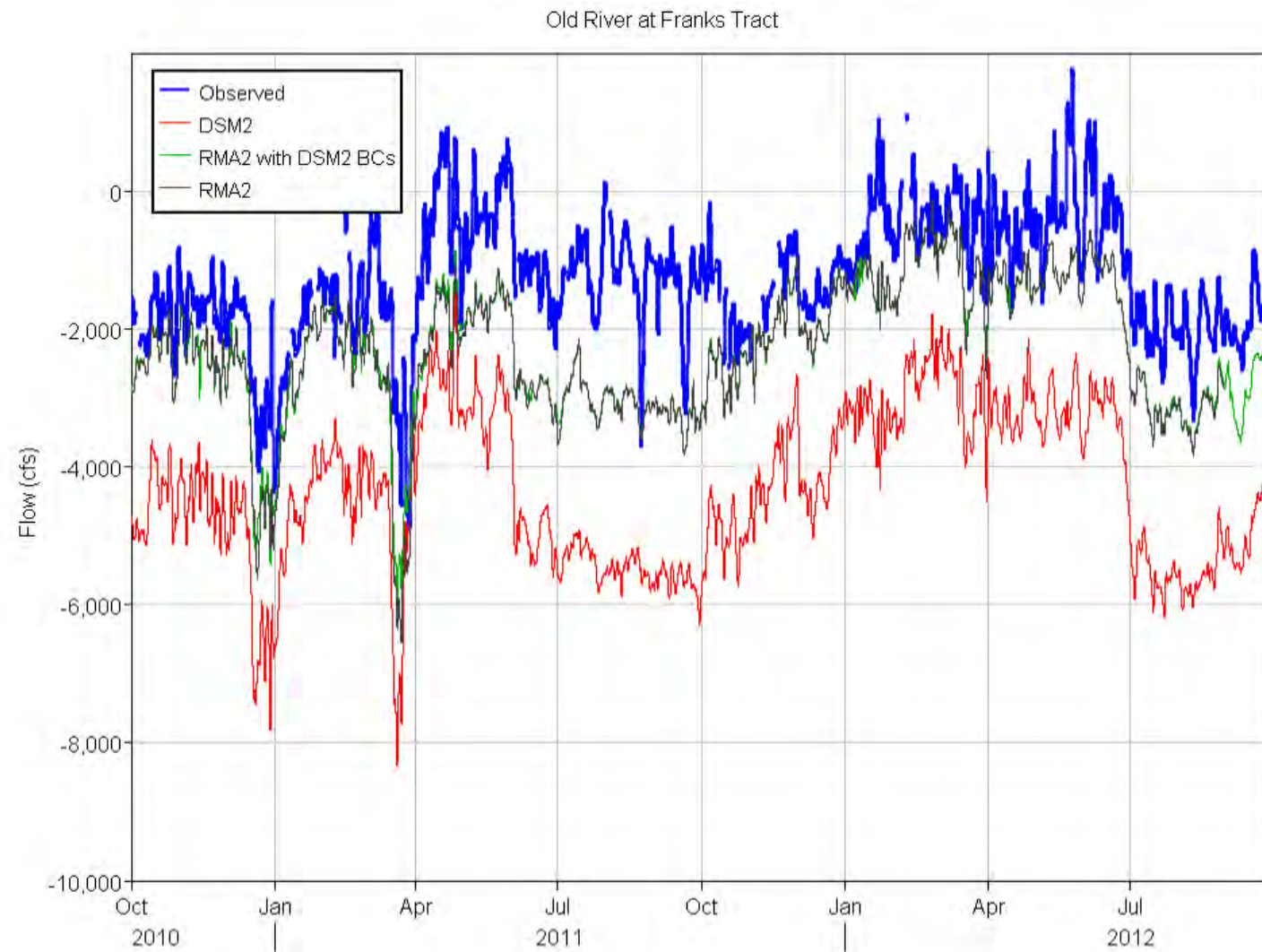


Figure 75 Tidally averaged observed and computed flows for Old River at Franks Tract.

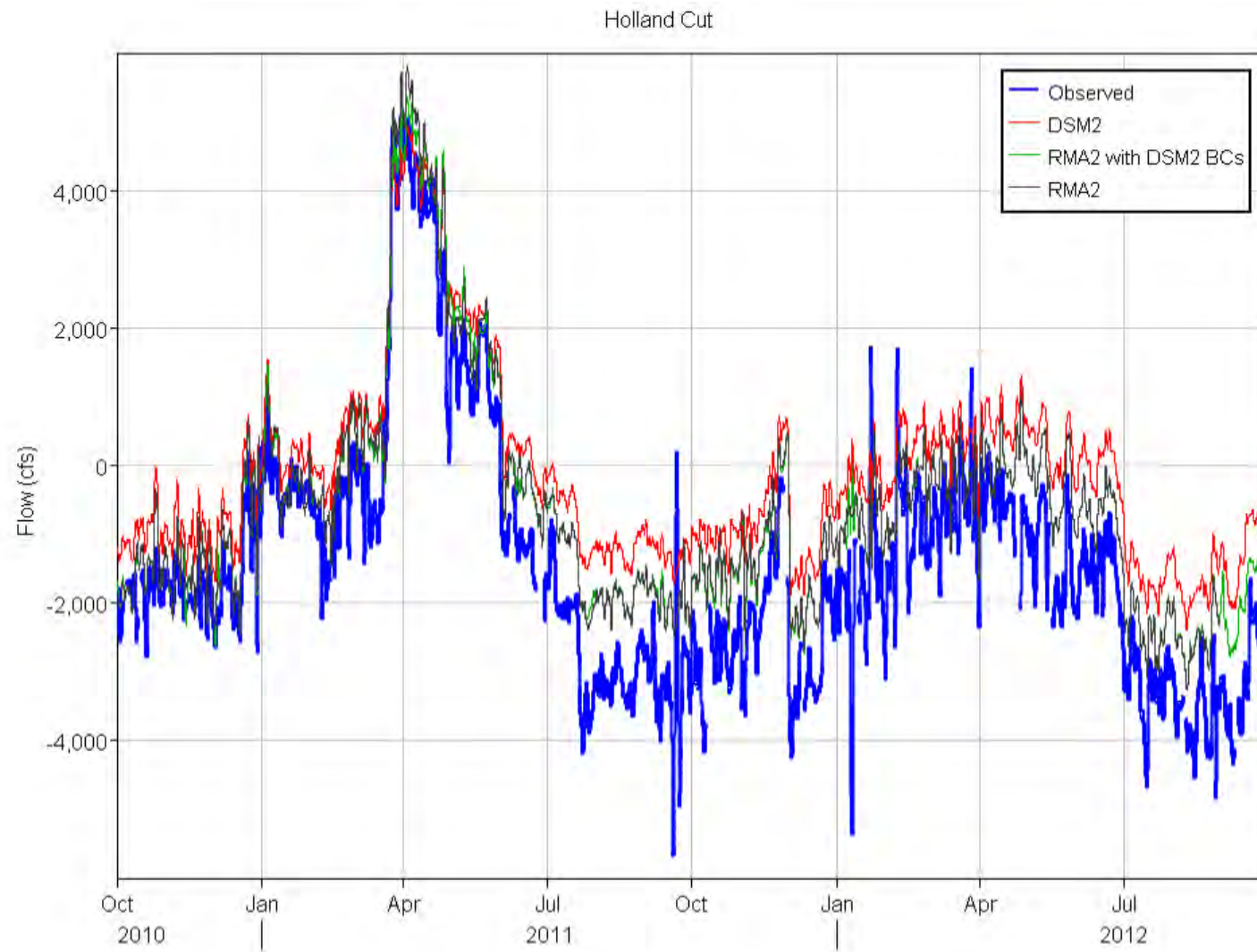


Figure 76 Tidally averaged observed and computed flows for Holland Cut.



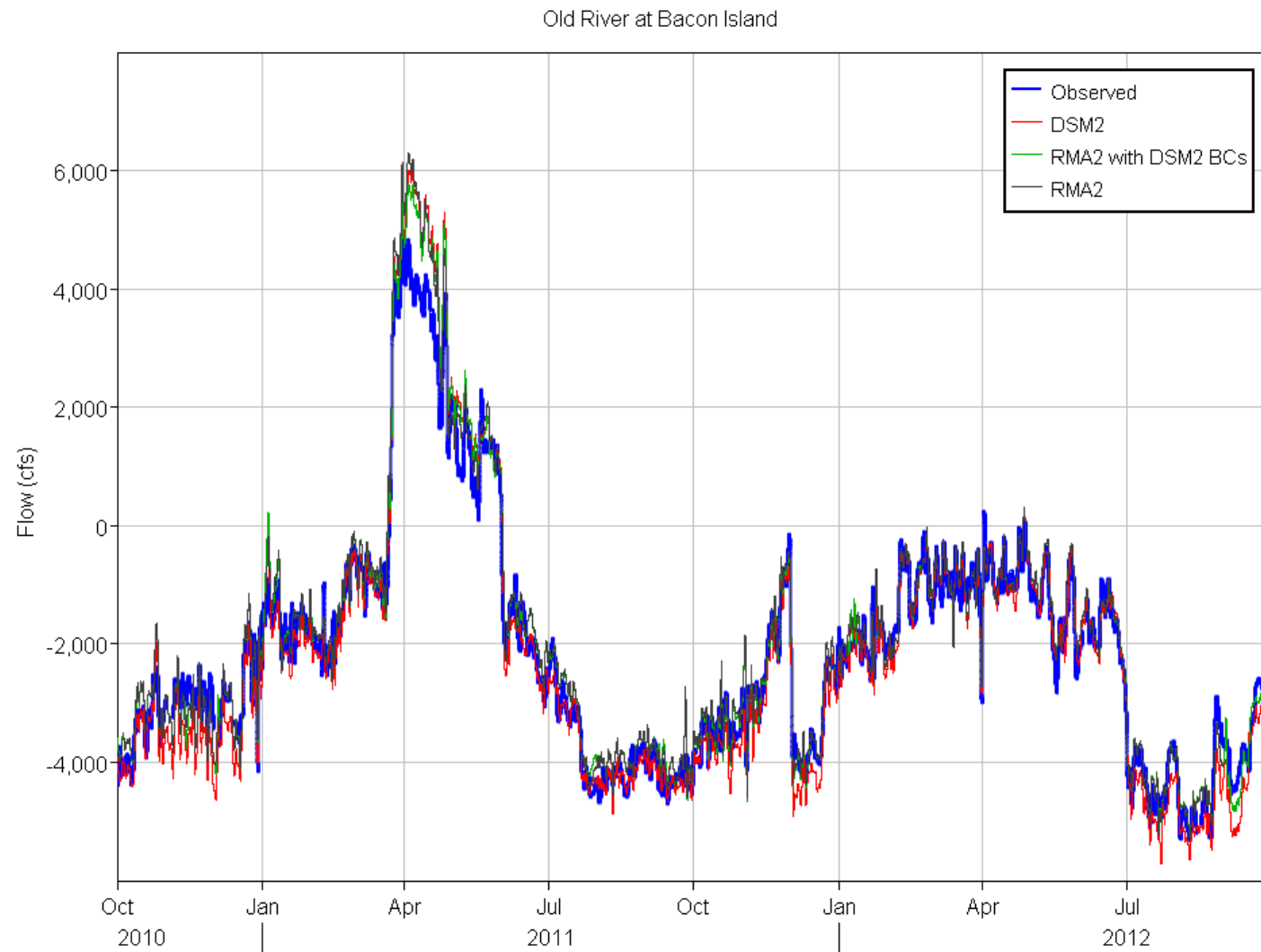


Figure 77 Tidally averaged observed and computed flows for Old River at Bacon Island.

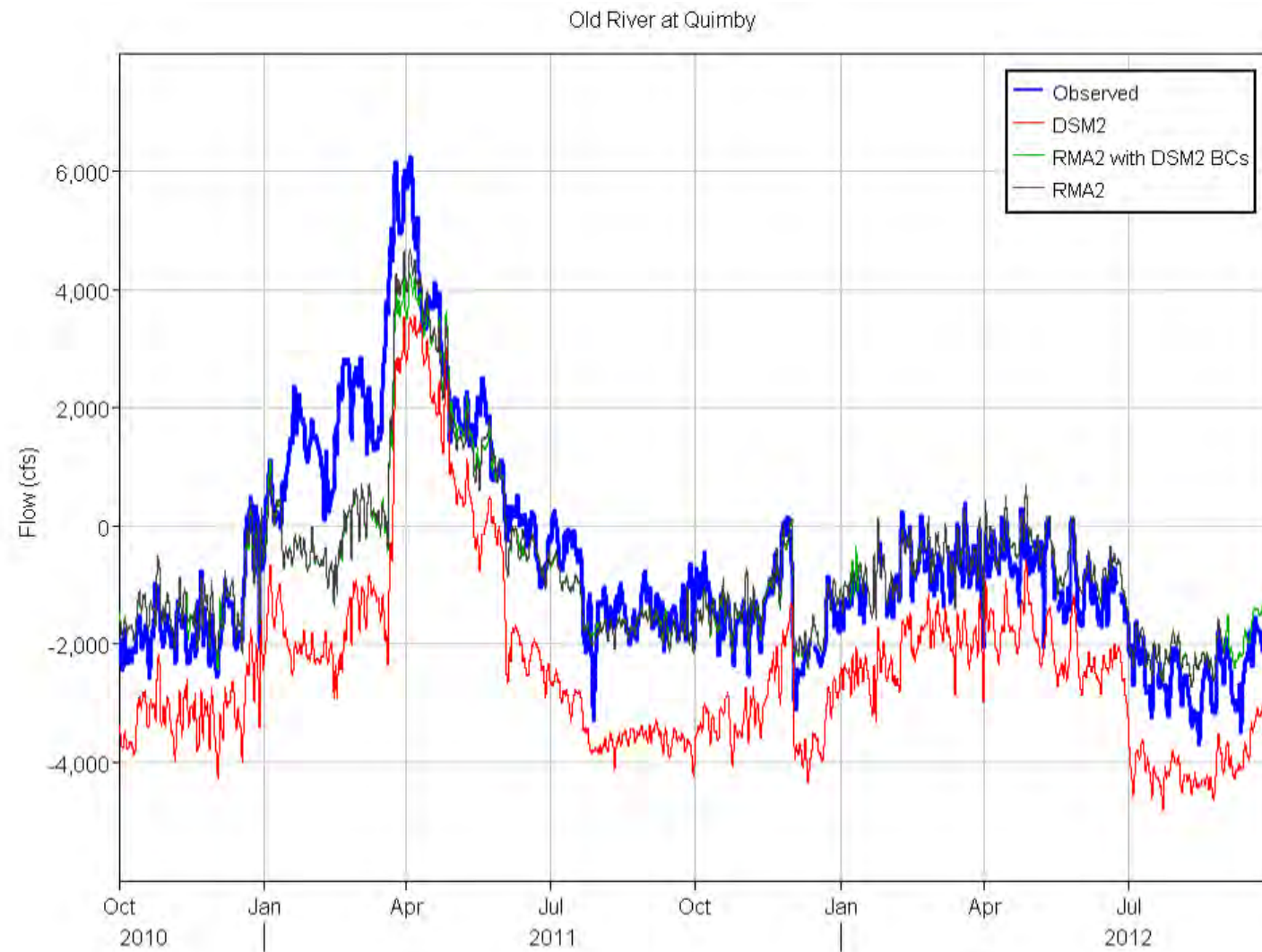


Figure 78 Tidally averaged observed and computed flows for Old River at Quimby.

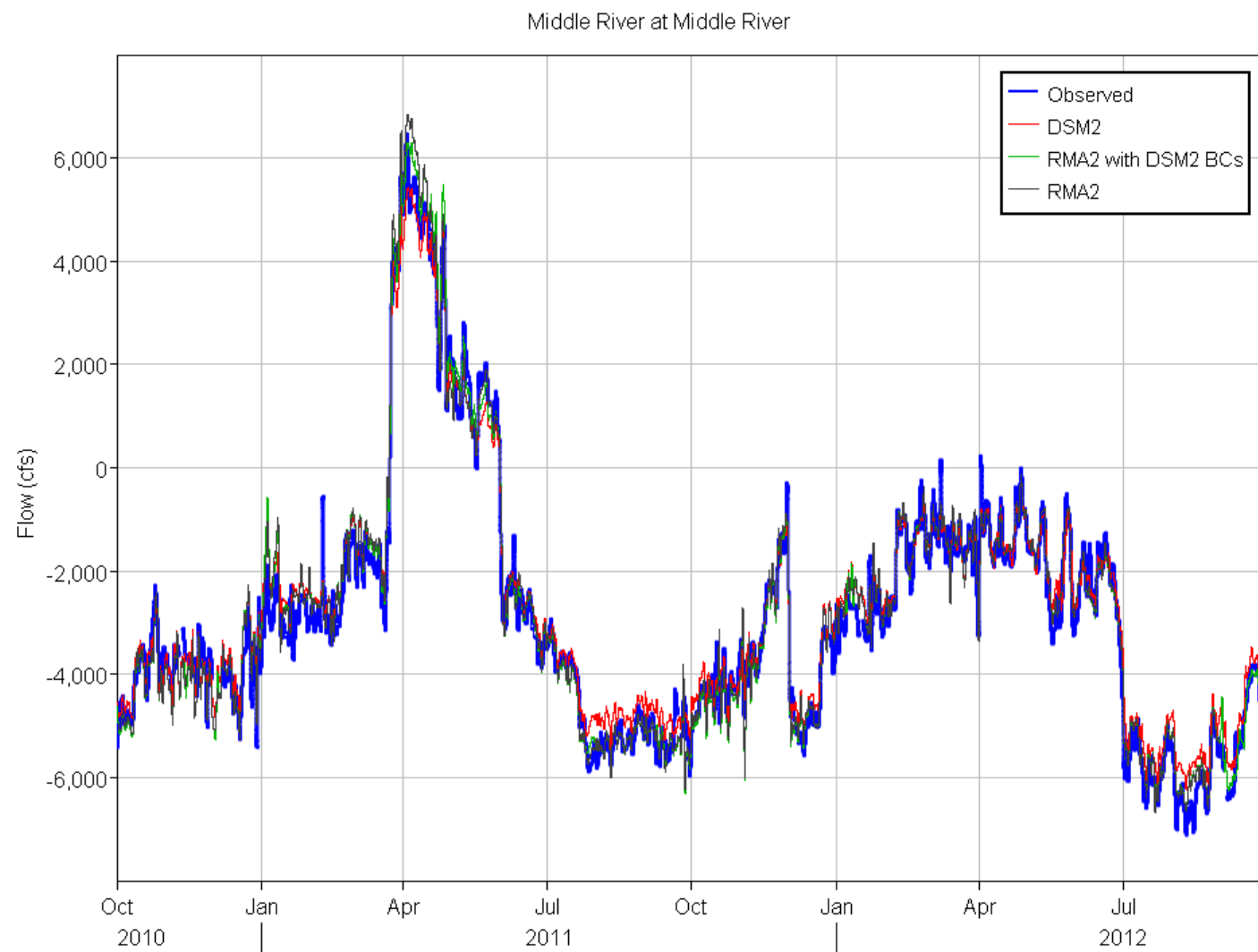


Figure 79 Tidally averaged observed and computed flows for Middle River at Middle River.



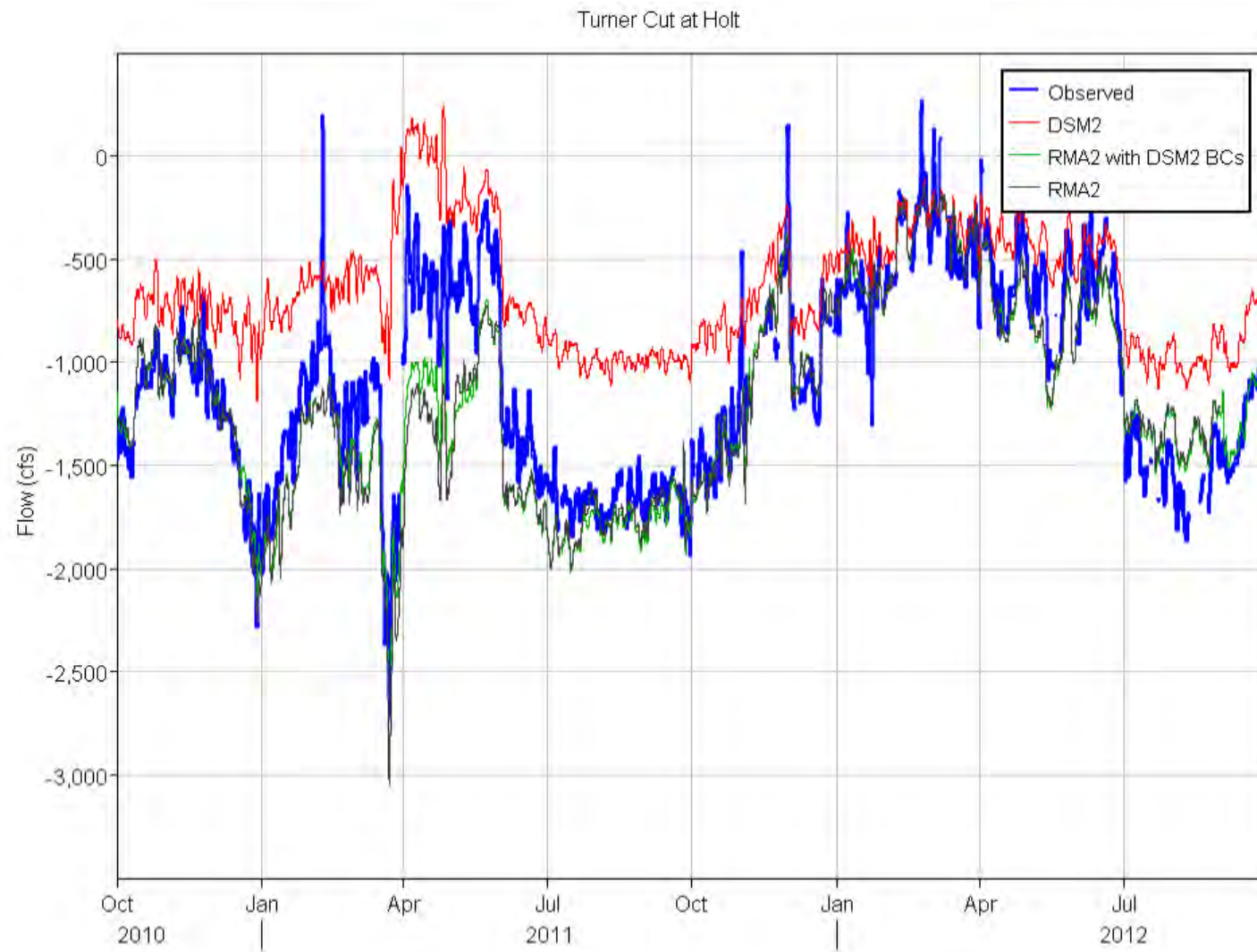


Figure 80 Tidally averaged observed and computed flows for Turner Cut at Holt.

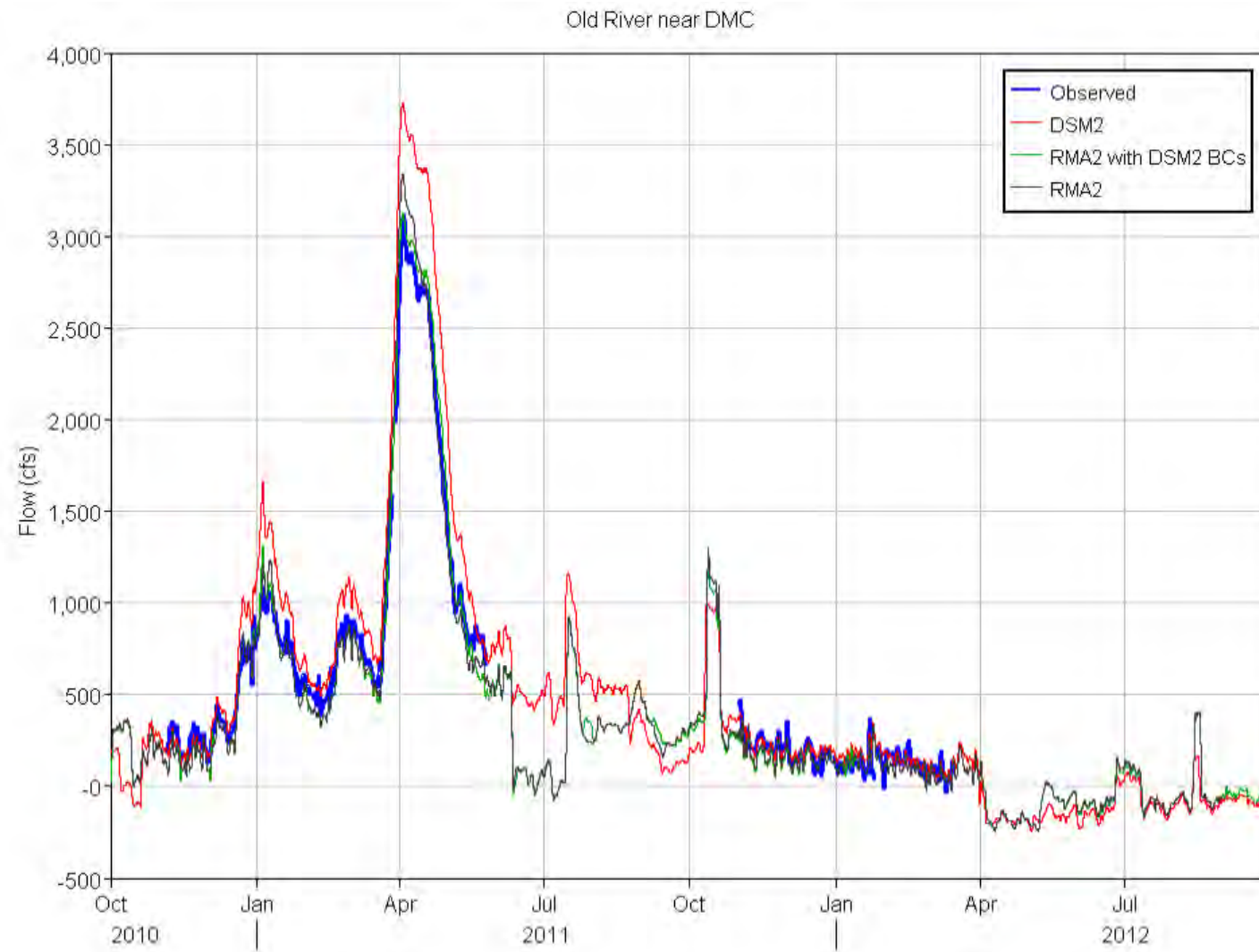


Figure 81 Tidally averaged observed and computed flows for Old River at DMC ds Barrier.

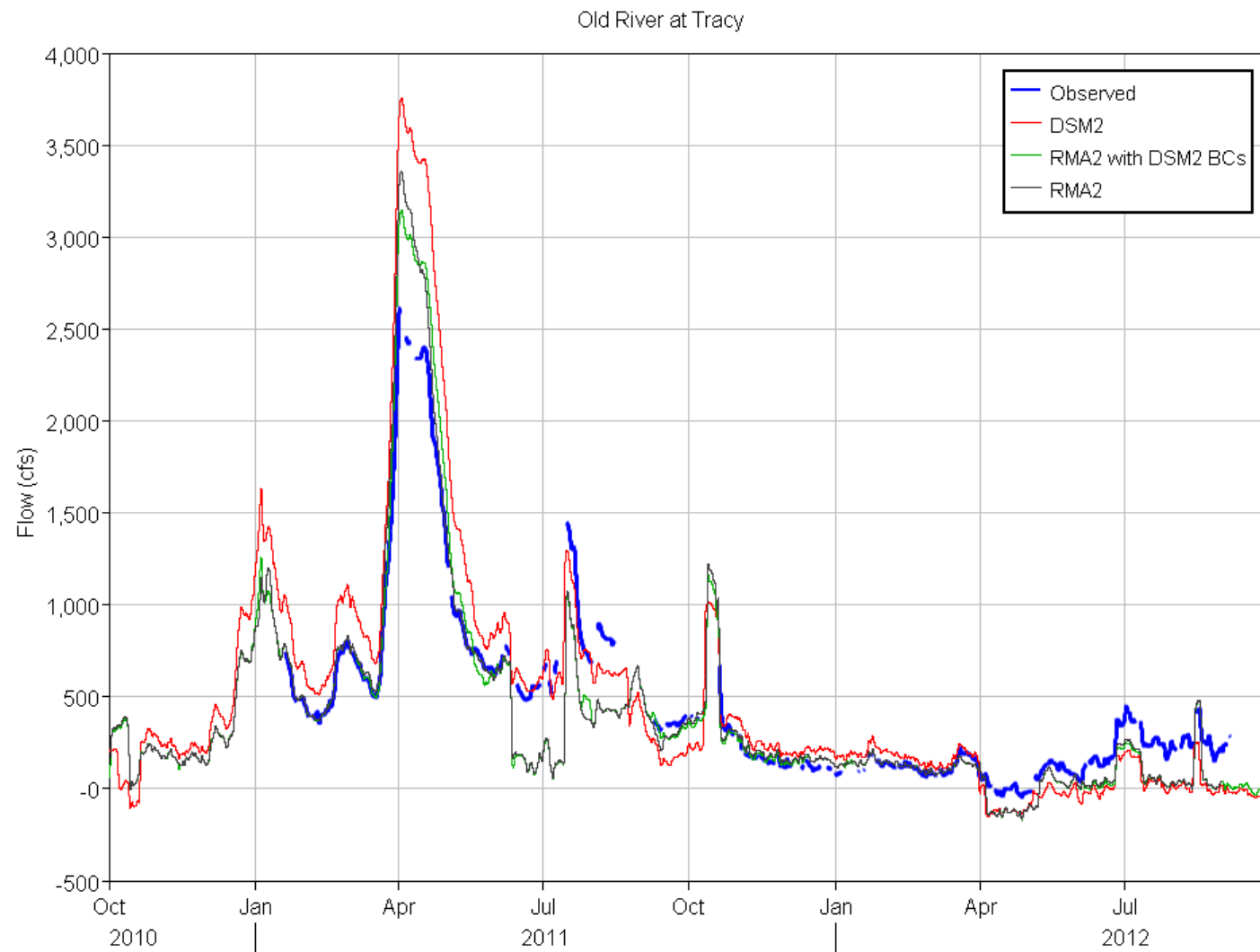


Figure 82 Tidally averaged observed and computed flows for Old River at Tracy.



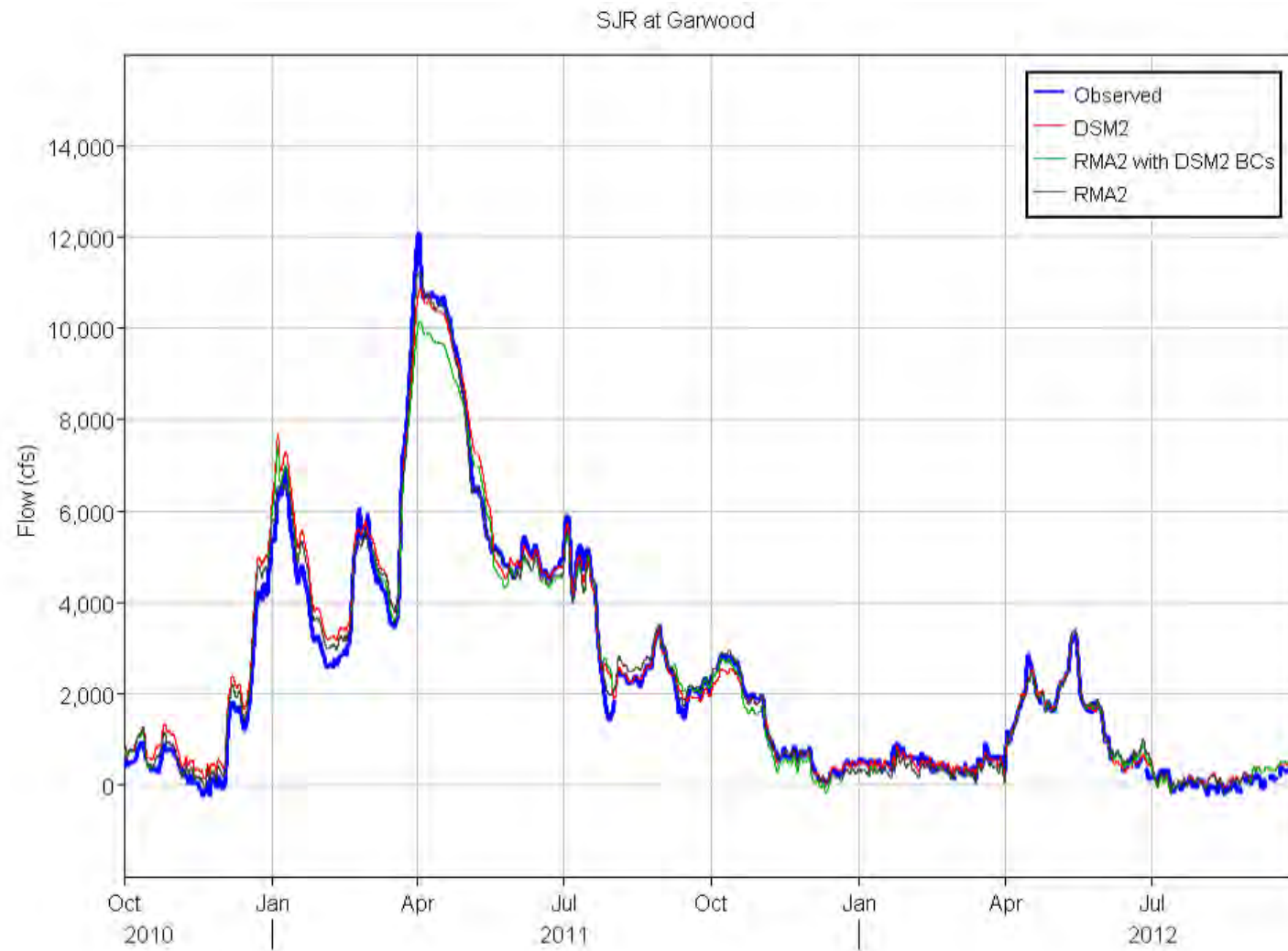


Figure 83 Tidally averaged observed and computed flows for Old River at Hwy 4.

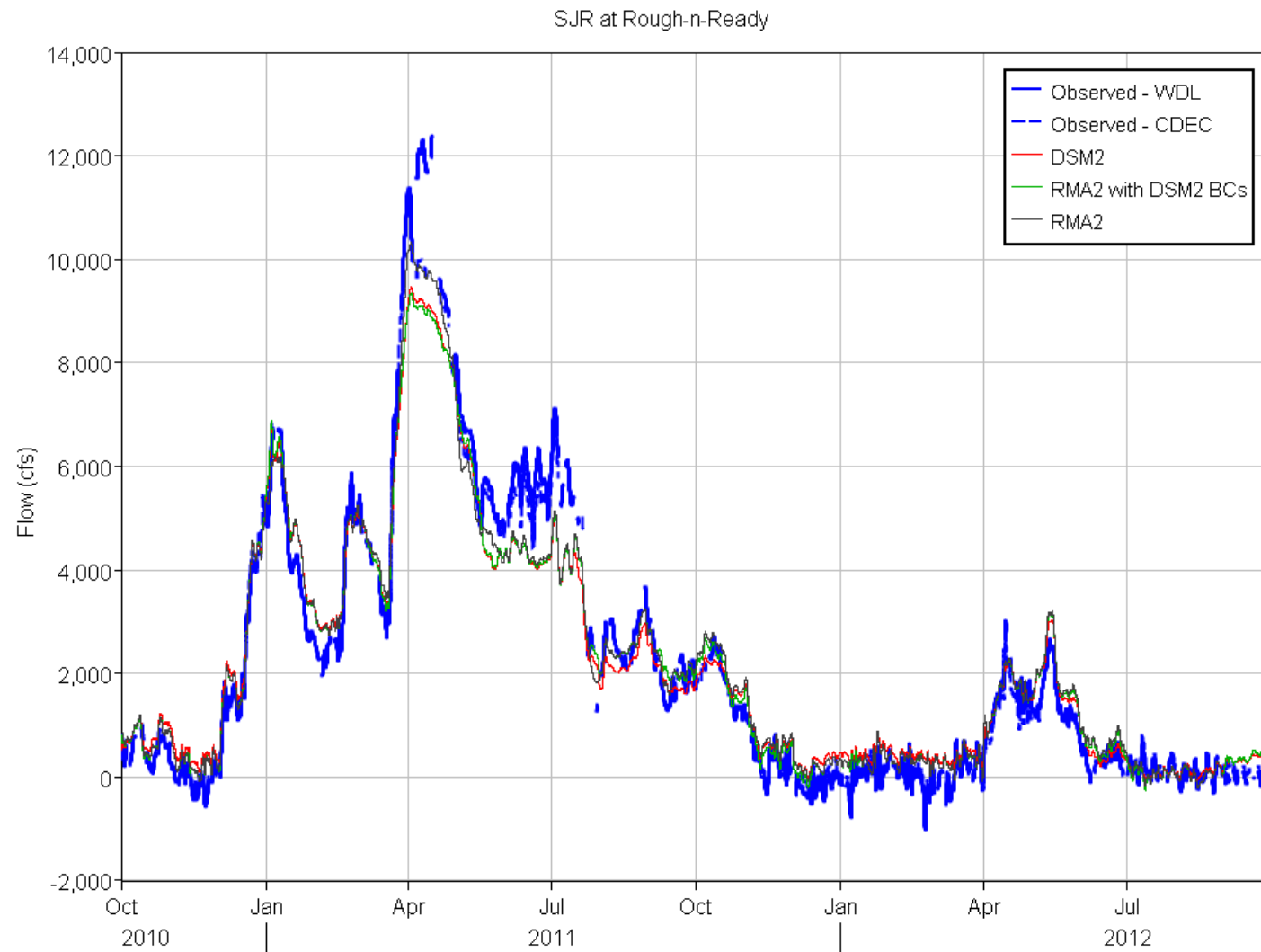


Figure 84 Tidally averaged observed and computed flows for SJR at Rough-n-Ready.

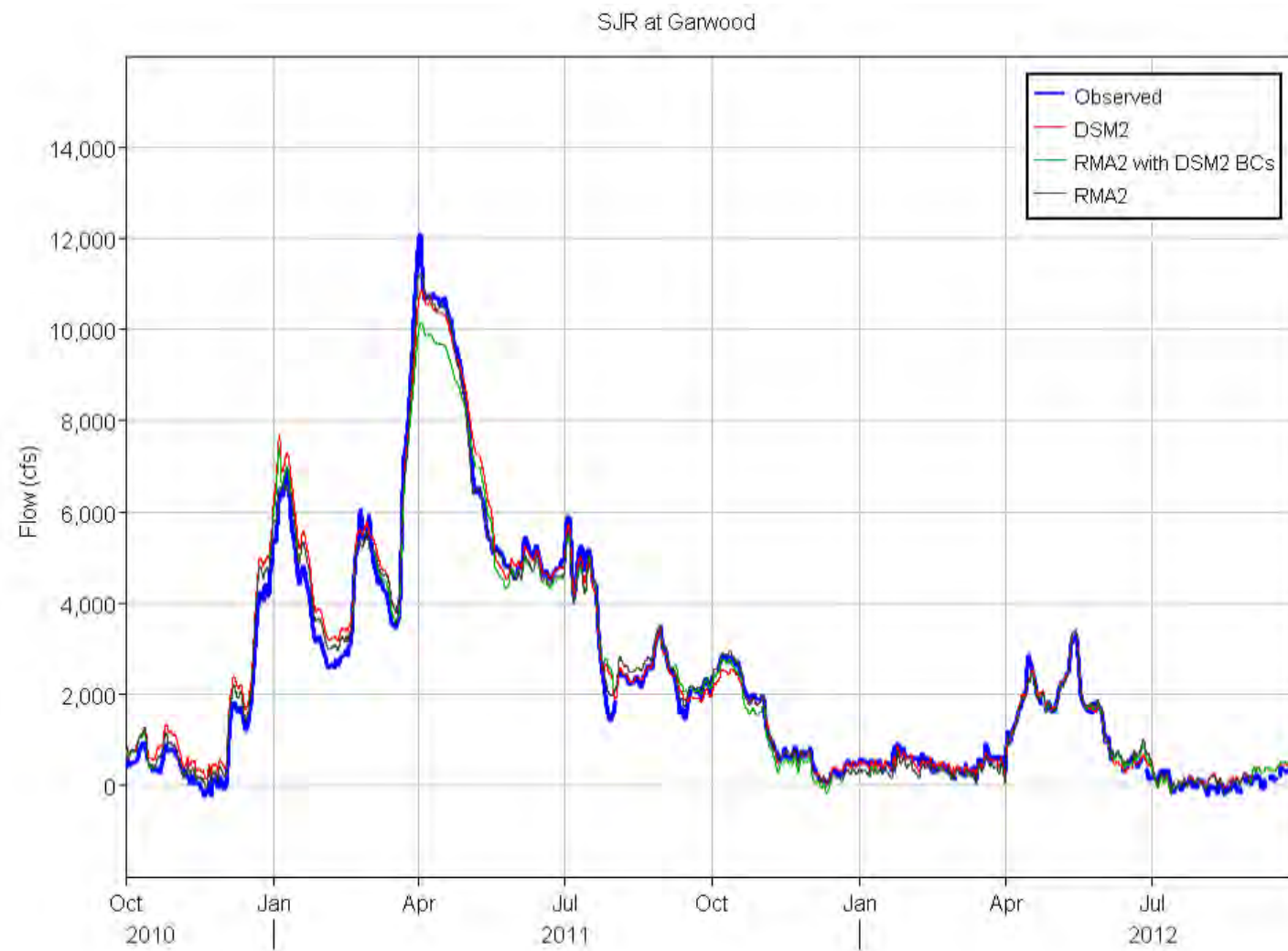


Figure 85 Tidally averaged observed and computed flows for SJR at Garwood.



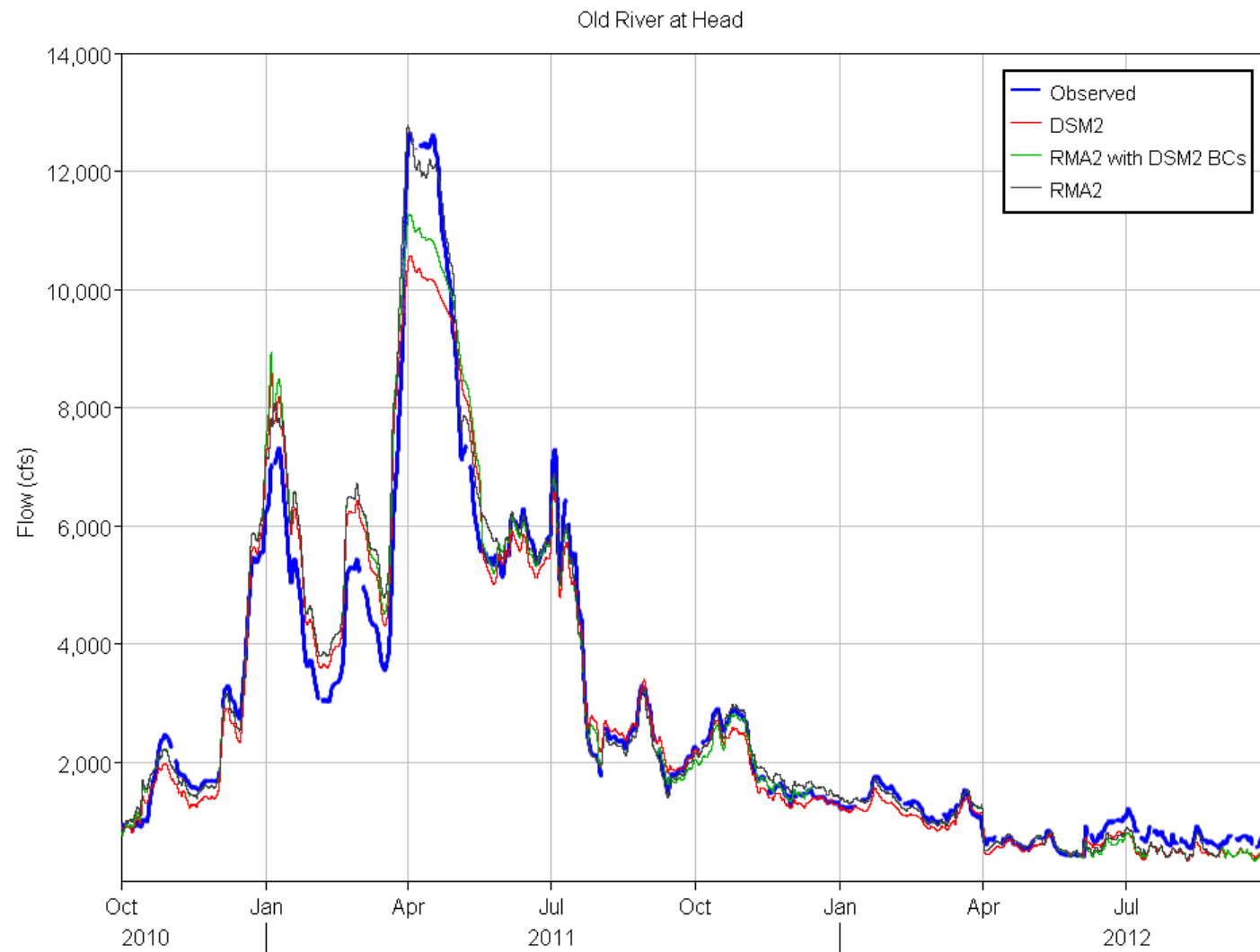


Figure 86 Tidally averaged observed and computed flows for Old River at Head.

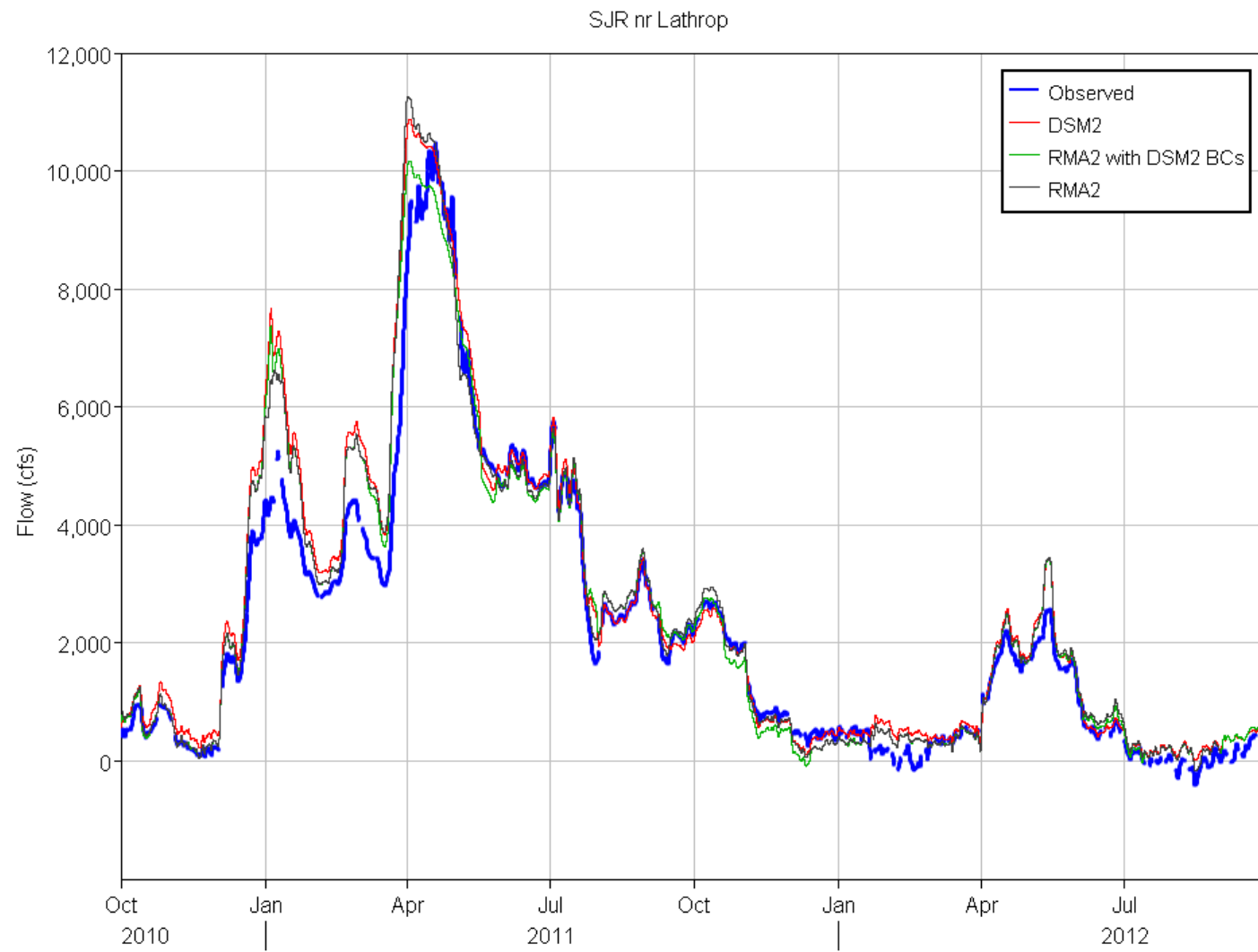


Figure 87 Tidally averaged observed and computed flows for SJR near Lathrop.

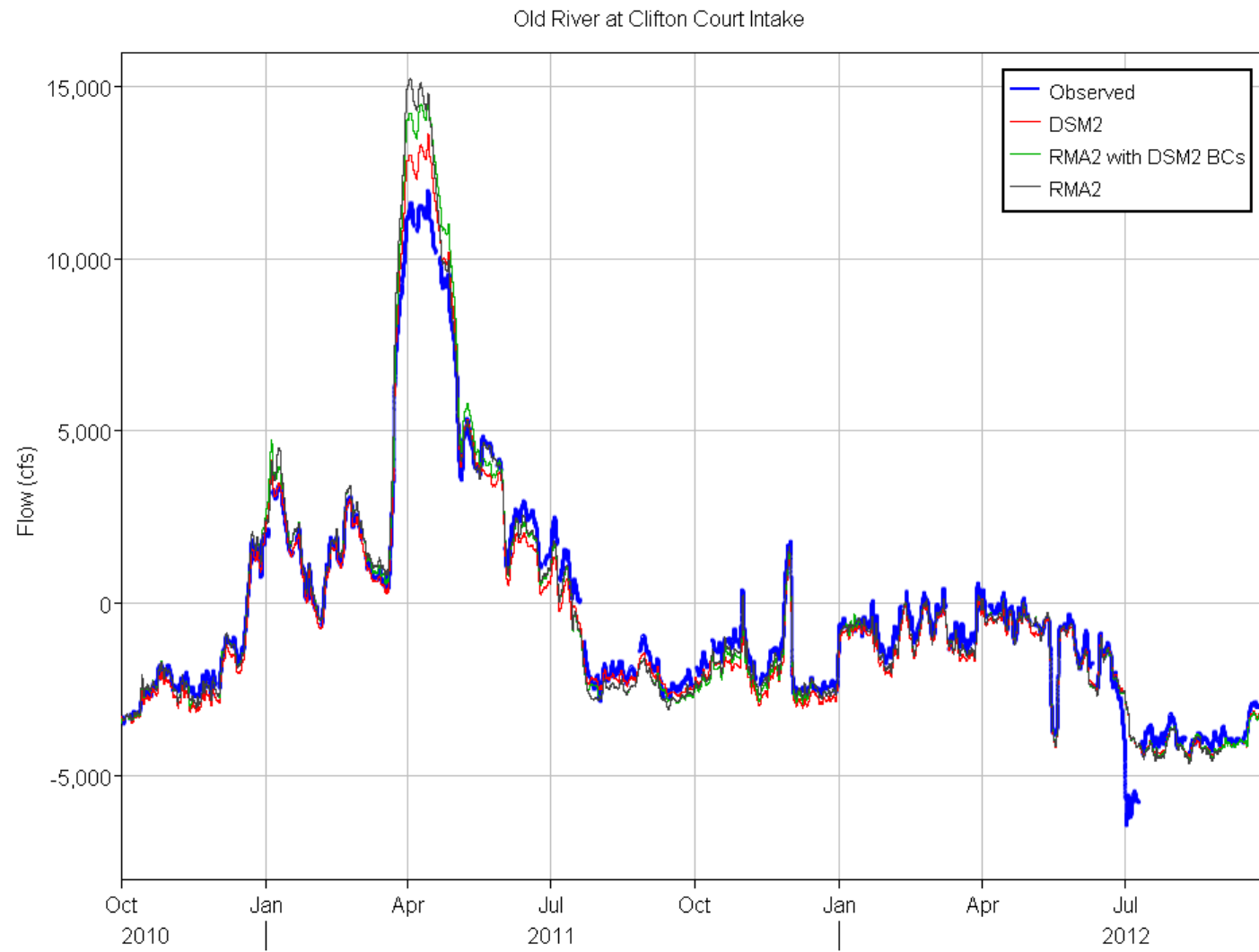


Figure 88 Tidally averaged observed and computed flows for Old River at Clifton Court Intake.

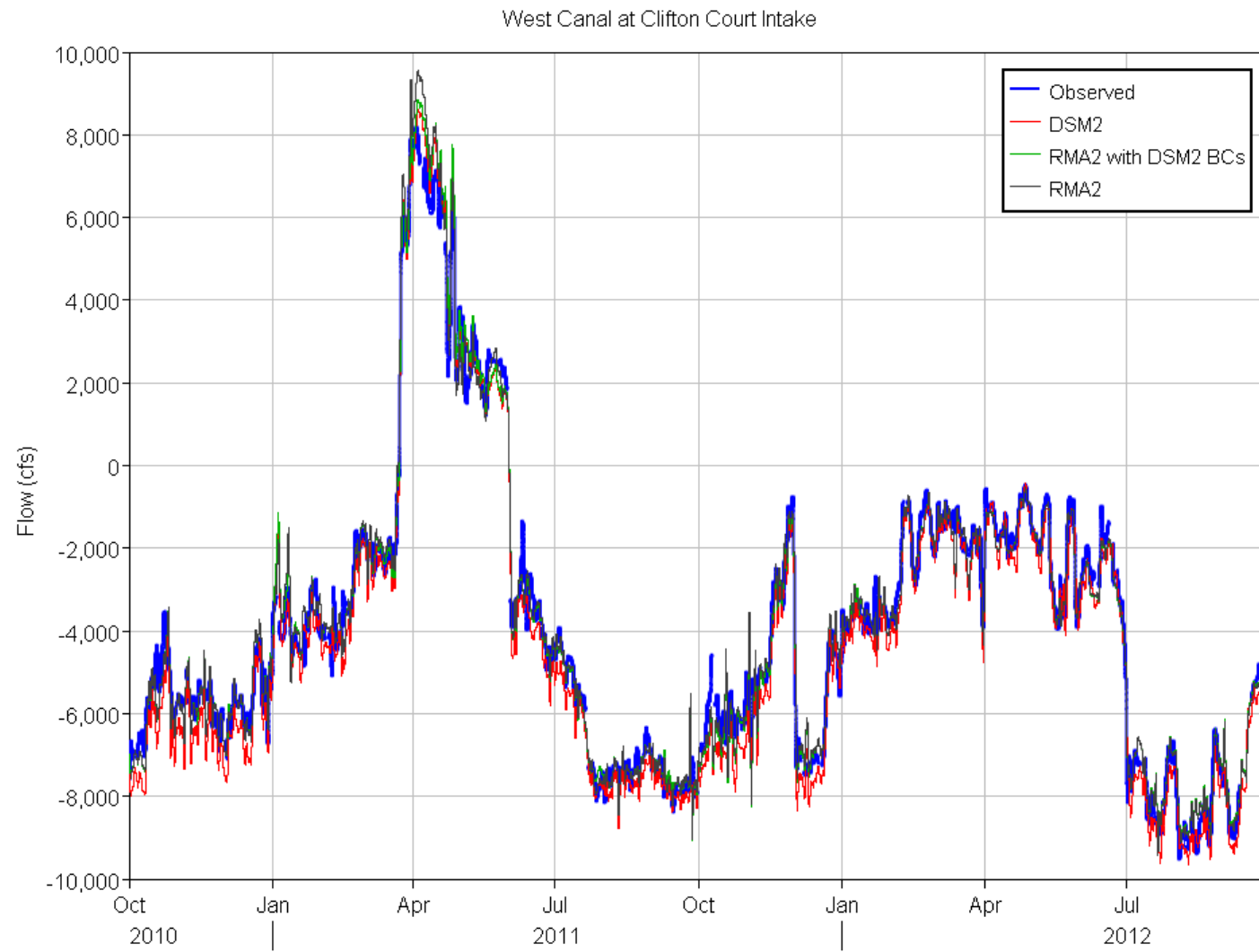


Figure 89 Tidally averaged observed and computed flows for West Canal at Clifton Court Intake.



## Velocity Results Comparison

In Figure 91 through Figure 138, computed velocities for the three model simulations are compared with CDEC and USGS observed data (data sources are noted in plot titles). [Error metrics](#) from these plots are summarized by location in Table 4. Plot locations are shown in Figure 90. USGS data were used where available. CDEC data are likely to contain uncorrected time shifts which can result in apparent larger lag errors.

Table 5 summarizes velocity results for each model by error metric (percent difference from observed, lag, amplitude ratio and  $R^2$ ) and model skill. Table cells are color coded for a quick assessment of goodness of fit with observed data, ranging from green for better fit to red for worse fit. Relative to the flow error metrics, the DSM2 and RMA velocity error metrics indicate worse agreement with observed data. However, for both models, the model skill is within the accurate range on average and for most individual stations. For velocity, a skill accuracy greater than 0.9 is considered accurate, 0.8-0.9 is considered acceptable and a skill accuracy below 0.8 is considered poor agreement. The average model skill for velocity is 0.940 for DSM2 and 0.945 for RMA2.

Comparison of velocity results among the model simulations and with observed data generally shows the same trends as flow data. Where there are disparities between flow and velocity comparison, this indicates either model geometry issues or problems with calculation of observed flow from observed velocity.

In Old River at Bacon, tidally averaged RMA2 results more closely match flow data than velocity data during periods of net flow greater than about +/-2000 cfs, which may indicate problems with the RMA2 model geometry.

For both models, tidal and tidally averaged flows are in reasonably good agreement with observed data in Old River at Hwy 4 (model skill = 0.970 for DSM2 and 0.979 for RMA2), whereas the matches with observed tidal and tidally averaged velocities are poor (model skill = 0.778 for DSM2 and 0.786 for RMA2). It is not clear whether this issue affects both models because they both use the same inaccurate bathymetry data to set model geometry, or whether there is an issue with the velocity observations.

Table 4 Velocity error metrics summary. Asterisks after station names indicate that observed data are from CDEC, which can contain time shift errors.

	DSM2	RMA2 w DSM2 BC	RMA2
<b>SJR at Brandt Bridge*</b>			
mean diff (ft/s)	-0.08	-0.10	-0.09
lag (minutes)	1	27	27
ampRatio	0.861	0.918	0.915
slope	0.873	0.889	0.892
intercept	0.1	0.0	0.0
R2	0.957	0.956	0.960
<b>SJR at Prisoners Point</b>			
mean diff (ft/s)	0.07	0.03	0.03
lag (minutes)	-43	-26	-26
ampRatio	0.904	0.927	0.927
slope	0.902	0.924	0.924
intercept	0.1	0.0	0.0
R2	0.975	0.972	0.973
<b>SJR at Jersey Pt</b>			
mean diff (ft/s)	-0.05	-0.01	-0.01
lag (minutes)	-27	-13	-13
ampRatio	0.652	0.953	0.953
slope	0.651	0.951	0.952
intercept	0.0	0.0	0.0
R2	0.987	0.987	0.989
<b>Old River at Franks Tr</b>			
mean diff (ft/s)	-0.14	-0.04	-0.04
lag (minutes)	-22	6	6
ampRatio	0.993	0.592	0.593
slope	0.990	0.593	0.593
intercept	-0.1	-0.1	-0.1
R2	0.936	0.917	0.918
<b>Holland Cut</b>			
mean diff (ft/s)	0.10	0.07	0.07
lag (minutes)	-27	-20	-20
ampRatio	0.973	0.900	0.900
slope	0.974	0.898	0.898
intercept	0.1	0.1	0.1
R2	0.974	0.973	0.974
<b>Old River at Bacon</b>			
mean diff (ft/s)	0.00	0.04	0.04
lag (minutes)	-17	-17	-17
ampRatio	0.879	0.909	0.909
slope	0.888	0.909	0.910
intercept	0.0	0.0	0.0
R2	0.972	0.977	0.979
	DSM2	RMA2 w DSM2 BC	RMA2
<b>Old River at Quimby</b>			
	-0.13	-0.01	-0.01
	-12	-15	-14
	0.899	0.910	0.911
	0.895	0.901	0.902
	-0.1	0.0	0.0
	0.967	0.968	0.969
<b>Turner Cut at Holt</b>			
	0.10	-0.01	-0.01
	-90	-8	-7
	0.896	0.504	0.505
	0.867	0.517	0.517
	0.1	-0.1	-0.1
	0.898	0.794	0.794
<b>Old River near DMC*</b>			
	0.11	0.04	0.04
	-26	9	9
	0.990	1.065	1.067
	1.052	1.087	1.087
	0.1	0.0	0.0
	0.899	0.896	0.897
<b>Old River at Tracy</b>			
	-0.07	-0.07	-0.07
	0	47	47
	0.822	0.741	0.743
	1.010	0.990	0.984
	-0.1	-0.1	-0.1
	0.806	0.736	0.734
<b>Old River at Hwy 4</b>			
	0.69	0.71	0.71
	-24	-8	-8
	0.395	0.403	0.404
	0.406	0.409	0.410
	0.0	0.0	0.0
	0.920	0.927	0.928
<b>SJR at Rough-n-Ready*</b>			
	0.01	-0.01	-0.01
	-9	14	15
	0.878	1.018	1.018
	0.881	0.947	0.955
	0.0	0.0	0.0
	0.849	0.832	0.839
	DSM2	RMA2 w DSM2 BC	RMA2
<b>SJR at Garwood</b>			
	0.06	0.02	0.04
	-32	-10	-10
	0.989	1.110	1.110
	1.004	1.026	1.043
	0.1	0.0	0.0
	0.973	0.971	0.978
<b>Old River at Head</b>			
	-0.13	-0.20	-0.18
	18	40	41
	0.748	0.625	0.619
	1.063	1.018	1.027
	-0.2	-0.2	-0.2
	0.922	0.922	0.921
<b>SJR nr Lathrop</b>			
	-0.14	-0.16	-0.15
	21	43	44
	0.584	0.655	0.656
	0.796	0.862	0.858
	0.1	0.0	0.0
	0.804	0.838	0.854
<b>Old R at Clifton Court Intake</b>			
	-0.06	-0.01	-0.01
	10	37	37
	1.043	0.947	0.946
	1.142	1.057	1.059
	0.0	0.0	0.0
	0.849	0.848	0.849
<b>West Canal at Clifton Ct*</b>			
	-0.10	-0.05	-0.05
	28	40	40
	1.006	0.973	0.974
	1.036	1.009	1.011
	-0.1	0.0	0.0
	0.860	0.860	0.861

**Table 5 Summary of velocity error metrics and model skill with shading ranging from green for better fit to red for worse fit. Asterisks after station names indicate that observed data are from CDEC, which can contain time shift errors.**

Station	% diff from observed			lag (minutes)			ampRatio			R2			Model Skill		
	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2
SJR at Brandt Bridge*	-6.6%	-8.8%	-7.4%	1	27	27	0.861	0.918	0.915	0.957	0.956	0.960	0.984	0.980	0.982
SJR at Prisoners Point	187.5%	97.7%	99.7%	-43	-26	-26	0.904	0.927	0.927	0.975	0.972	0.973	0.954	0.978	0.978
SJR at Jersey Pt	-33.2%	-8.9%	-6.5%	-27	-13	-13	0.652	0.953	0.953	0.987	0.987	0.989	0.940	0.993	0.993
Old River at Franks Tr	-253.3%	-69.1%	-70.9%	-22	6	6	0.993	0.592	0.593	0.936	0.917	0.918	0.956	0.920	0.920
Holland Cut	93.2%	64.7%	65.2%	-27	-20	-20	0.973	0.900	0.900	0.974	0.973	0.974	0.975	0.981	0.982
Old River at Bacon	2.3%	21.4%	21.8%	-17	-17	-17	0.879	0.909	0.909	0.972	0.977	0.979	0.985	0.986	0.987
Old River at Quimby	-394.6%	-18.0%	-16.5%	-12	-15	-14	0.899	0.910	0.911	0.967	0.968	0.969	0.979	0.985	0.986
Turner Cut at Holt	55.0%	-5.2%	-5.4%	-90	-8	-7	0.896	0.504	0.505	0.898	0.794	0.794	0.805	0.871	0.871
Old River near DMC	34.7%	13.2%	13.1%	-26	9	9	0.990	1.065	1.067	0.899	0.896	0.897	0.952	0.966	0.966
Old River at Tracy*	-18.6%	-18.3%	-17.8%	0	47	47	0.822	0.741	0.743	0.806	0.736	0.734	0.937	0.902	0.902
Old River at Hwy 4	58.9%	60.6%	60.7%	-24	-8	-8	0.395	0.403	0.404	0.920	0.927	0.928	0.778	0.785	0.786
SJR at Rough-n-Ready*	4.6%	-7.1%	-5.2%	-9	14	15	0.878	1.018	1.018	0.849	0.832	0.839	0.957	0.949	0.951
SJR at Garwood	8.4%	3.1%	5.1%	-32	-10	-10	0.989	1.110	1.110	0.973	0.971	0.978	0.983	0.991	0.993
Old River at Head*	-10.2%	-15.7%	-14.5%	18	40	41	0.748	0.625	0.619	0.922	0.922	0.921	0.969	0.958	0.960
SJR nr Lathrop*	-12.4%	-14.2%	-13.1%	21	43	44	0.584	0.655	0.656	0.804	0.838	0.854	0.931	0.932	0.937
Old R at Clifton Court Intake*	-95.2%	-23.8%	-21.4%	10	37	37	1.043	0.947	0.946	0.849	0.848	0.849	0.945	0.936	0.936
West Canal at Clifton Ct Intake*	-14.3%	-7.4%	-7.2%	28	40	40	1.006	0.973	0.974	0.860	0.860	0.861	0.949	0.940	0.940
<b>Average of absolute values</b>	<b>72.8%</b>	<b>25.6%</b>	<b>25.3%</b>	<b>24</b>	<b>22</b>	<b>22</b>	<b>0.854</b>	<b>0.832</b>	<b>0.832</b>	<b>0.915</b>	<b>0.904</b>	<b>0.907</b>	<b>0.940</b>	<b>0.944</b>	<b>0.945</b>

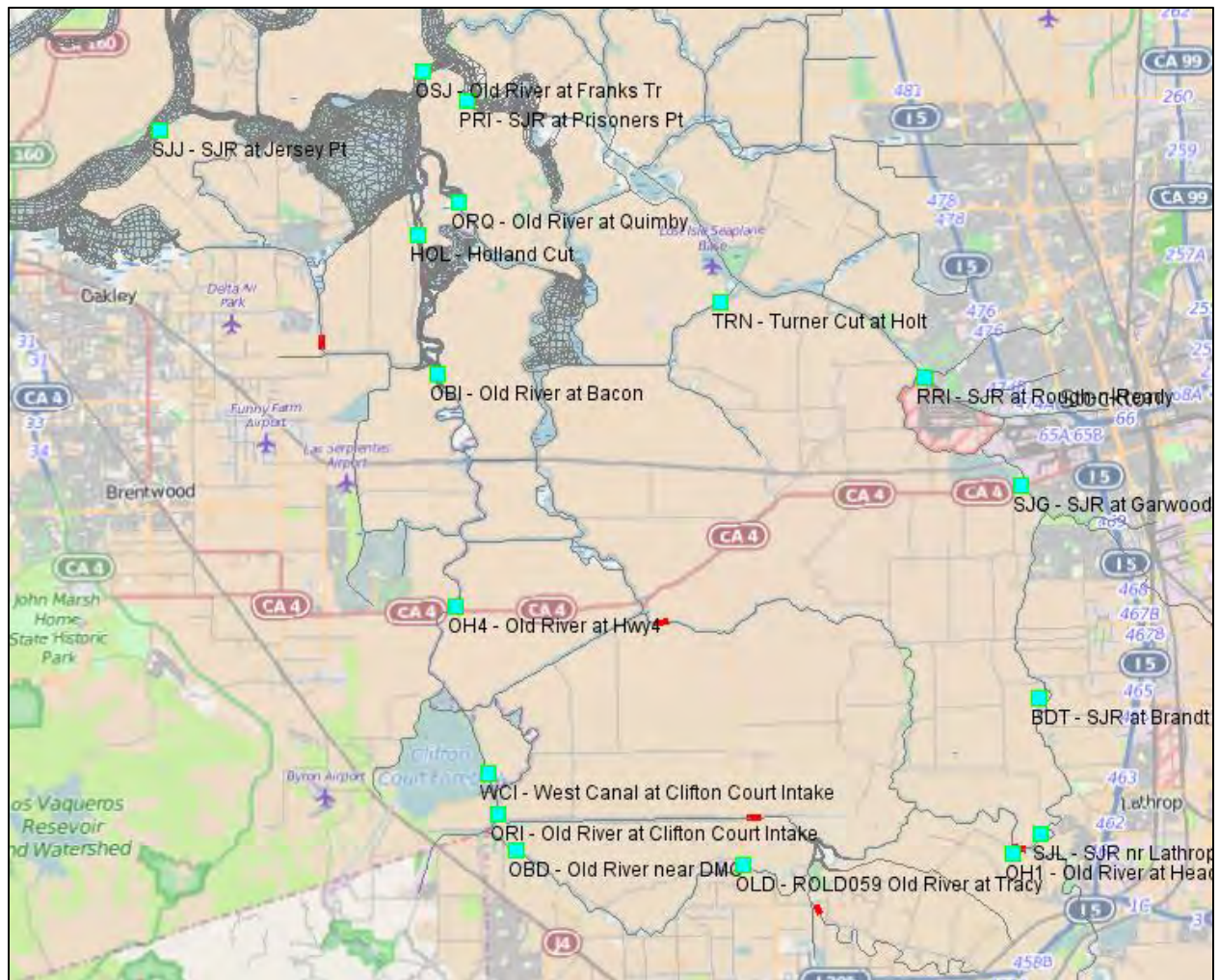


Figure 90 Velocity comparison plot locations.



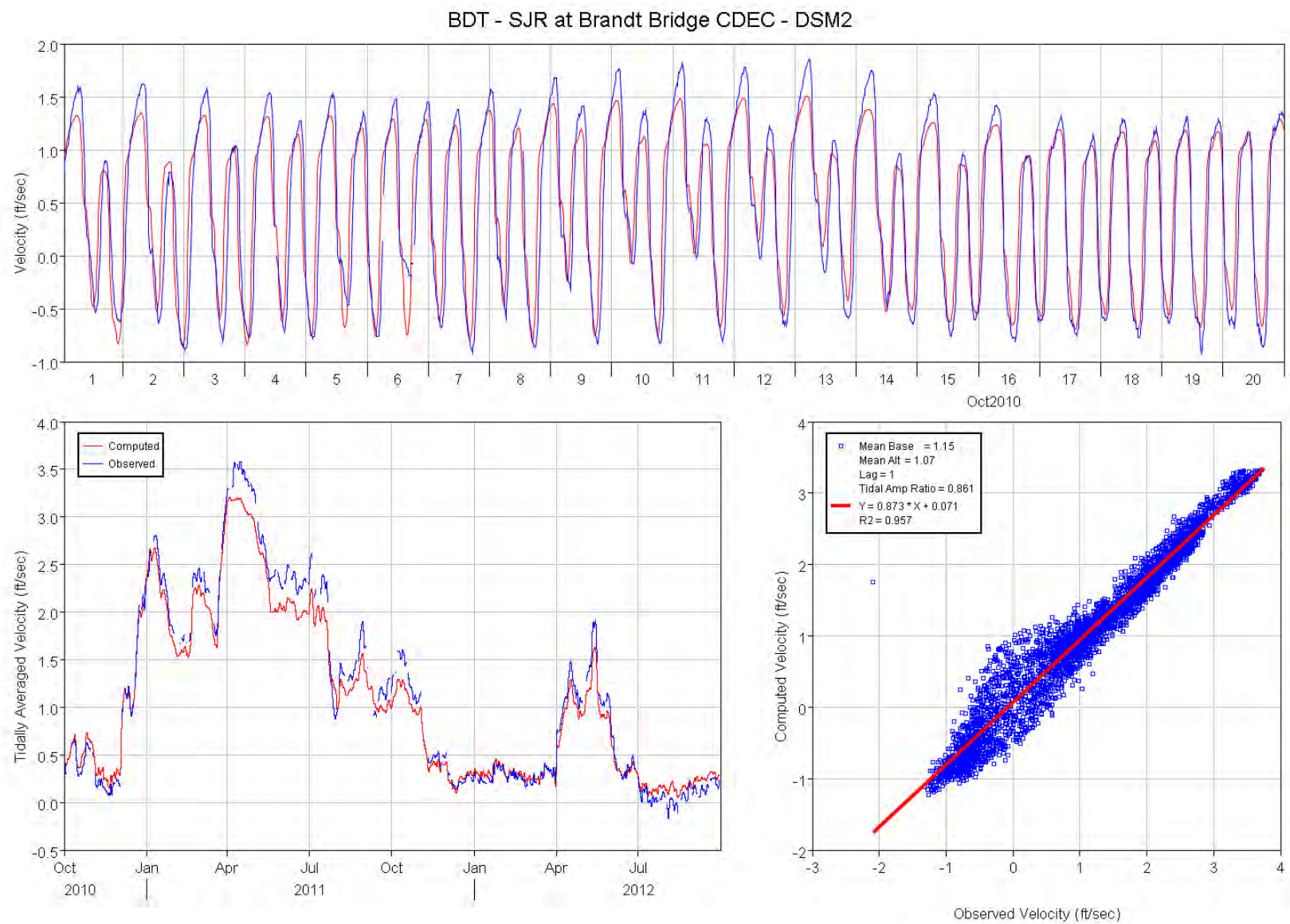


Figure 91 Computed (DSM2) and observed velocity comparison plots for San Joaquin River at Brandt Bridge.

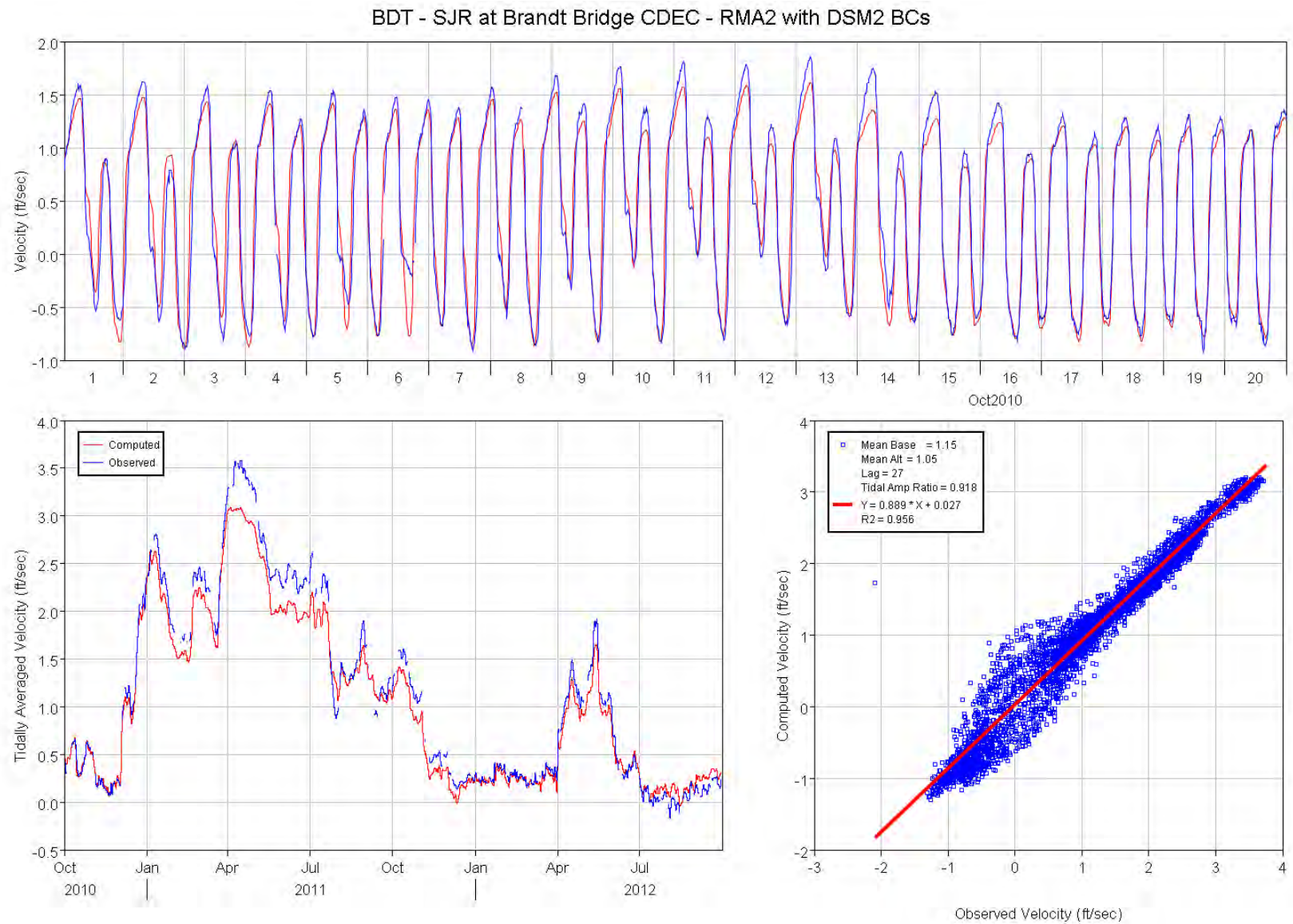


Figure 92 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for San Joaquin River at Brandt Bridge.

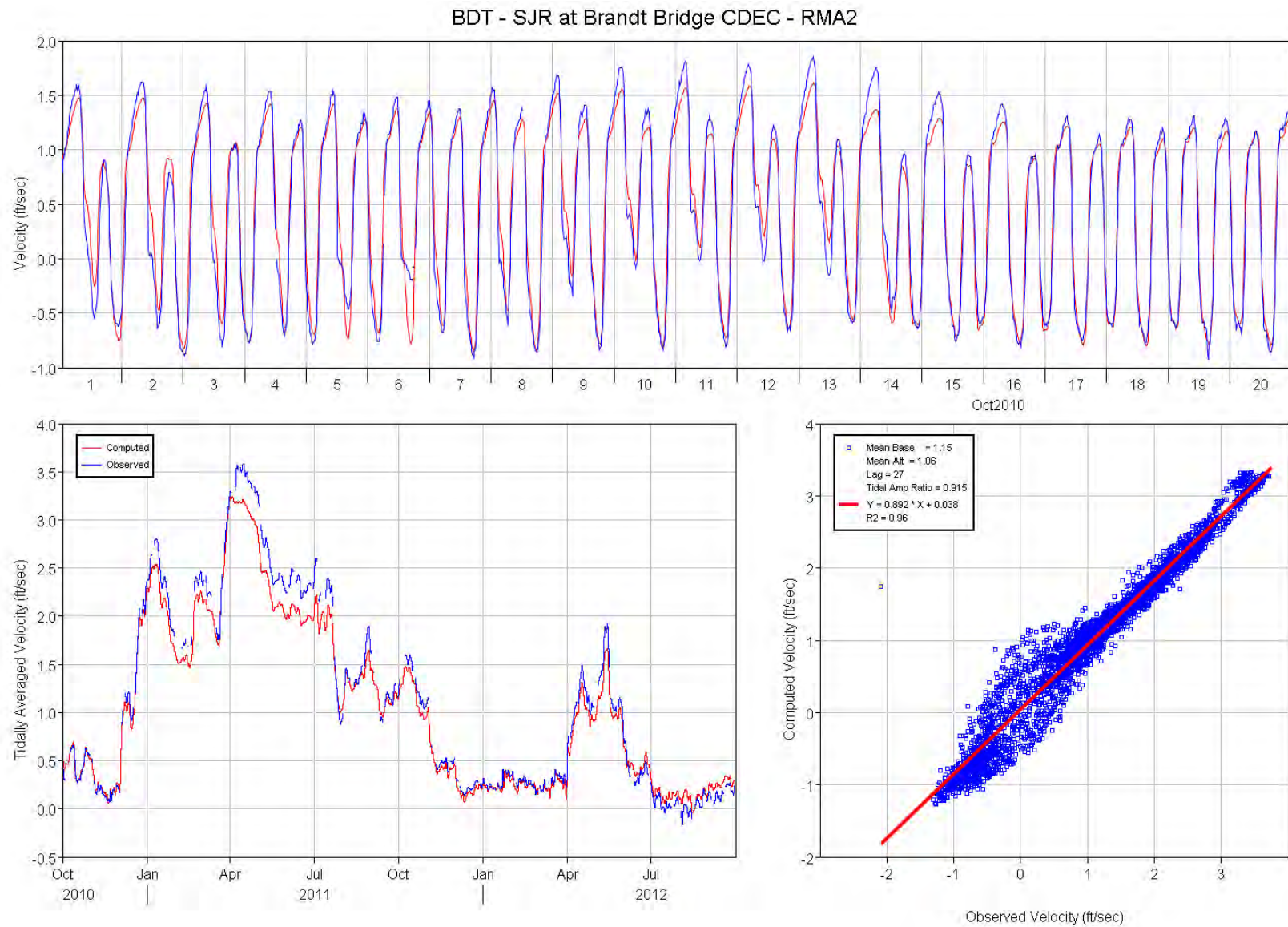


Figure 93 Computed (RMA2) and observed velocity comparison plots for San Joaquin River at Brandt Bridge.



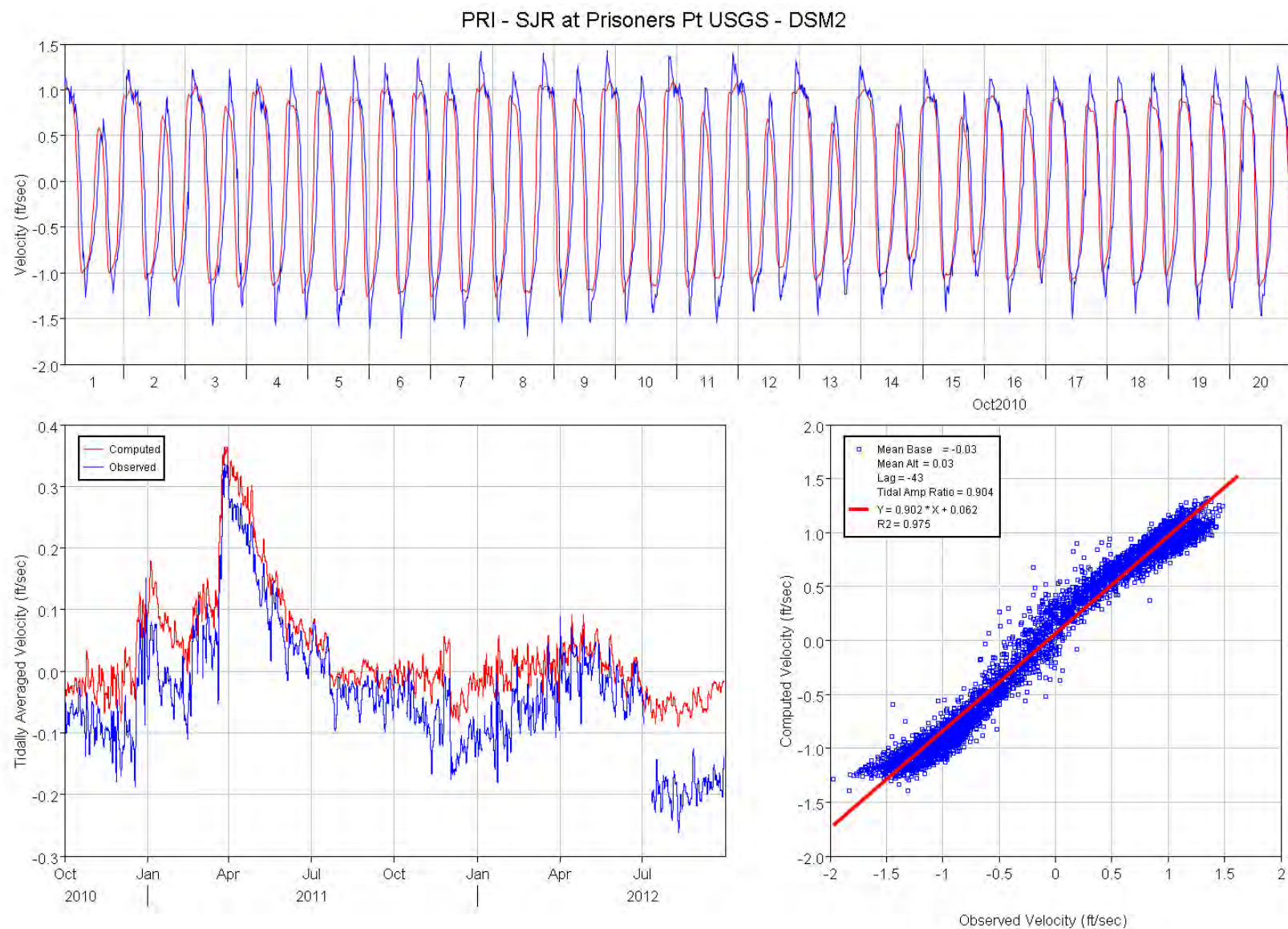


Figure 94 Computed (DSM2) and observed velocity comparison plots for San Joaquin River at Prisoners Point.



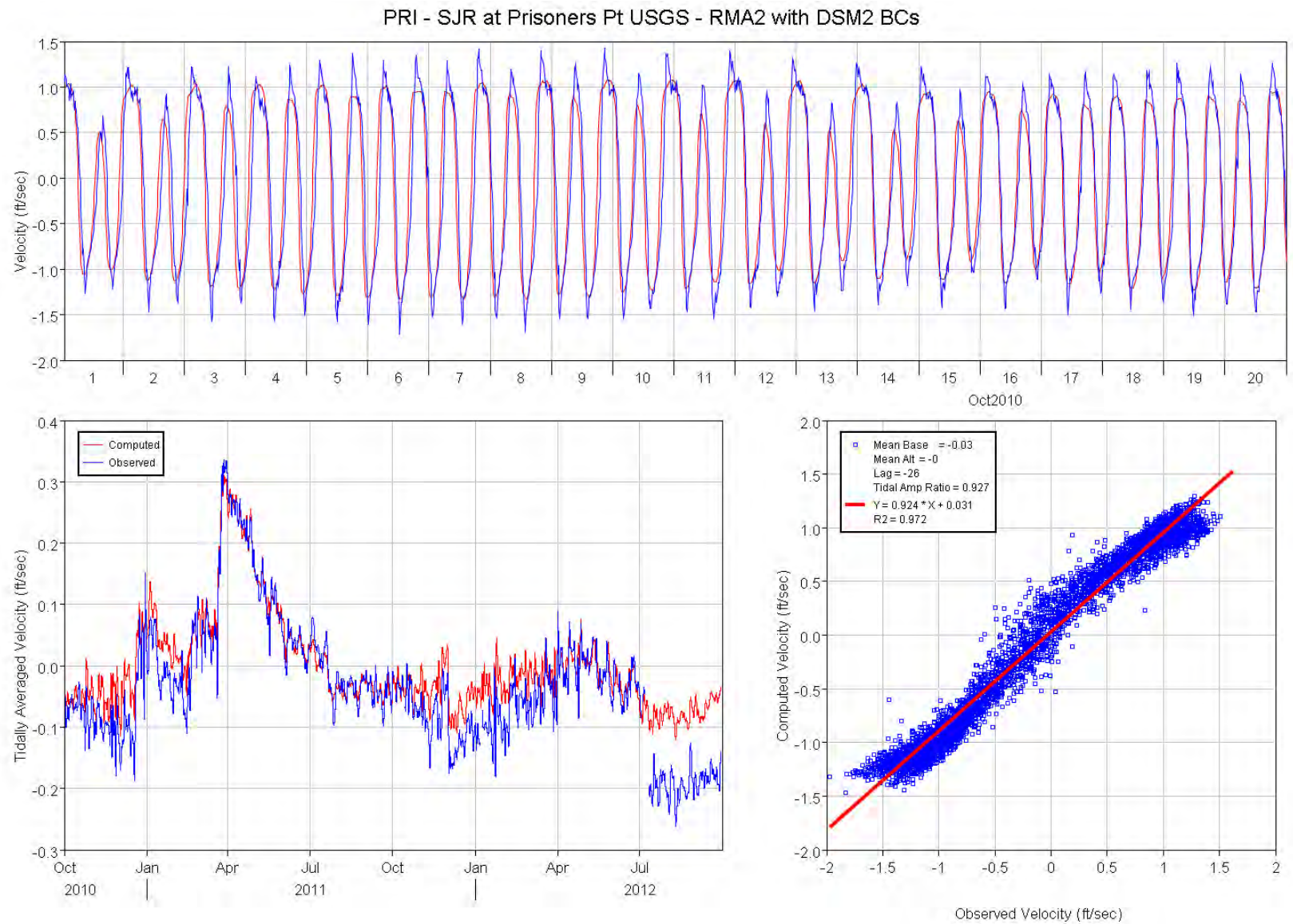


Figure 95 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for San Joaquin River at Prisoners Point.

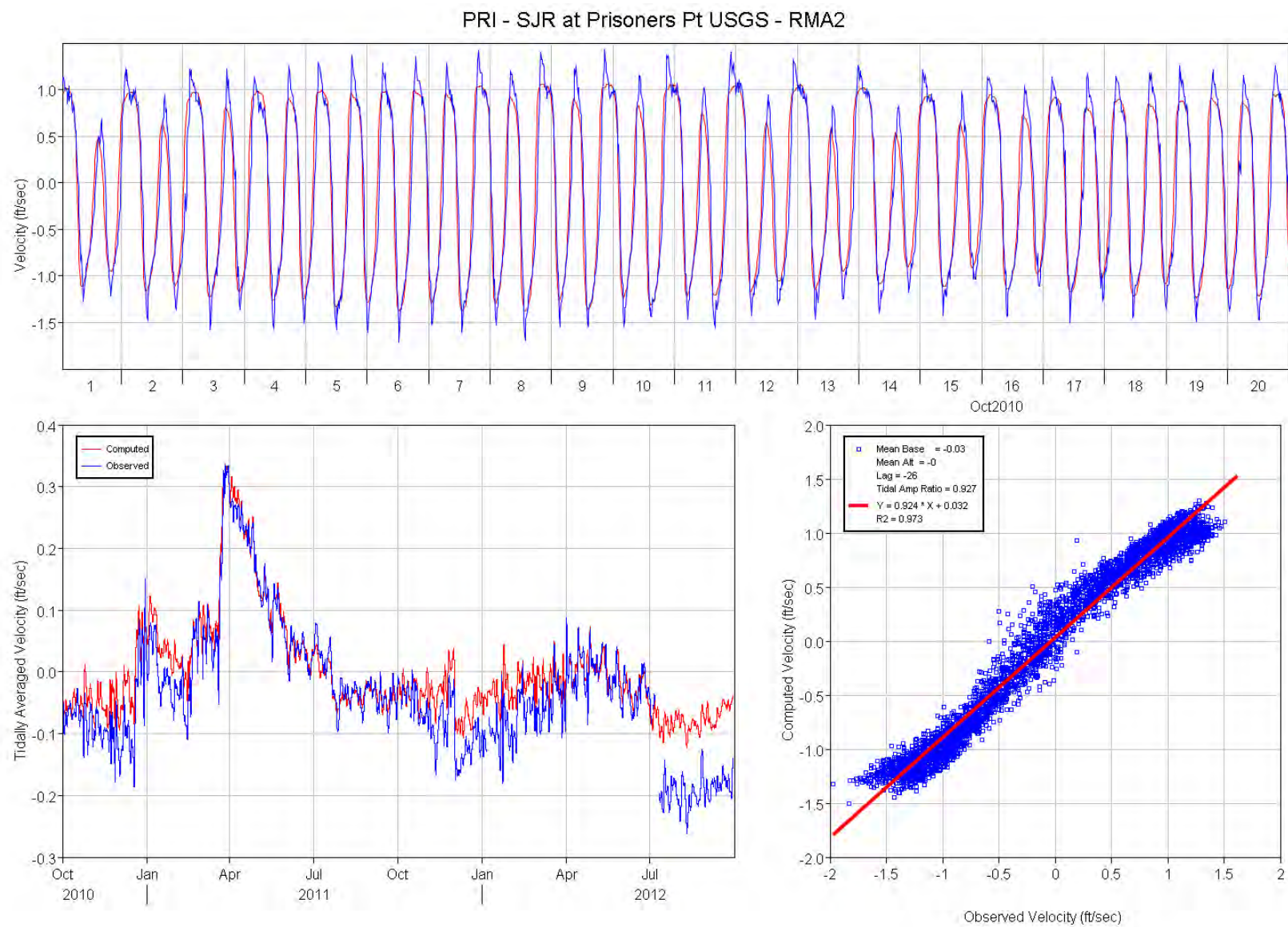


Figure 96 Computed (RMA2) and observed velocity comparison plots for San Joaquin River at Prisoners Point.



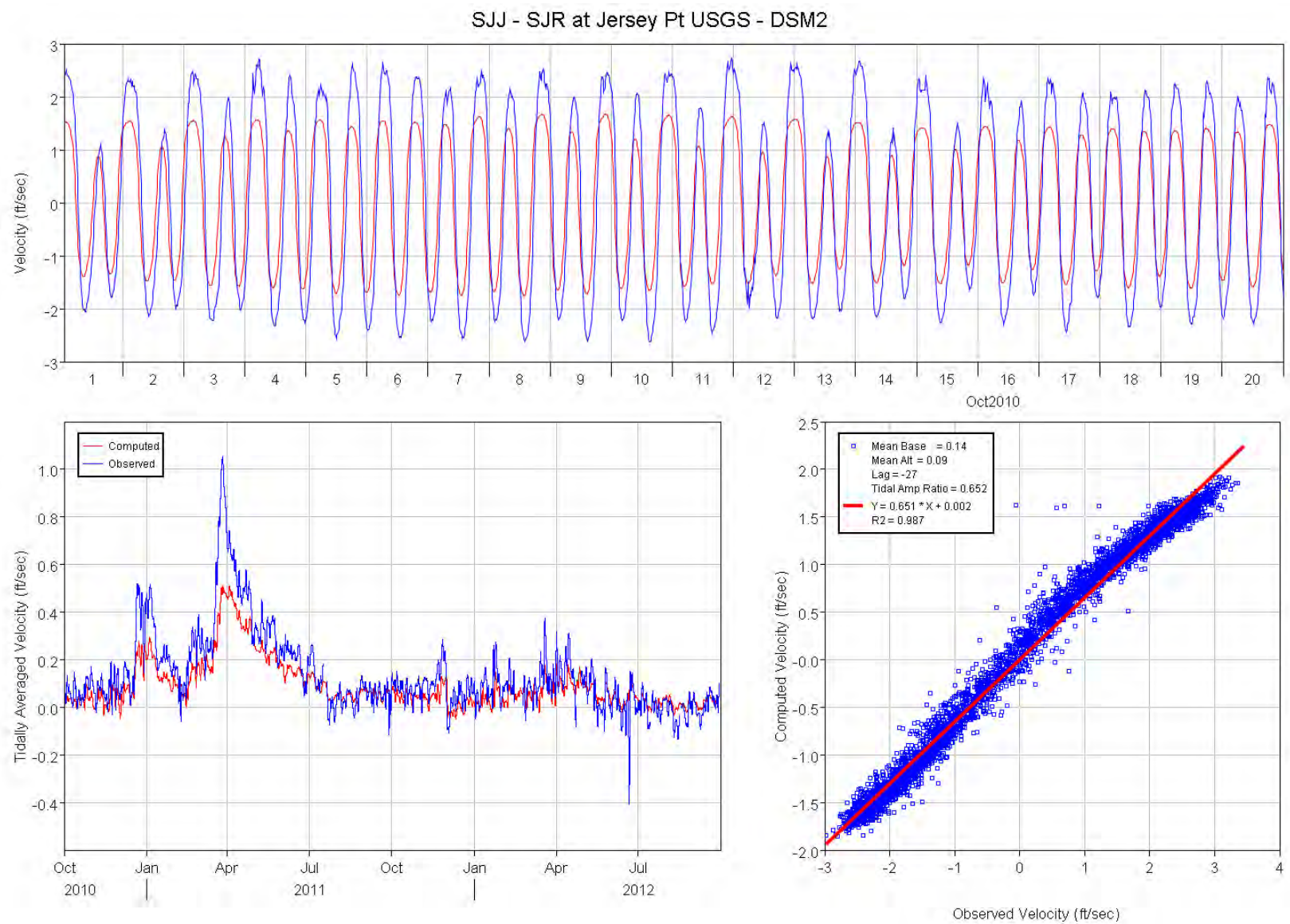


Figure 97 Computed (DSM2) and observed velocity comparison plots for San Joaquin River at Jersey Point.

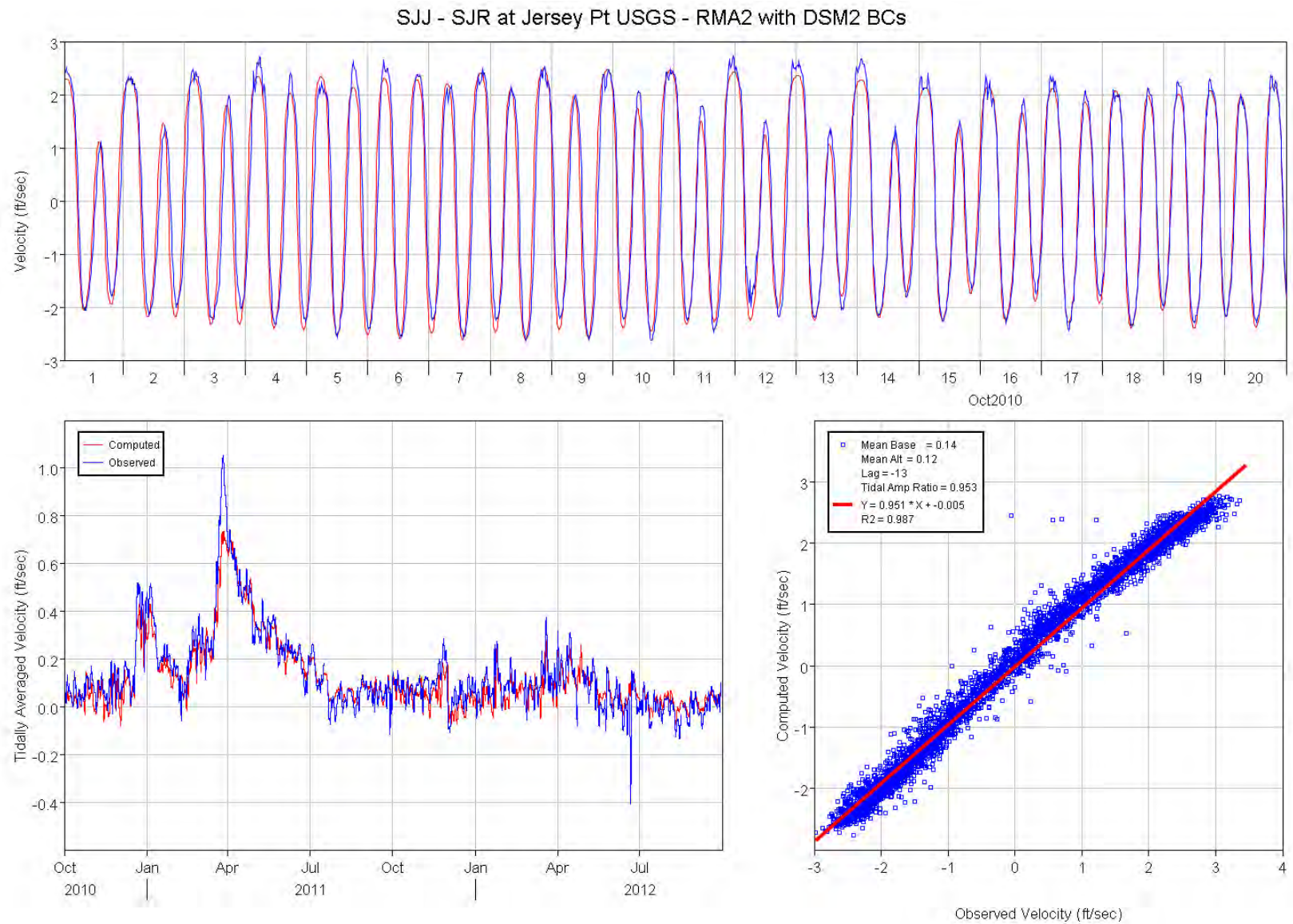


Figure 98 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for San Joaquin River at Jersey Point.



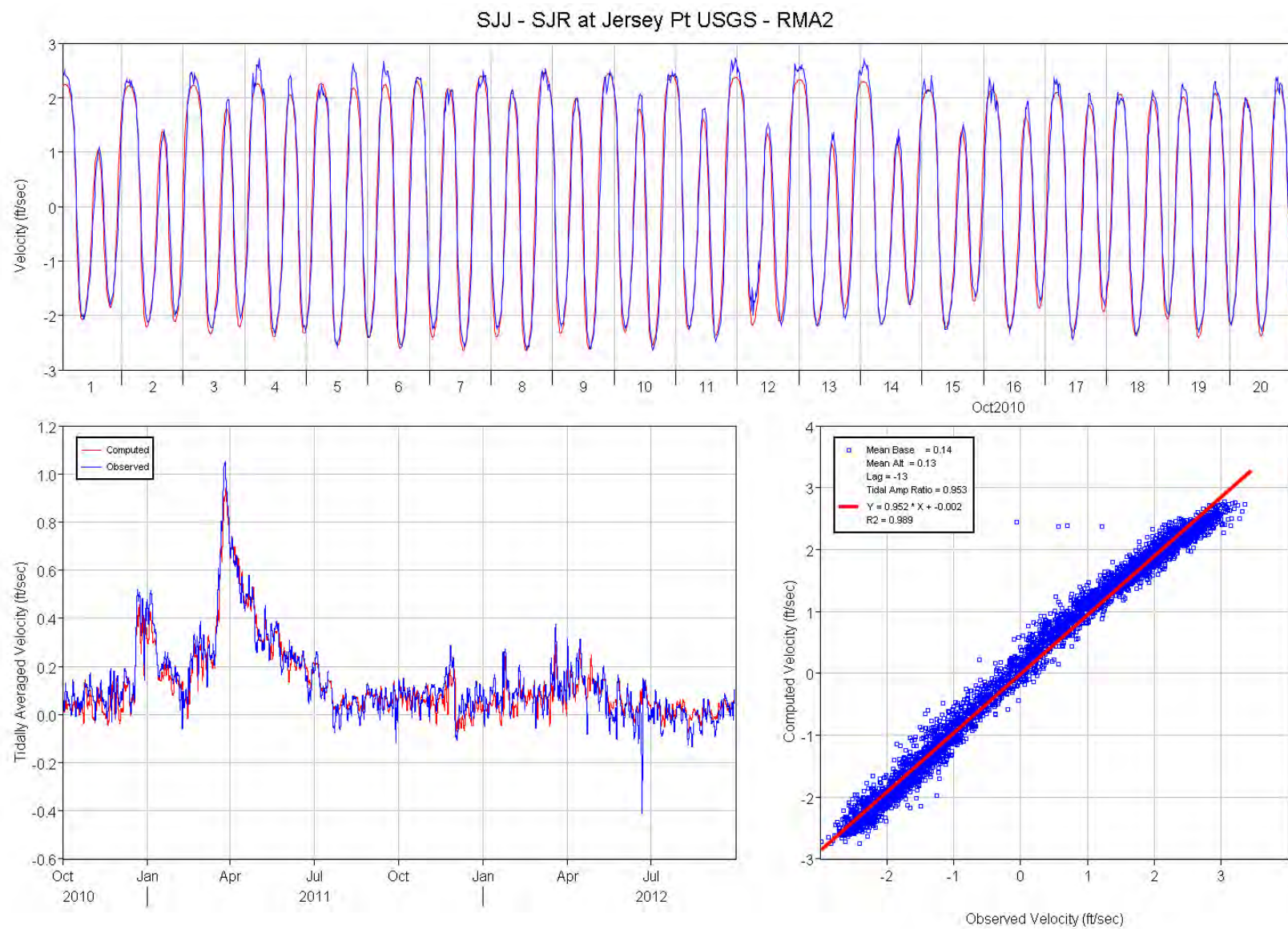


Figure 99 Computed (RMA2) and observed velocity comparison plots for San Joaquin River at Jersey Point.

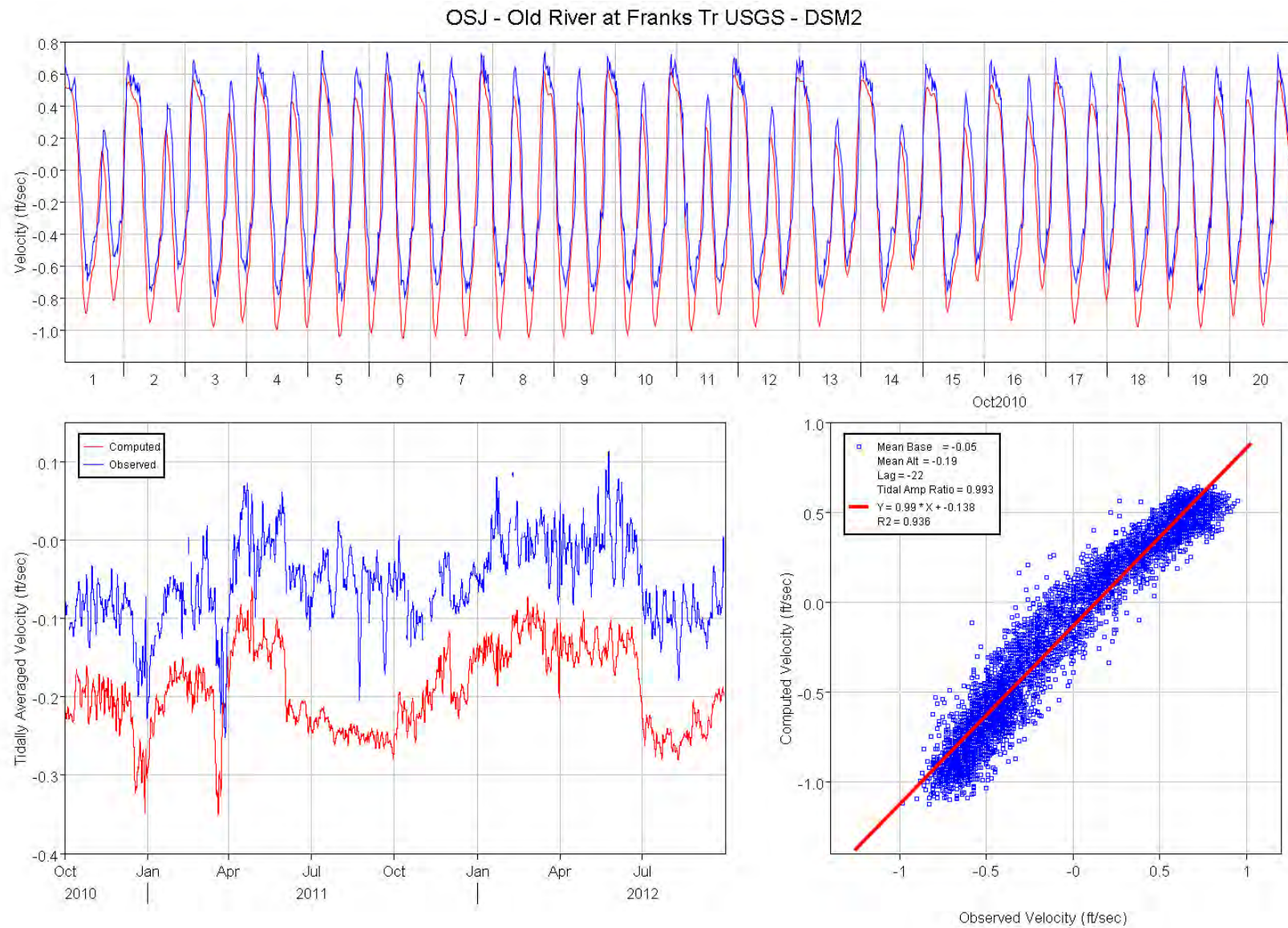


Figure 100 Computed (DSM2) and observed velocity comparison plots for Old River at Franks Tract.



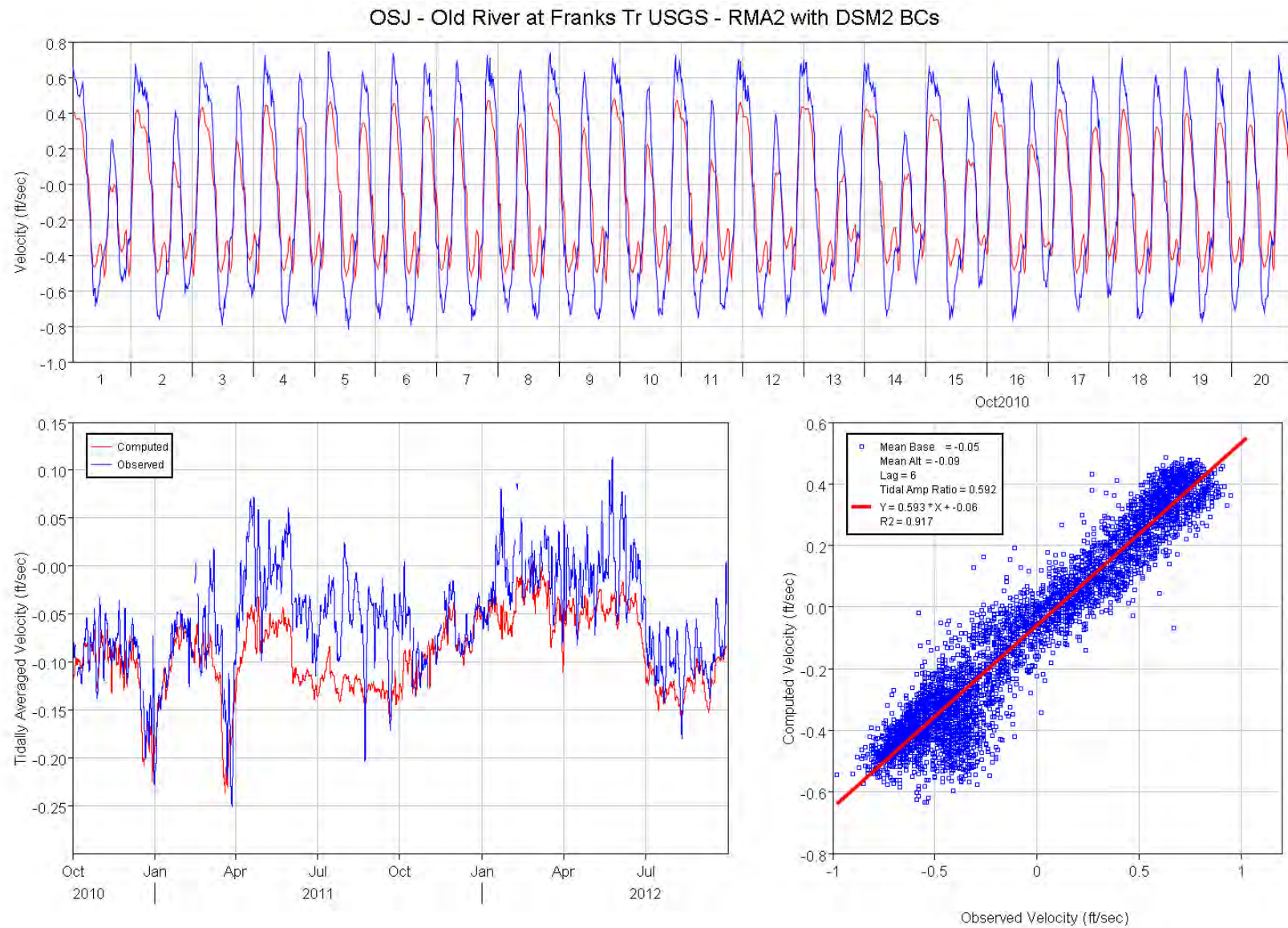


Figure 101 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Franks Tract.

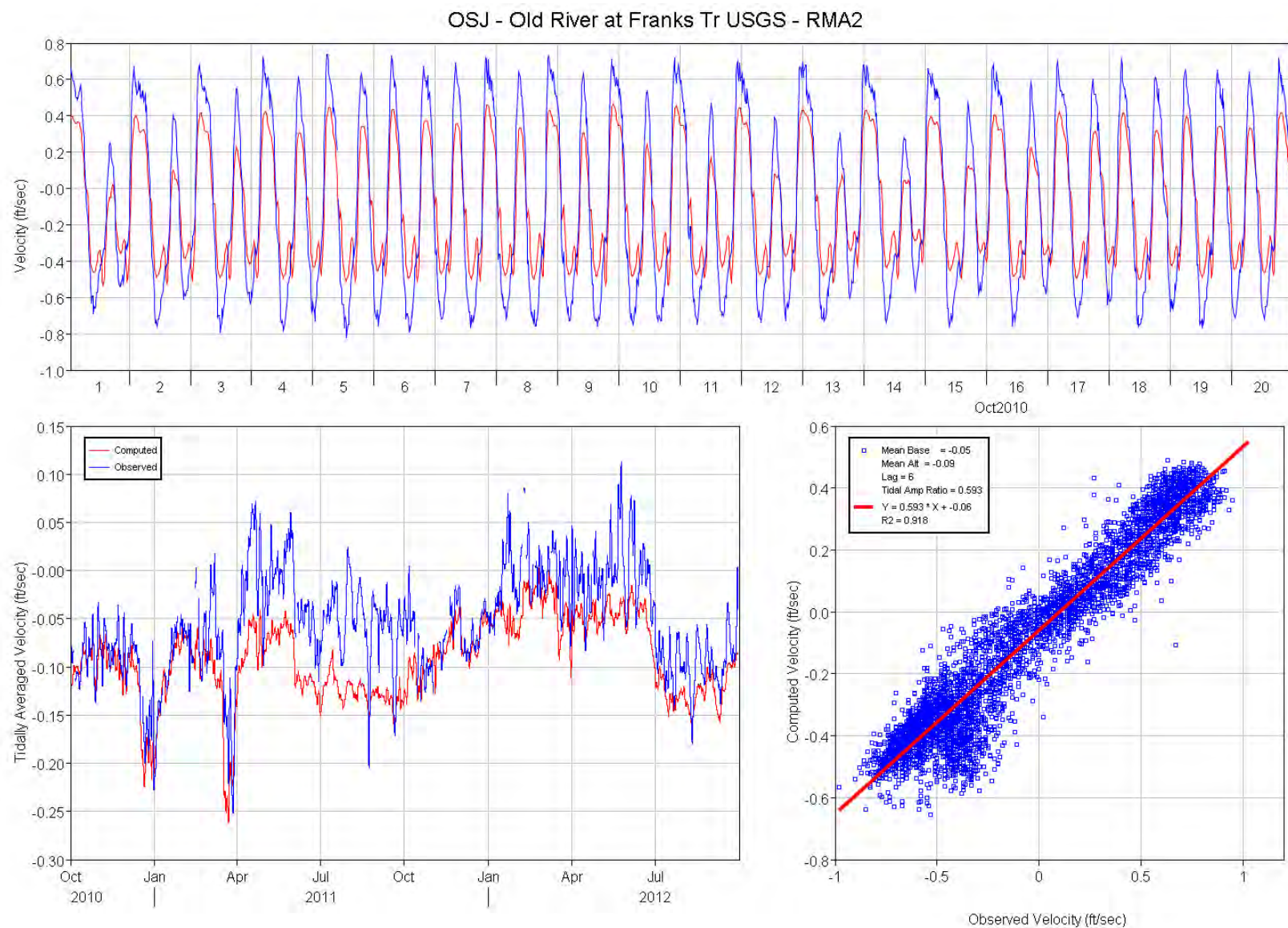


Figure 102 Computed (RMA2) and observed velocity comparison plots for Old River at Franks Tract.



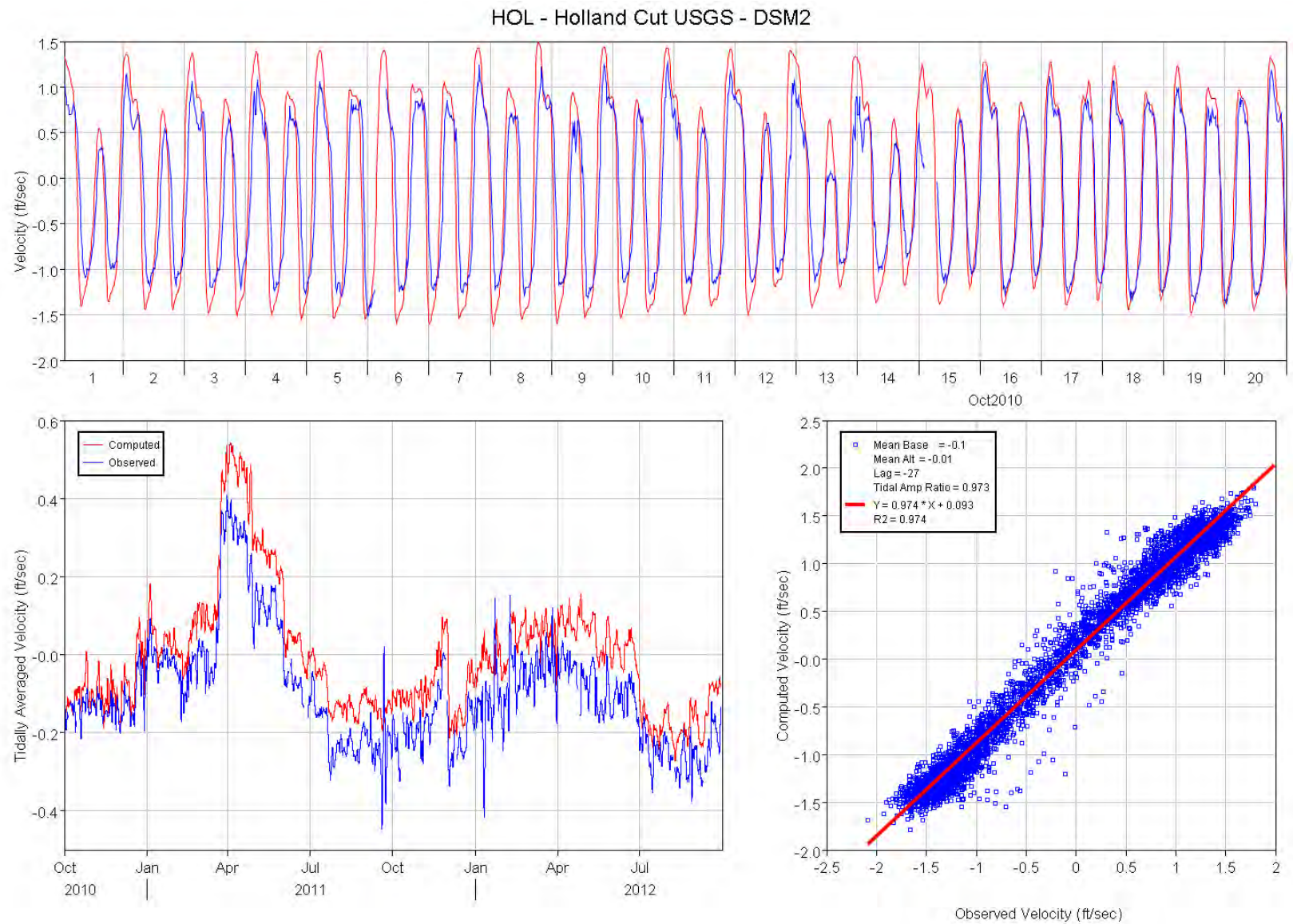


Figure 103 Computed (DSM2) and observed velocity comparison plots for Holland Tract.

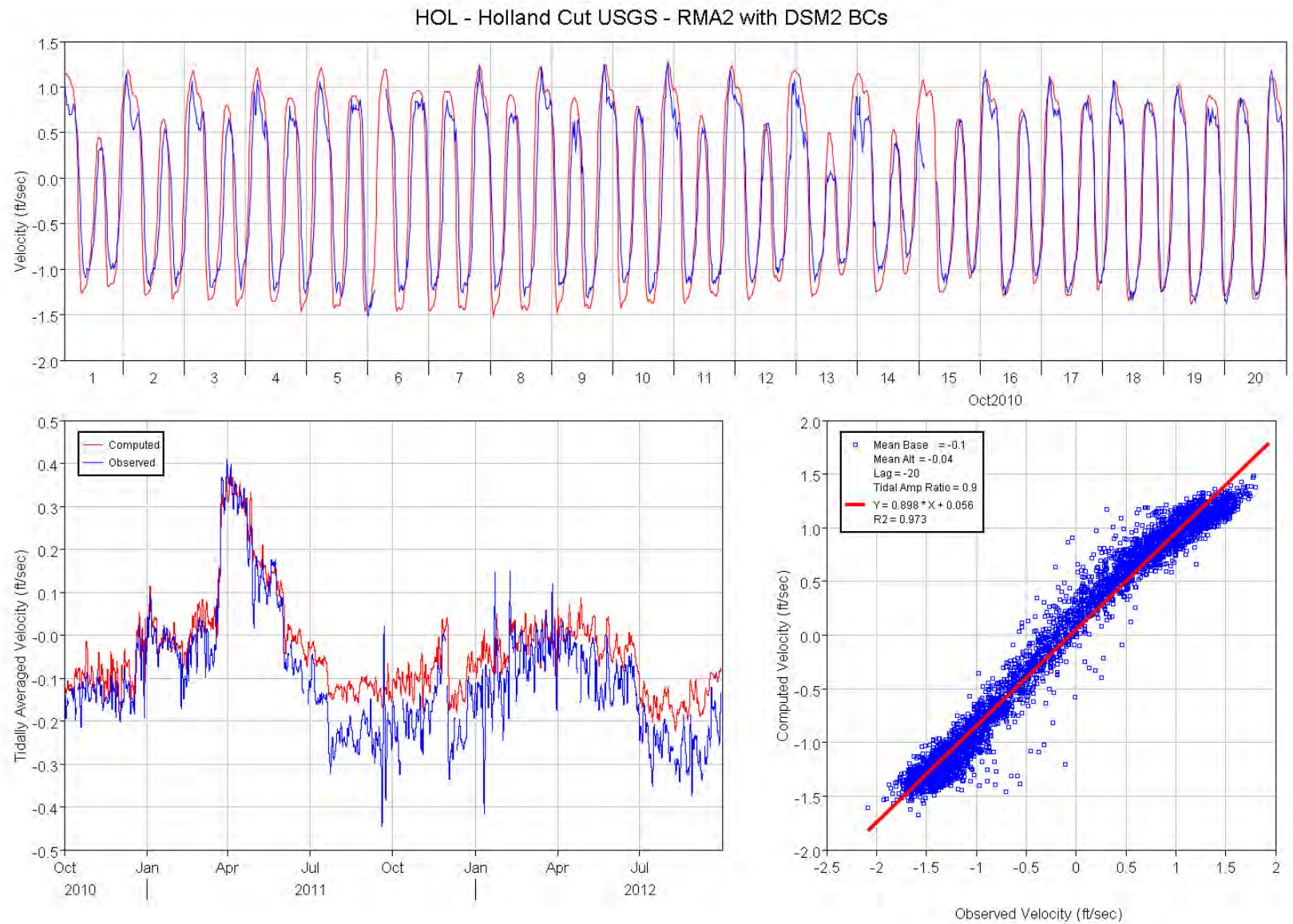


Figure 104 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Holland Tract.



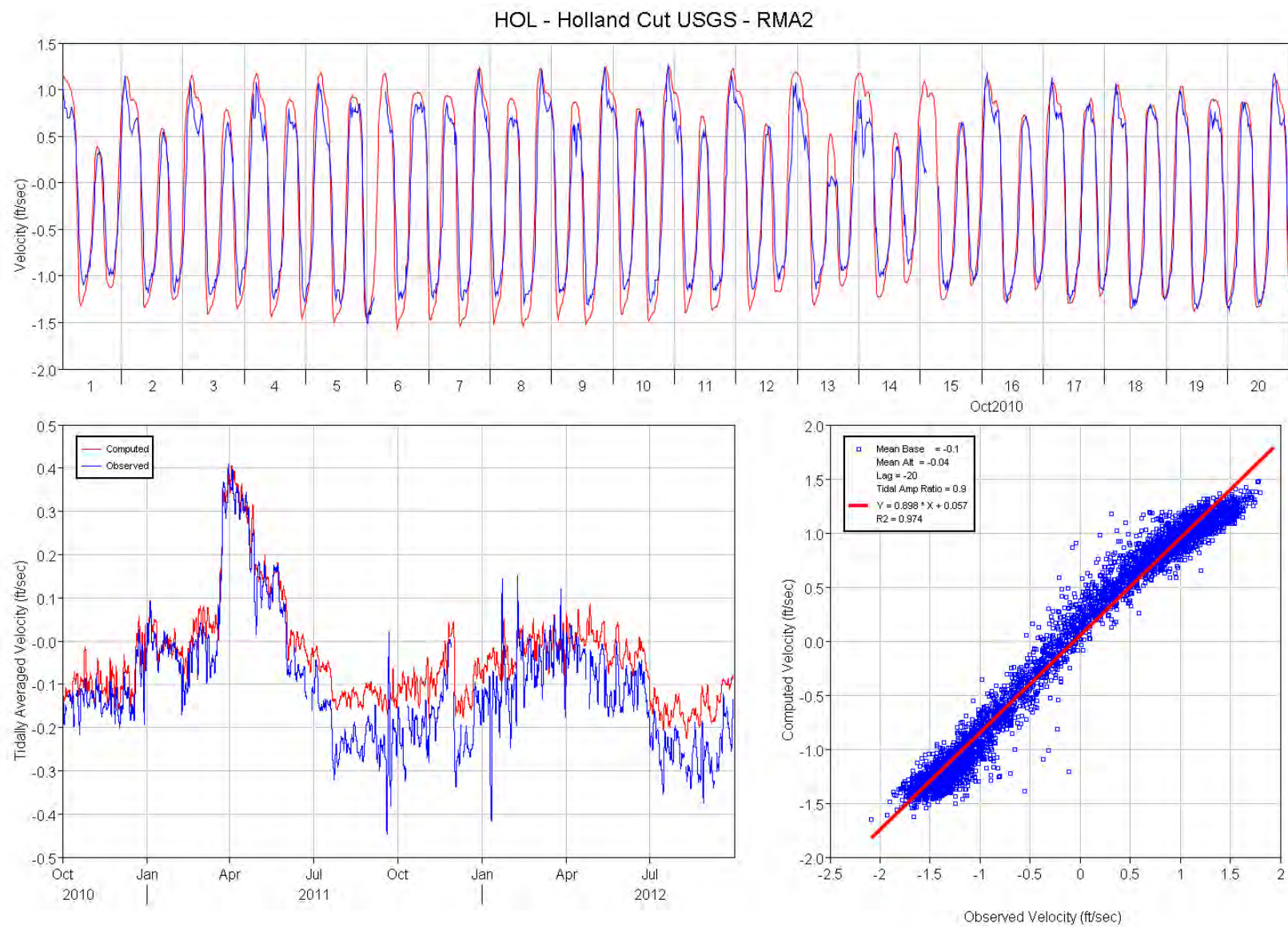


Figure 105 Computed (RMA2) and observed velocity comparison plots for Holland Tract.

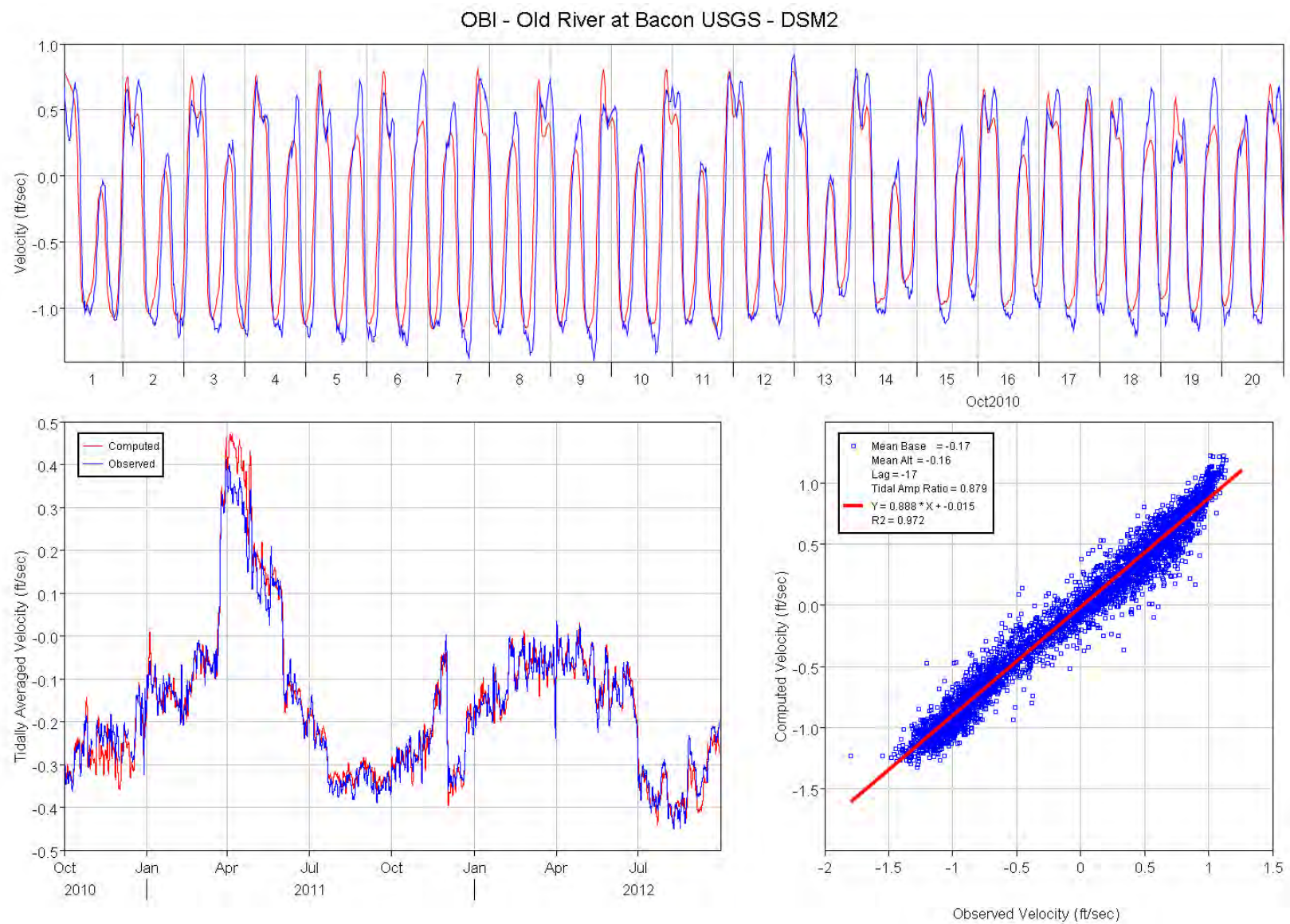


Figure 106 Computed (DSM2) and observed velocity comparison plots for Old River at Bacon Island.



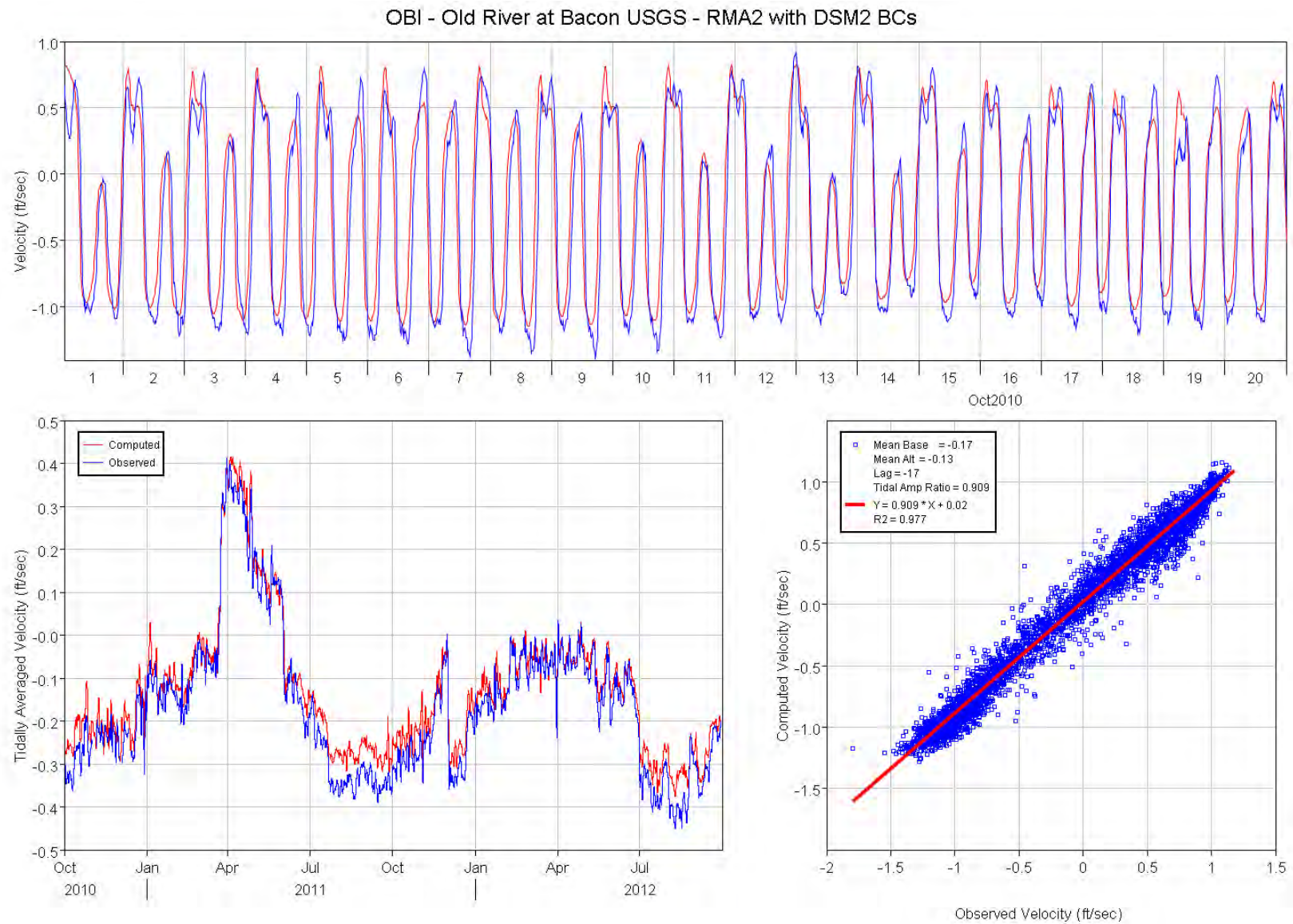


Figure 107 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Bacon Island.

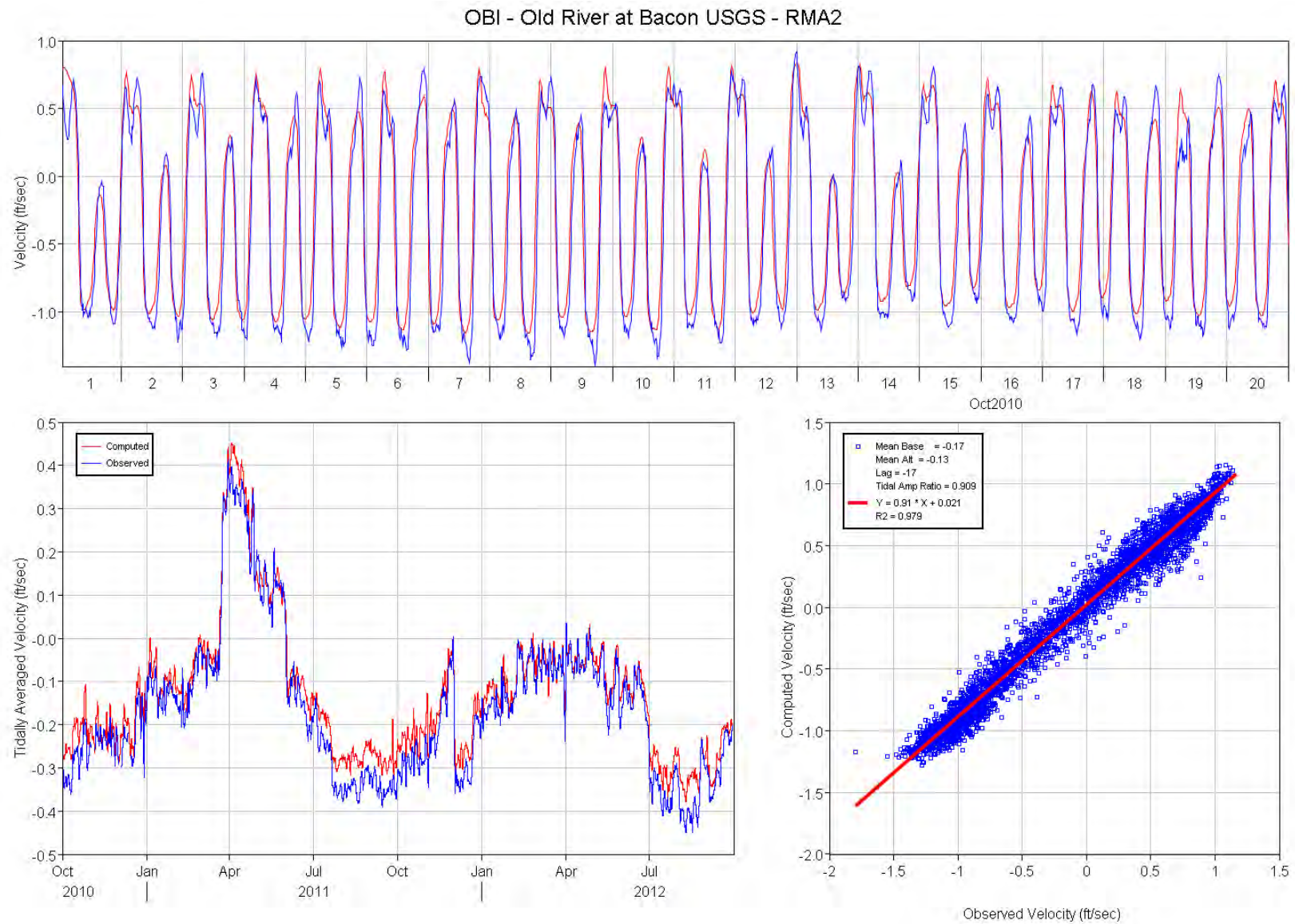


Figure 108 Computed (RMA2) and observed velocity comparison plots for Old River at Bacon Island.



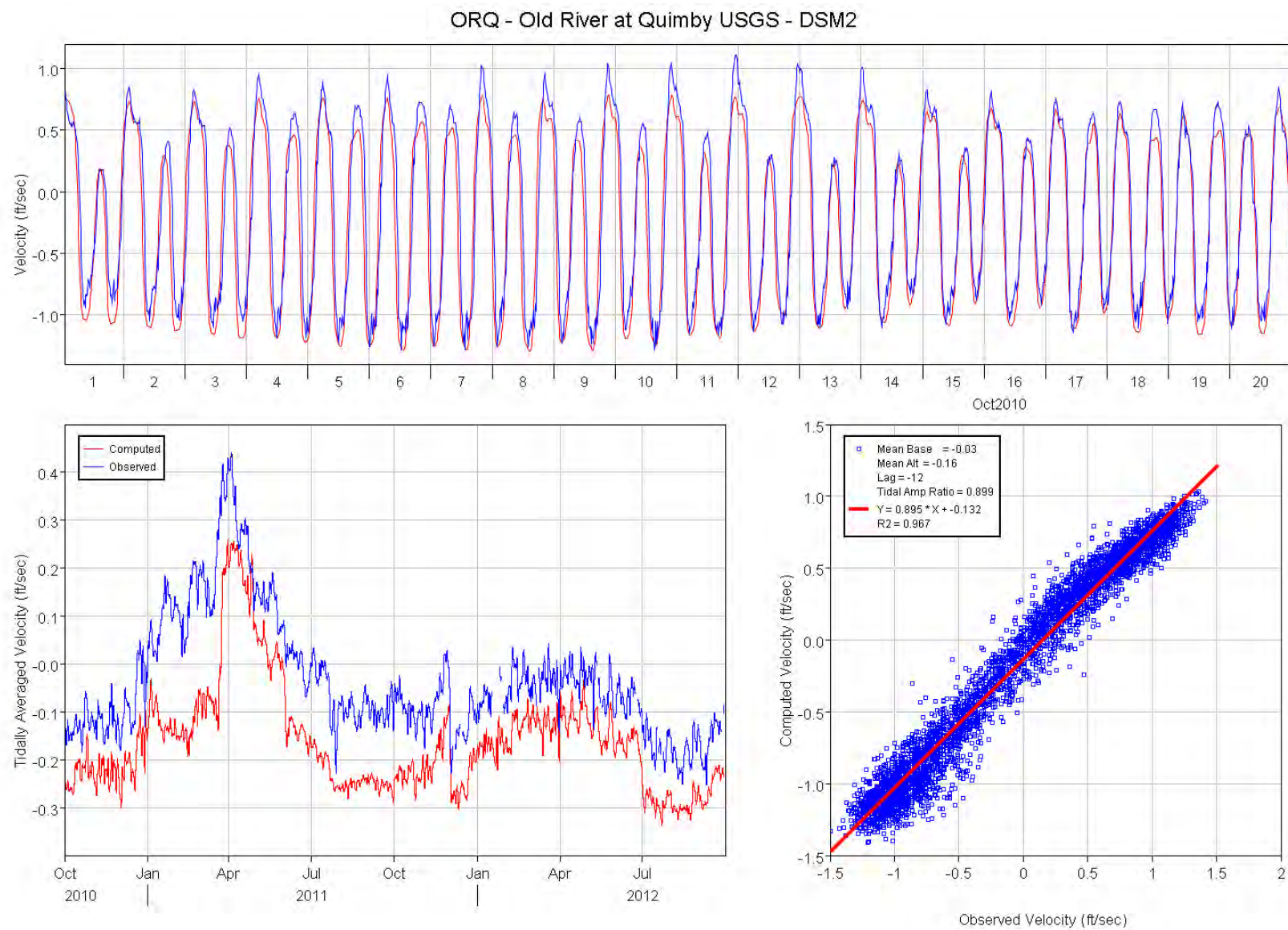


Figure 109 Computed (DSM2) and observed velocity comparison plots for Old River at Quimby.



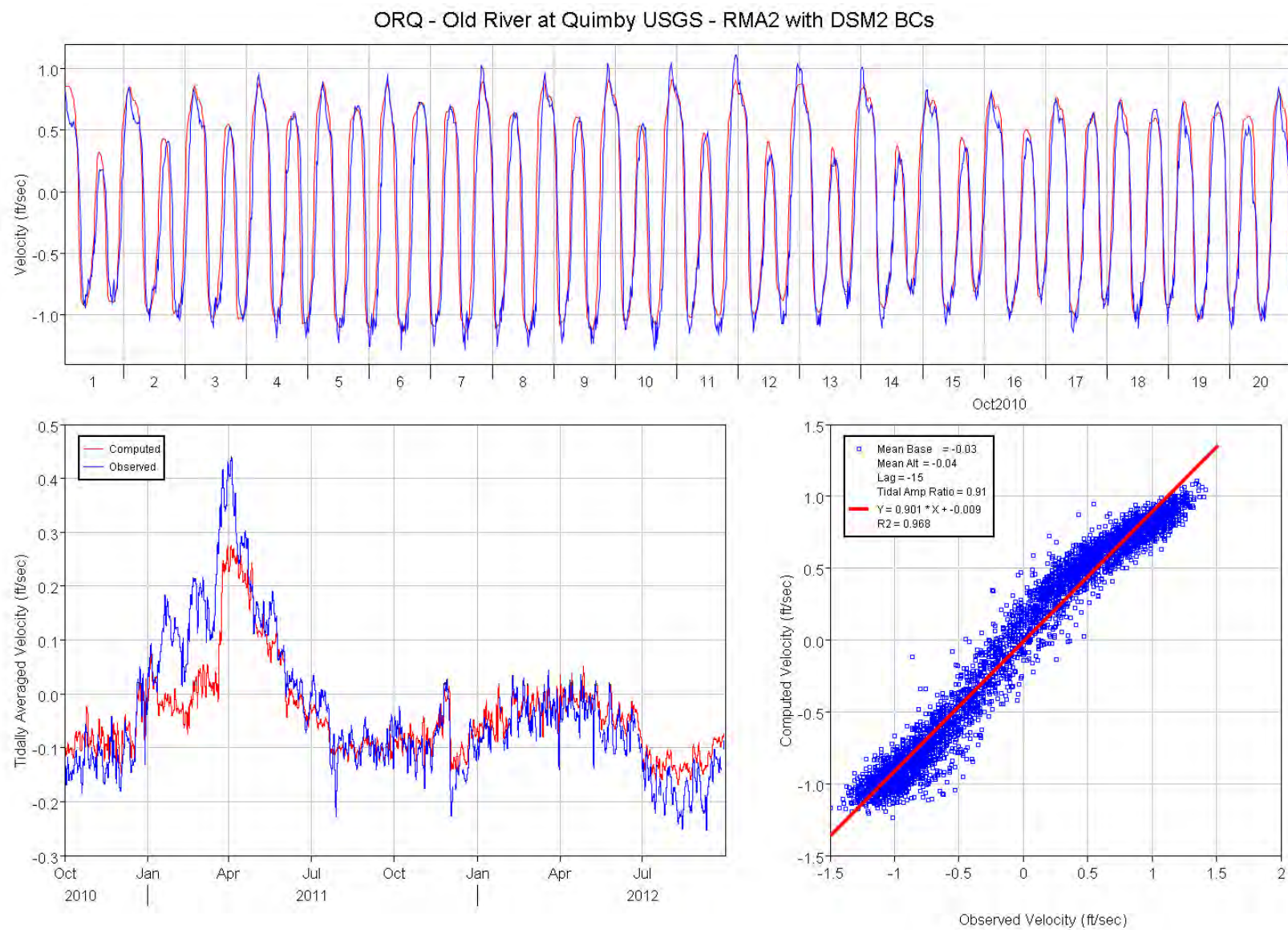


Figure 110 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Quimby.

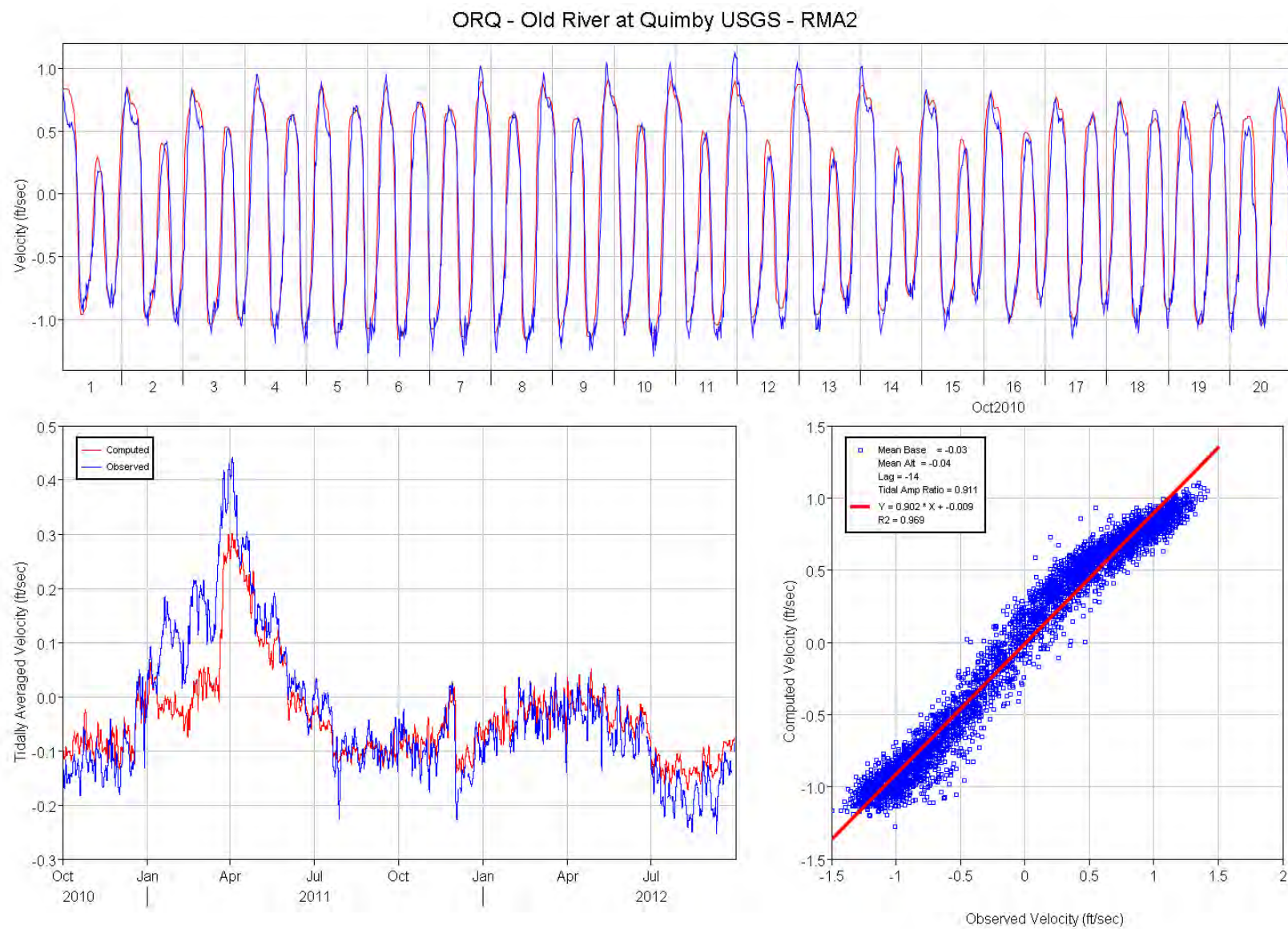


Figure 111 Computed (RMA2) and observed velocity comparison plots for Old River at Quimby.



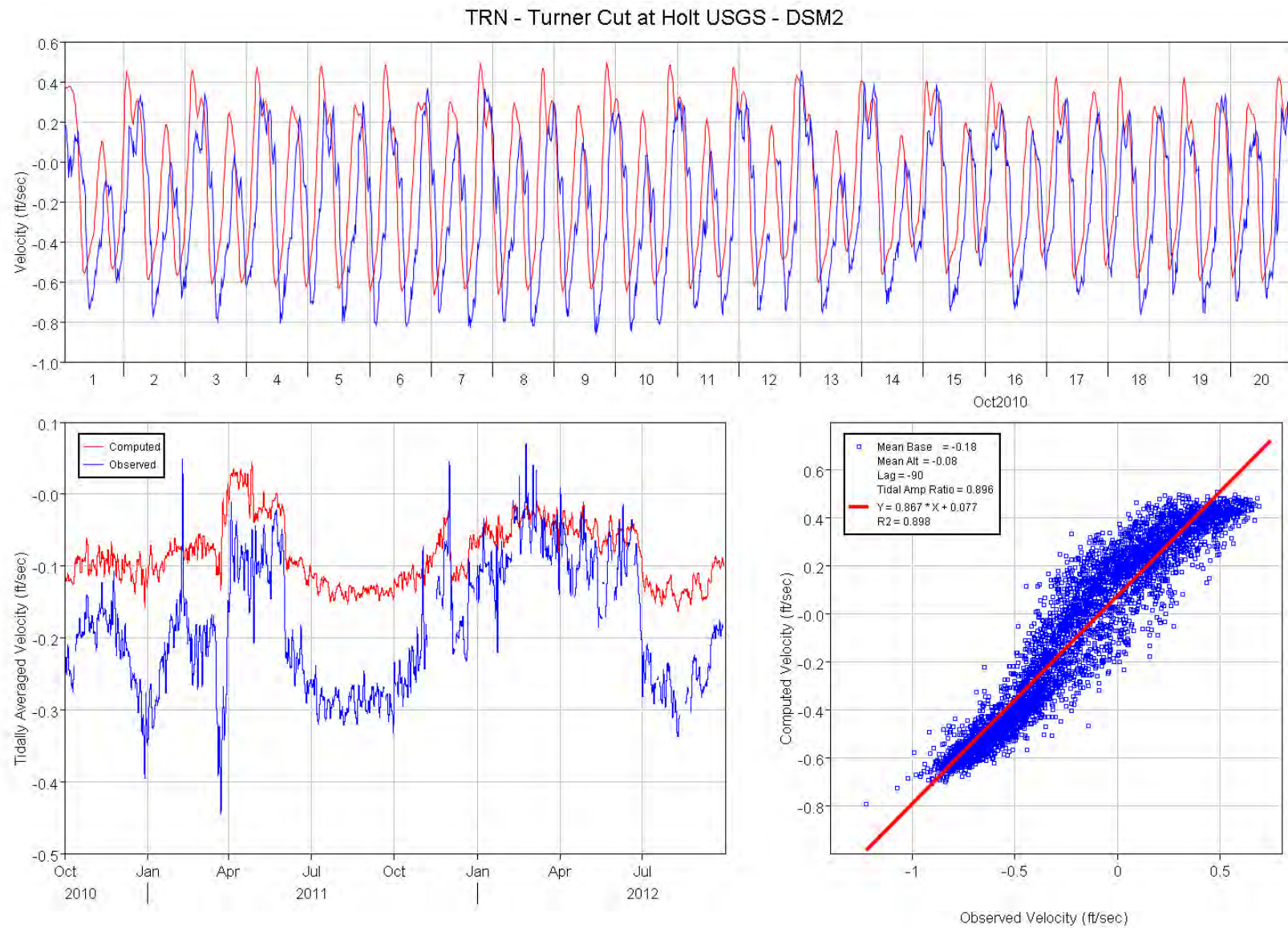


Figure 112 Computed (DSM2) and observed velocity comparison plots for Turner Cut at Holt.



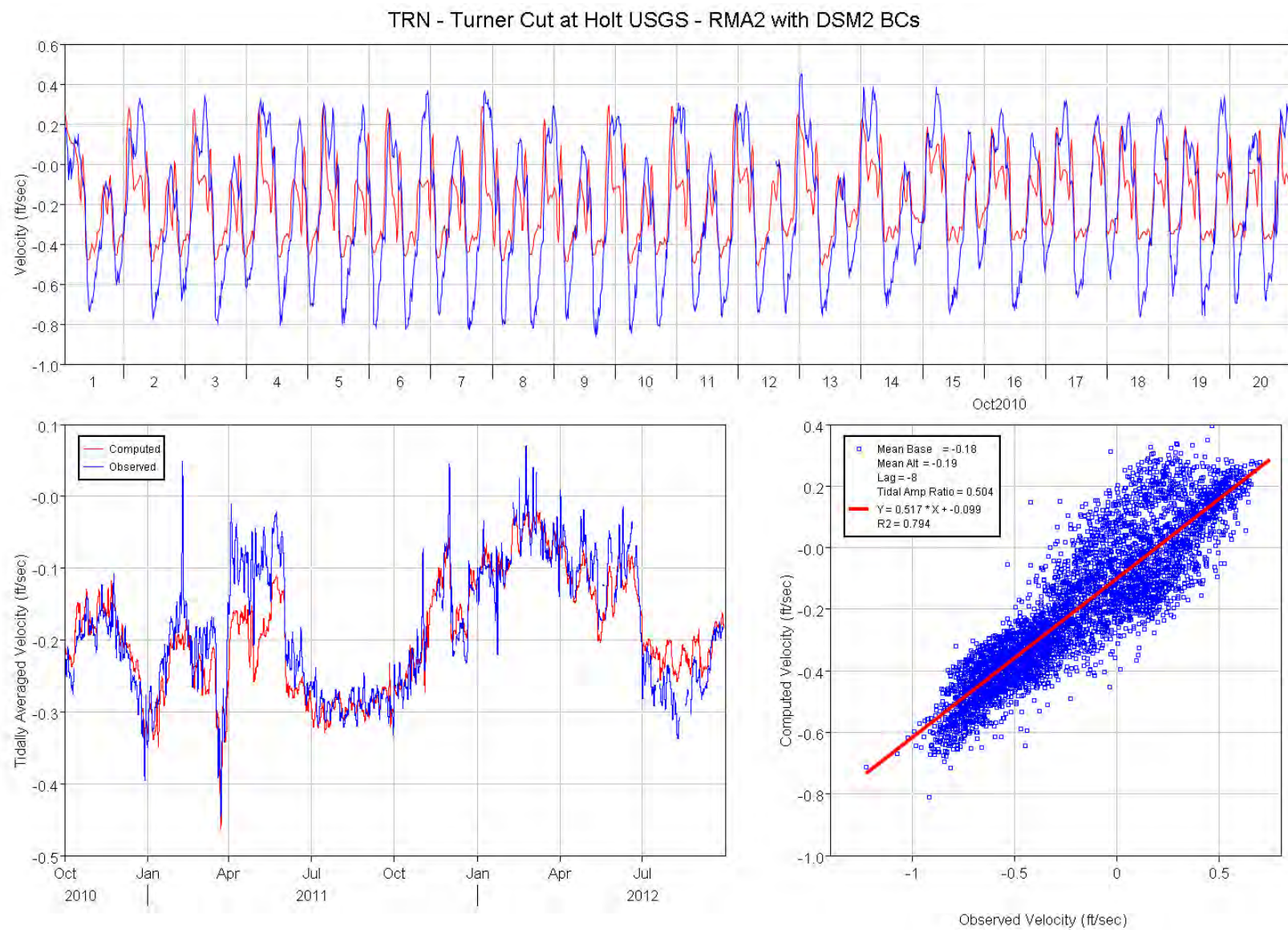


Figure 113 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Turner Cut at Holt.

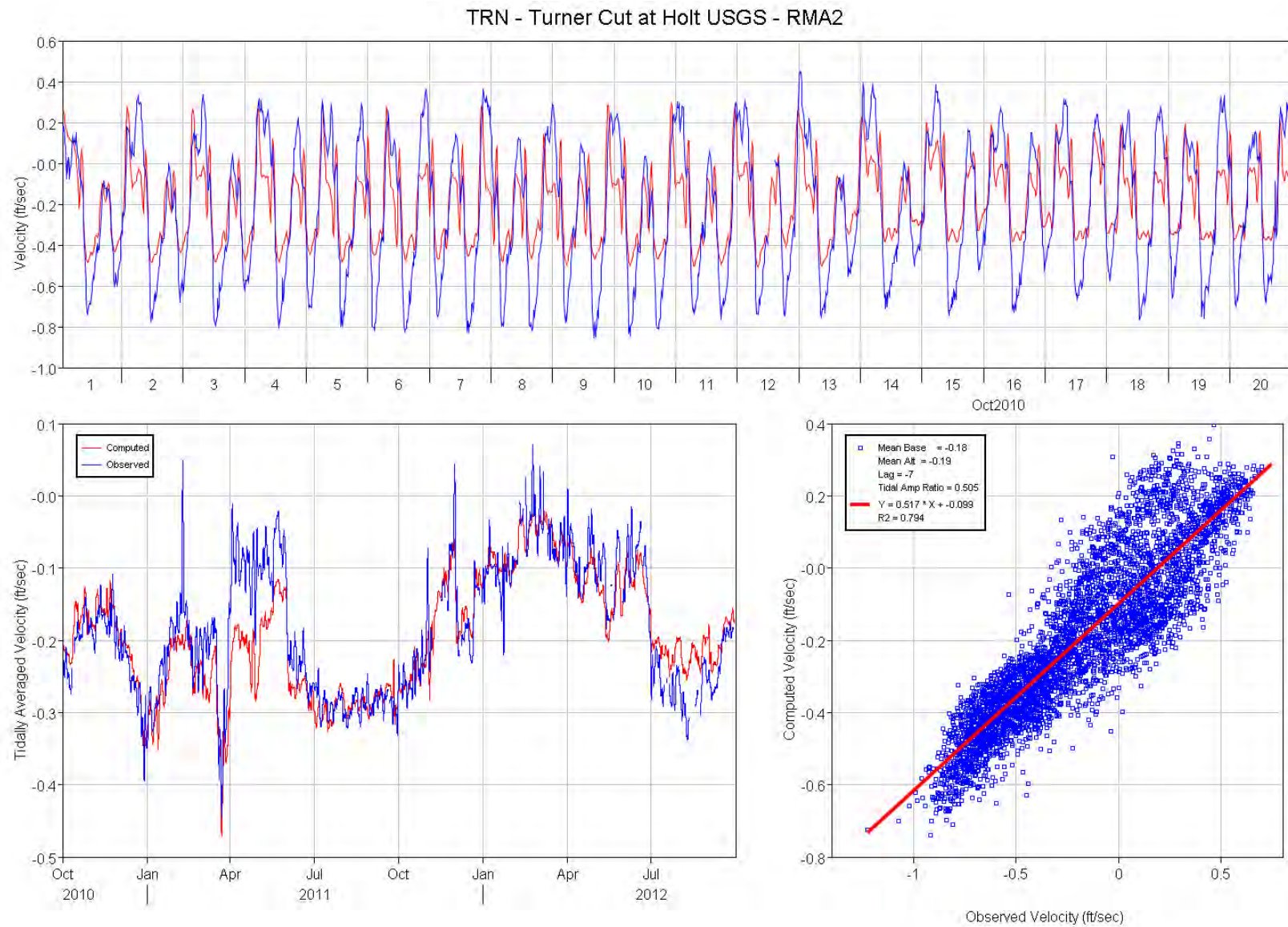


Figure 114 Computed (RMA2) and observed velocity comparison plots for Turner Cut at Holt.



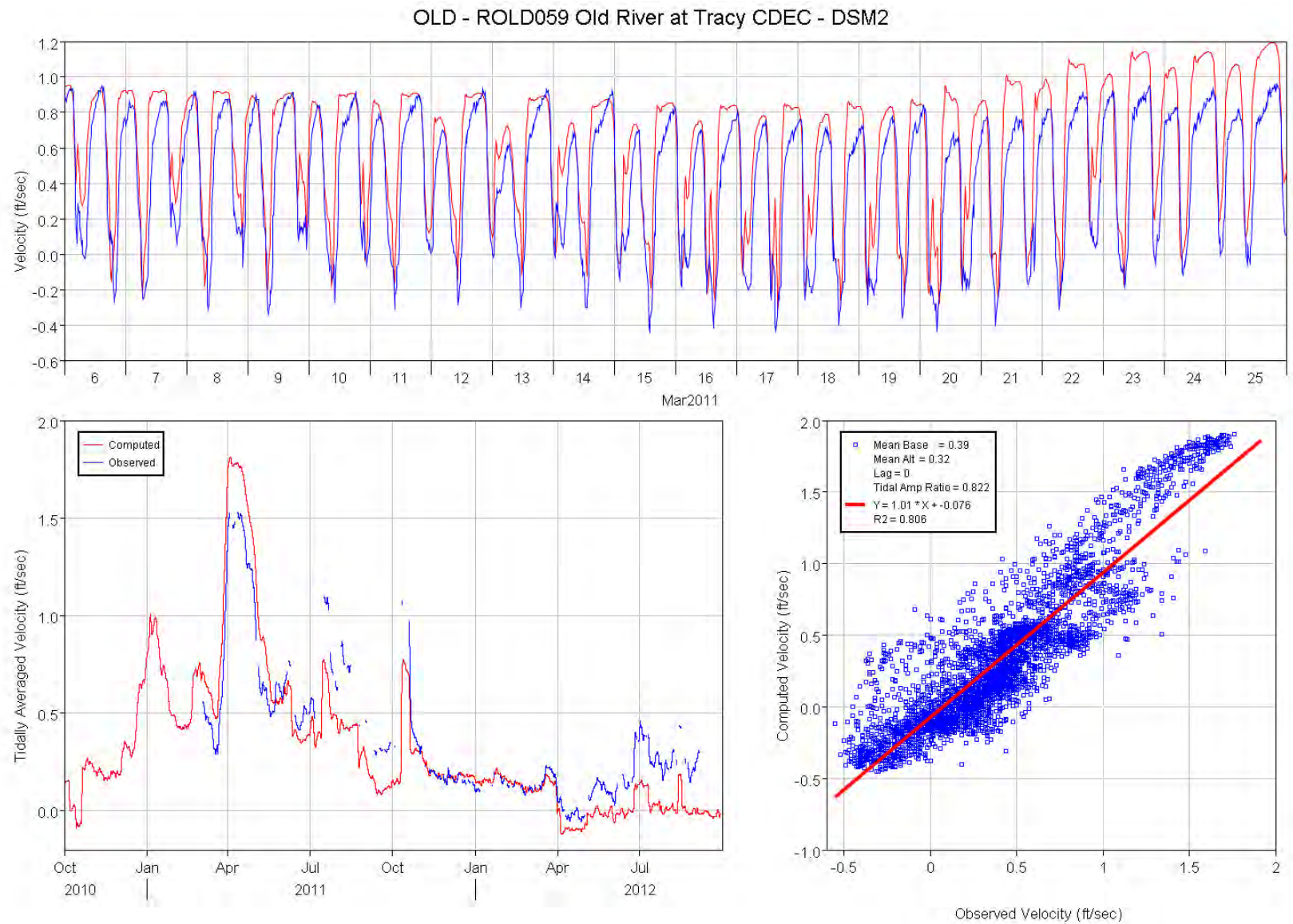


Figure 115 Computed (DSM2) and observed velocity comparison plots for Old River at Tracy.



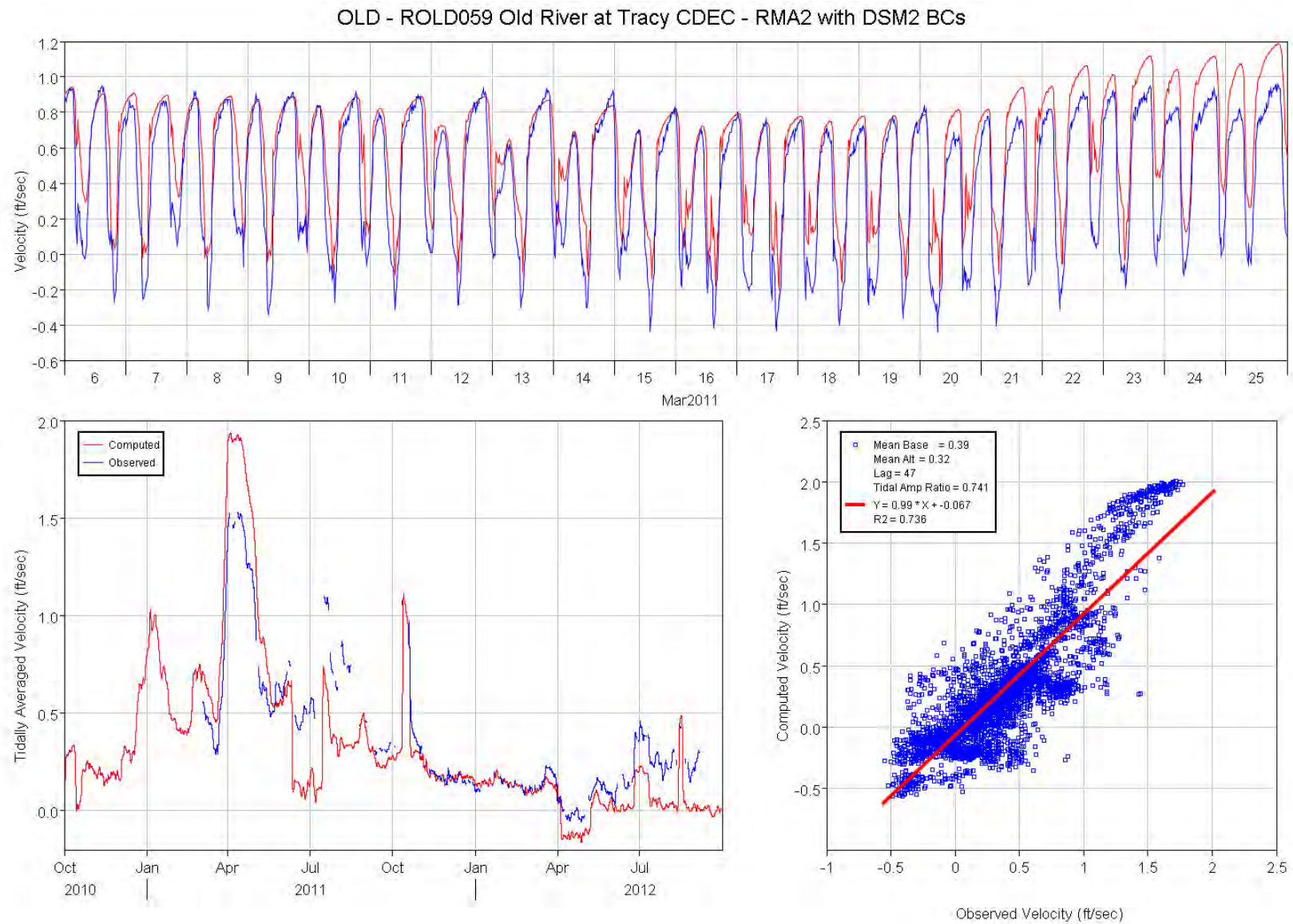


Figure 116 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Tracy.

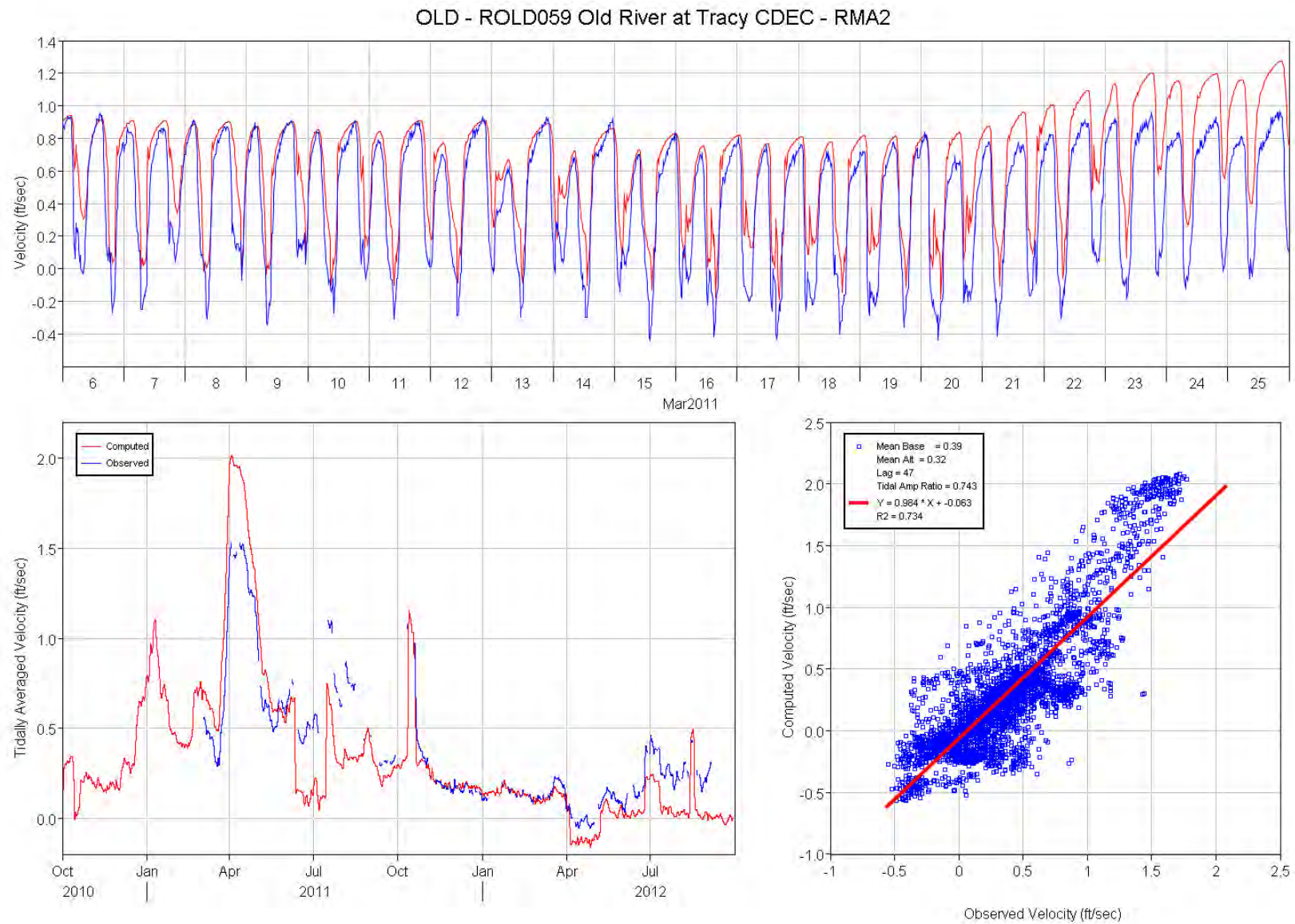


Figure 117 Computed (RMA2) and observed velocity comparison plots for Old River at Tracy.



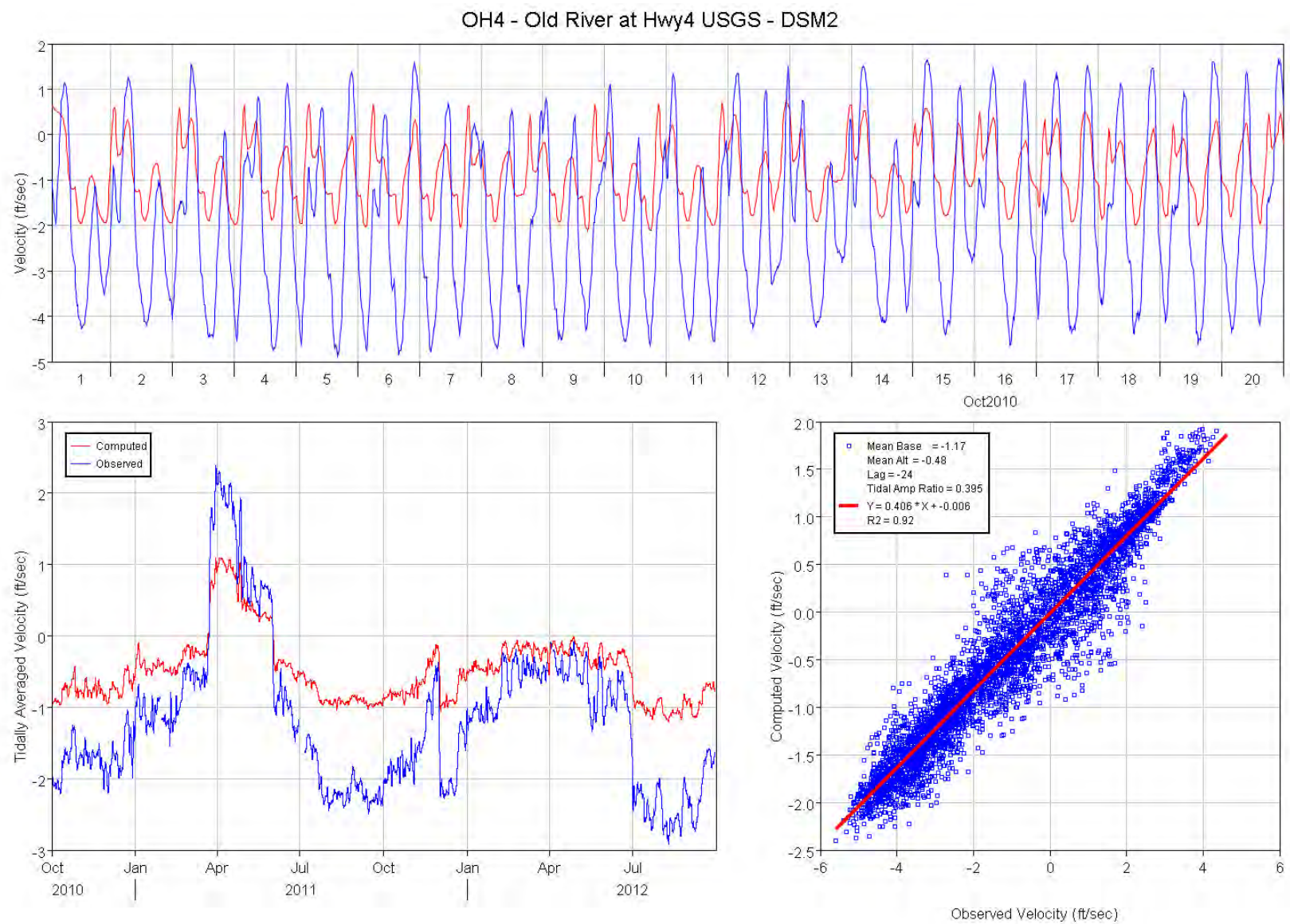


Figure 118 Computed (DSM2) and observed velocity comparison plots for Old River at Hwy 4.



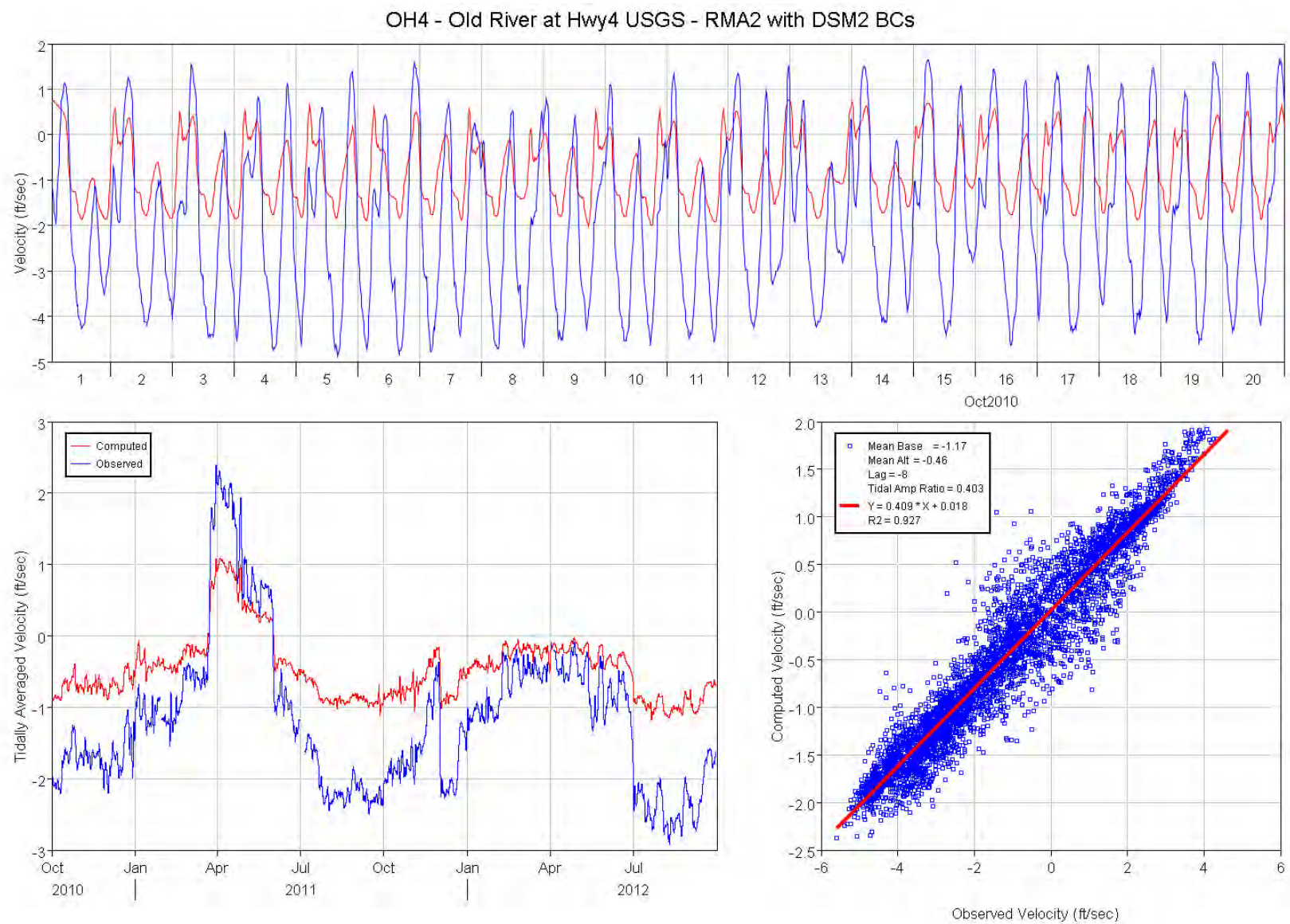


Figure 119 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Hwy 4.

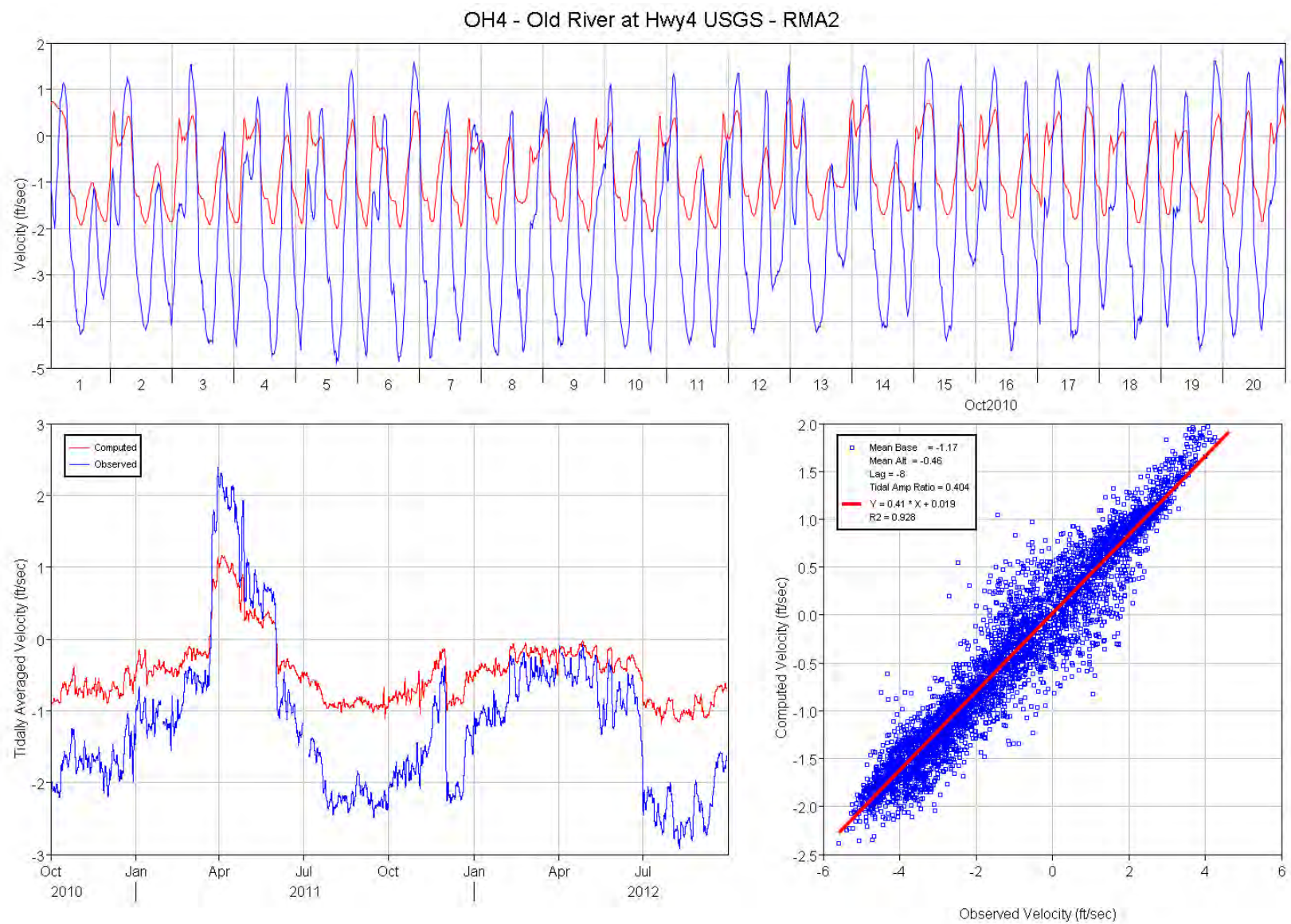


Figure 120 Computed (RMA2) and observed velocity comparison plots for Old River at Hwy 4.



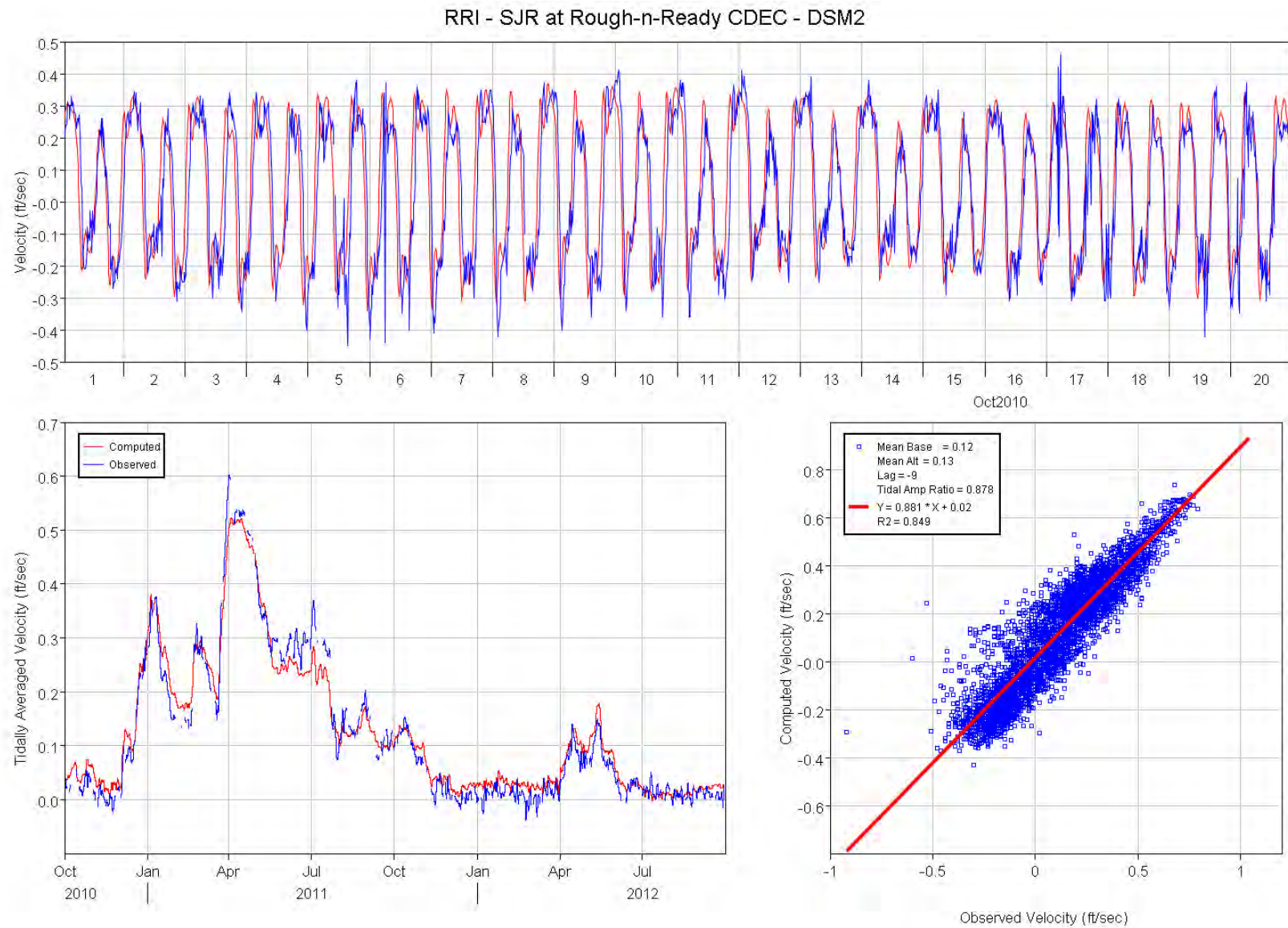


Figure 121 Computed (DSM2) and observed velocity comparison plots for SJR at Rough-n-Ready.



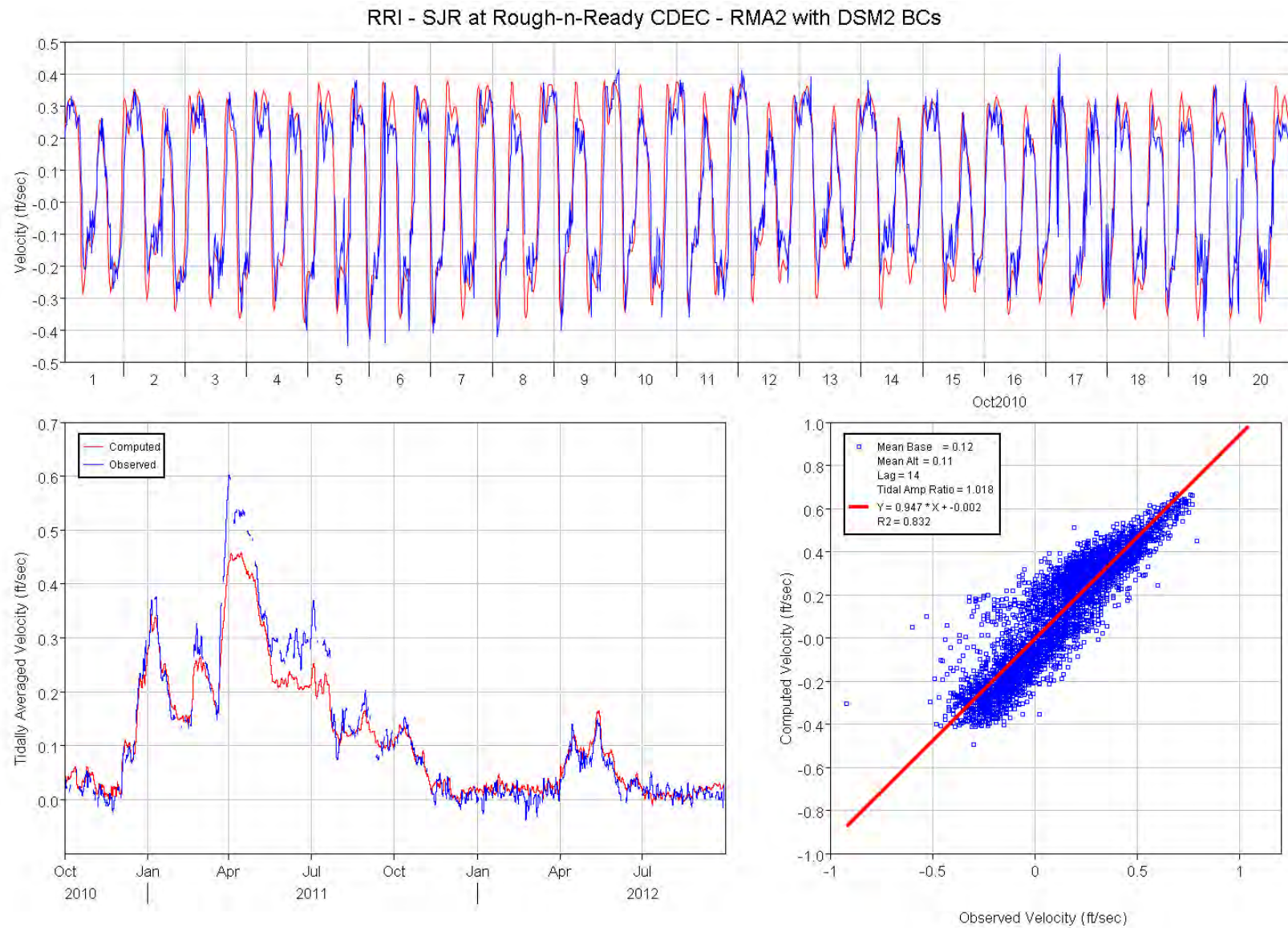


Figure 122 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for SJR at Rough-n-Ready.

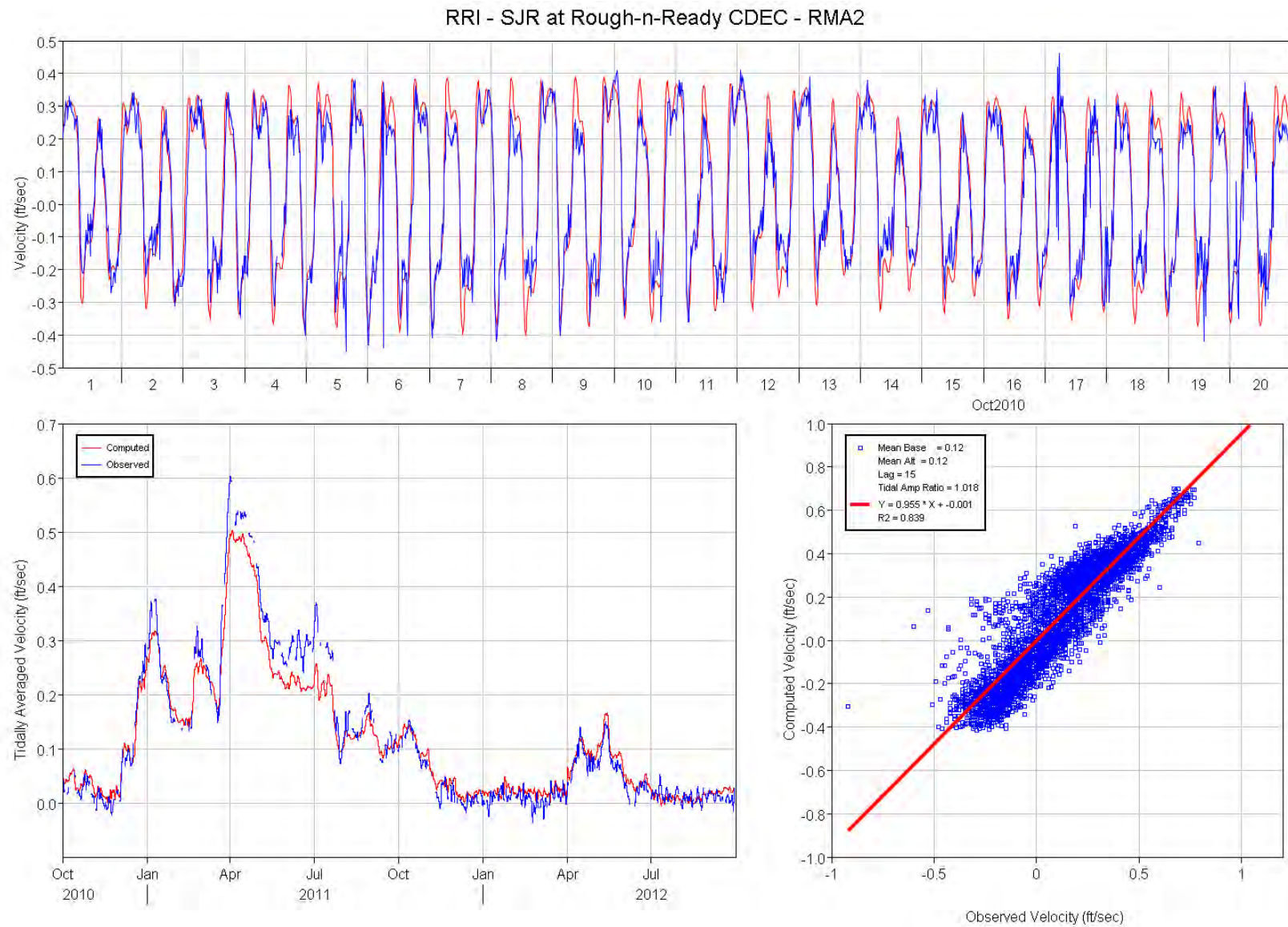


Figure 123 Computed (RMA2) and observed velocity comparison plots for SJR at Rough-n-Ready.



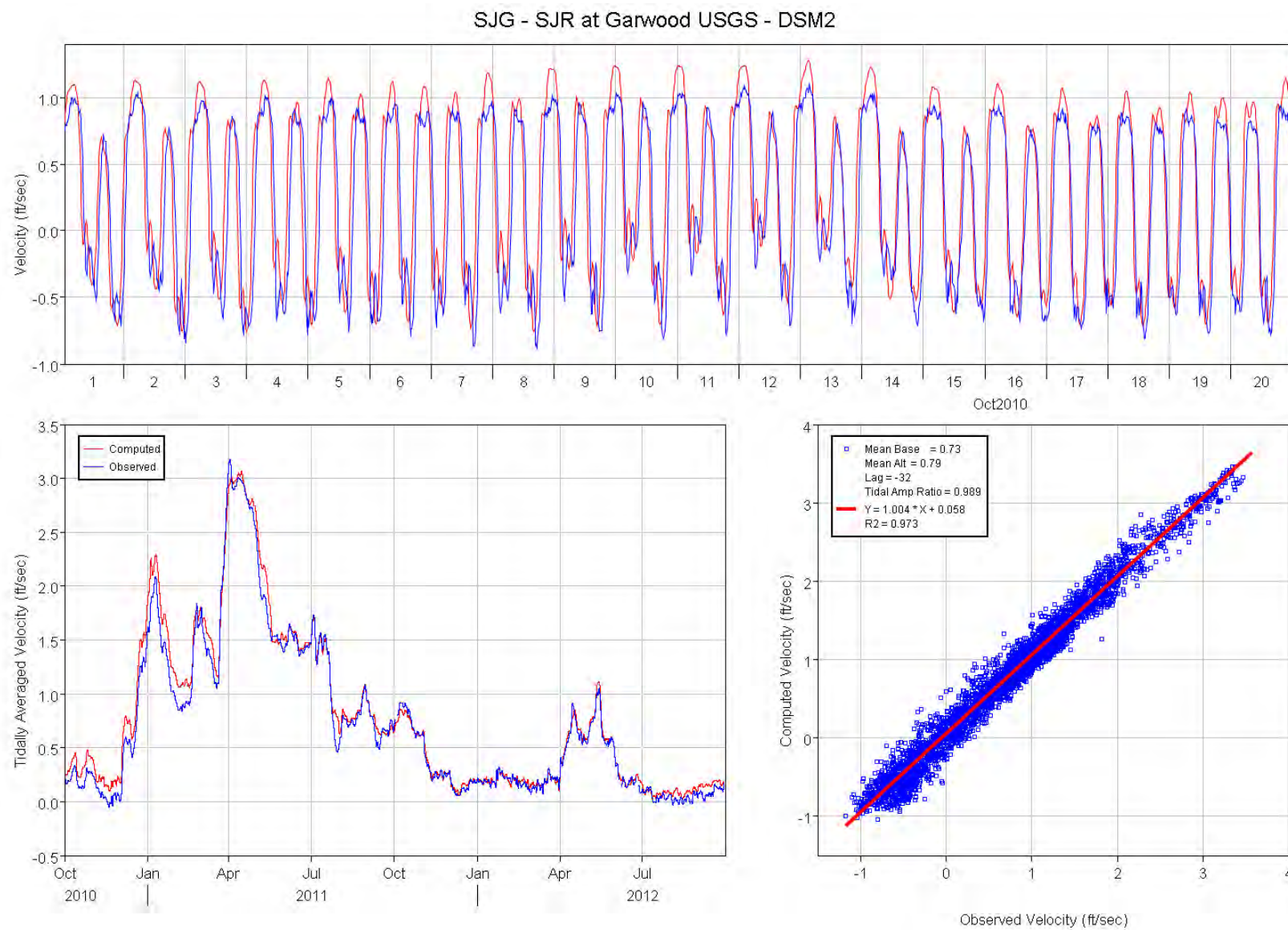


Figure 124 Computed (DSM2) and observed velocity comparison plots for SJR at Garwood.



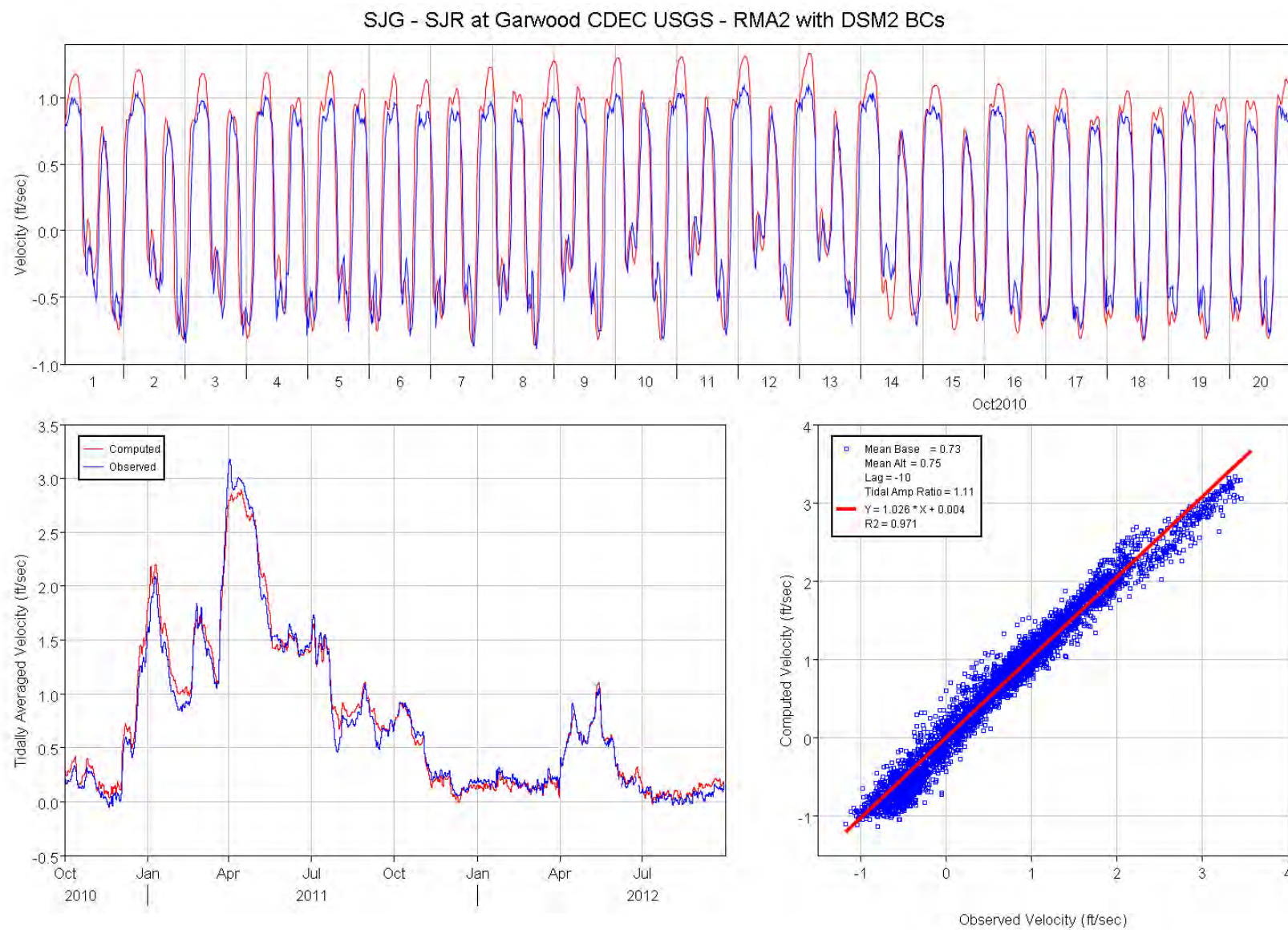


Figure 125 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for SJR at Garwood.

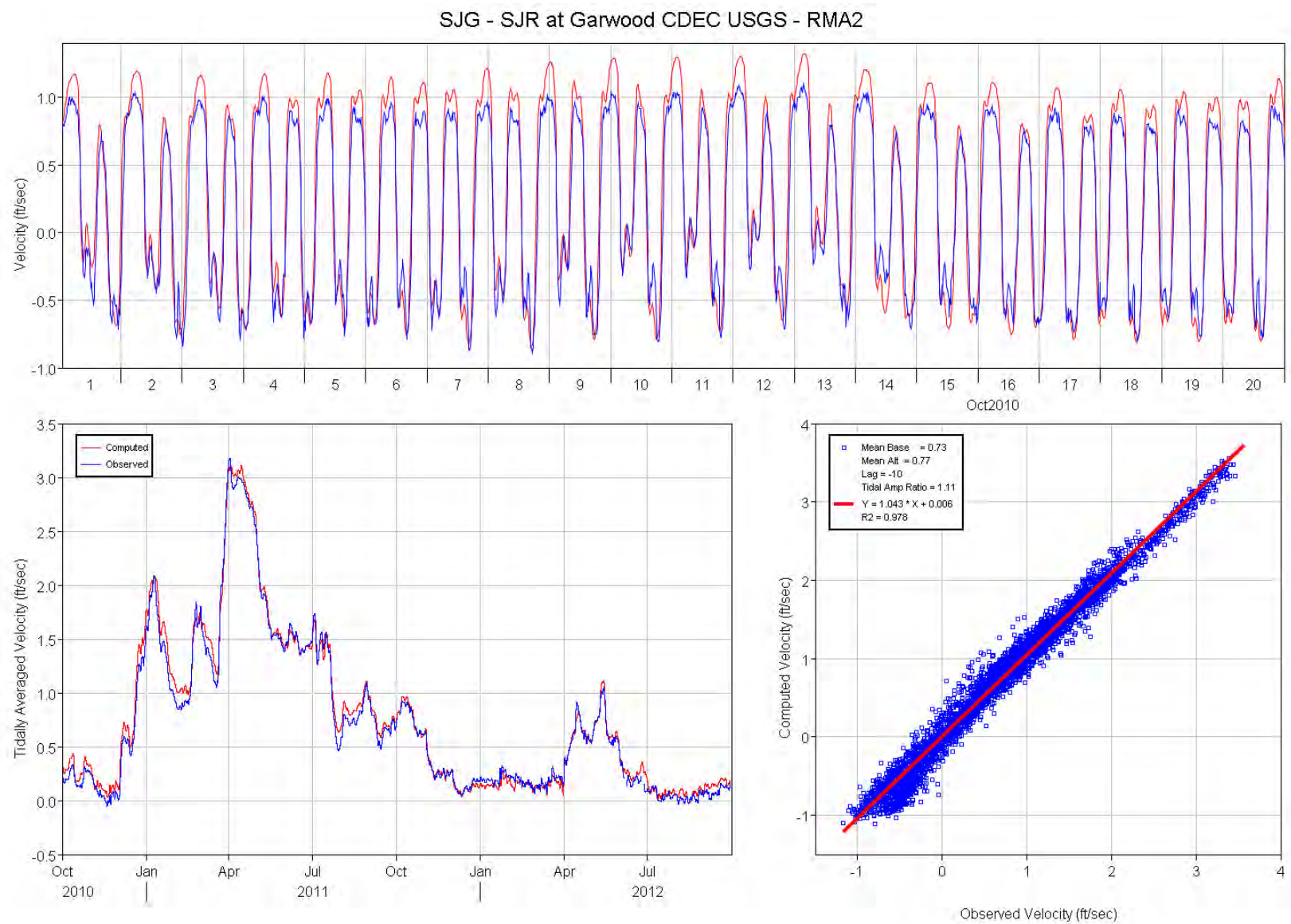


Figure 126 Computed (RMA2) and observed velocity comparison plots for SJR at Garwood.

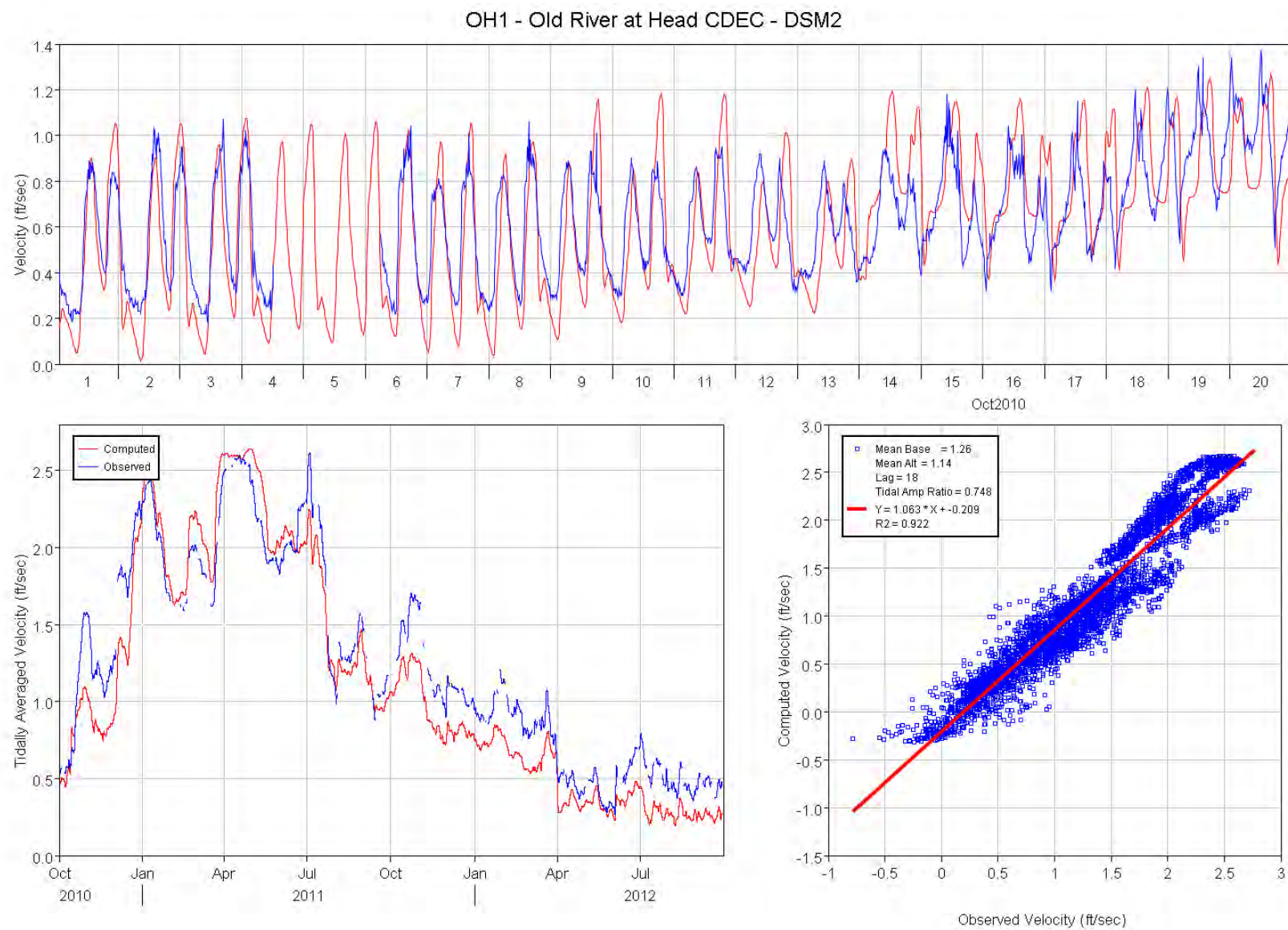


Figure 127 Computed (DSM2) and observed velocity comparison plots for Old River at Head.



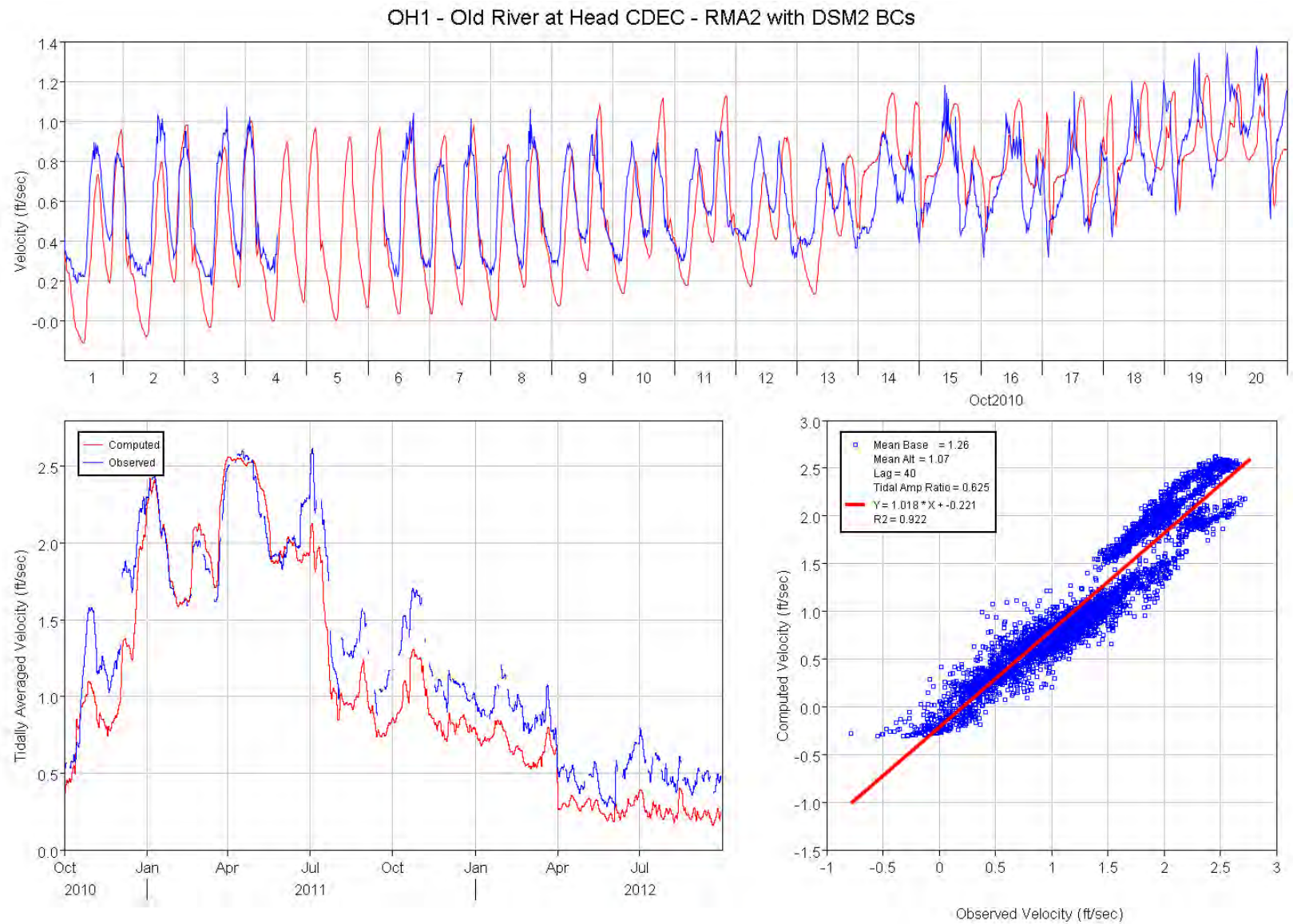


Figure 128 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Head.

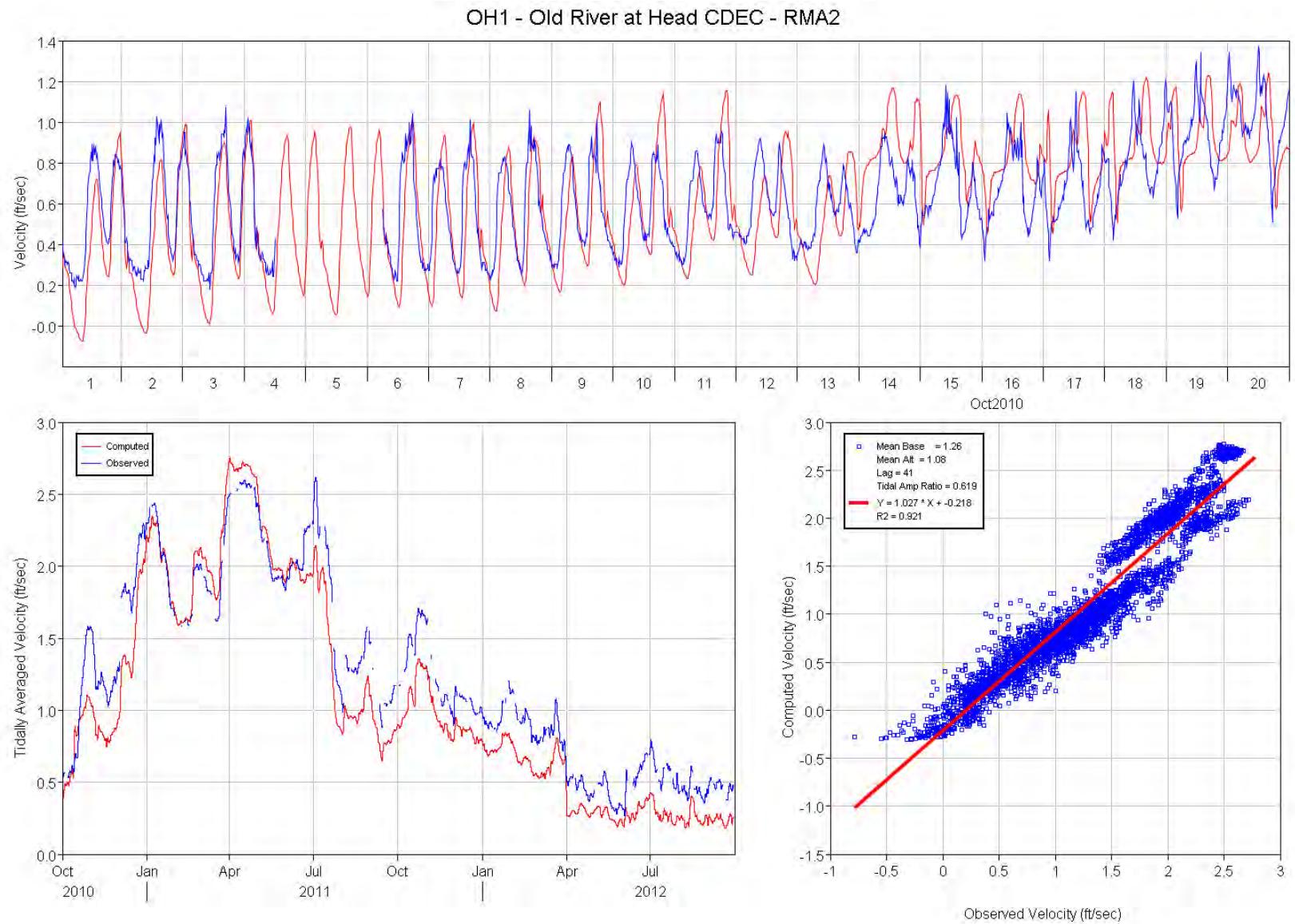


Figure 129 Computed (RMA2) and observed velocity comparison plots for Old River at Head.



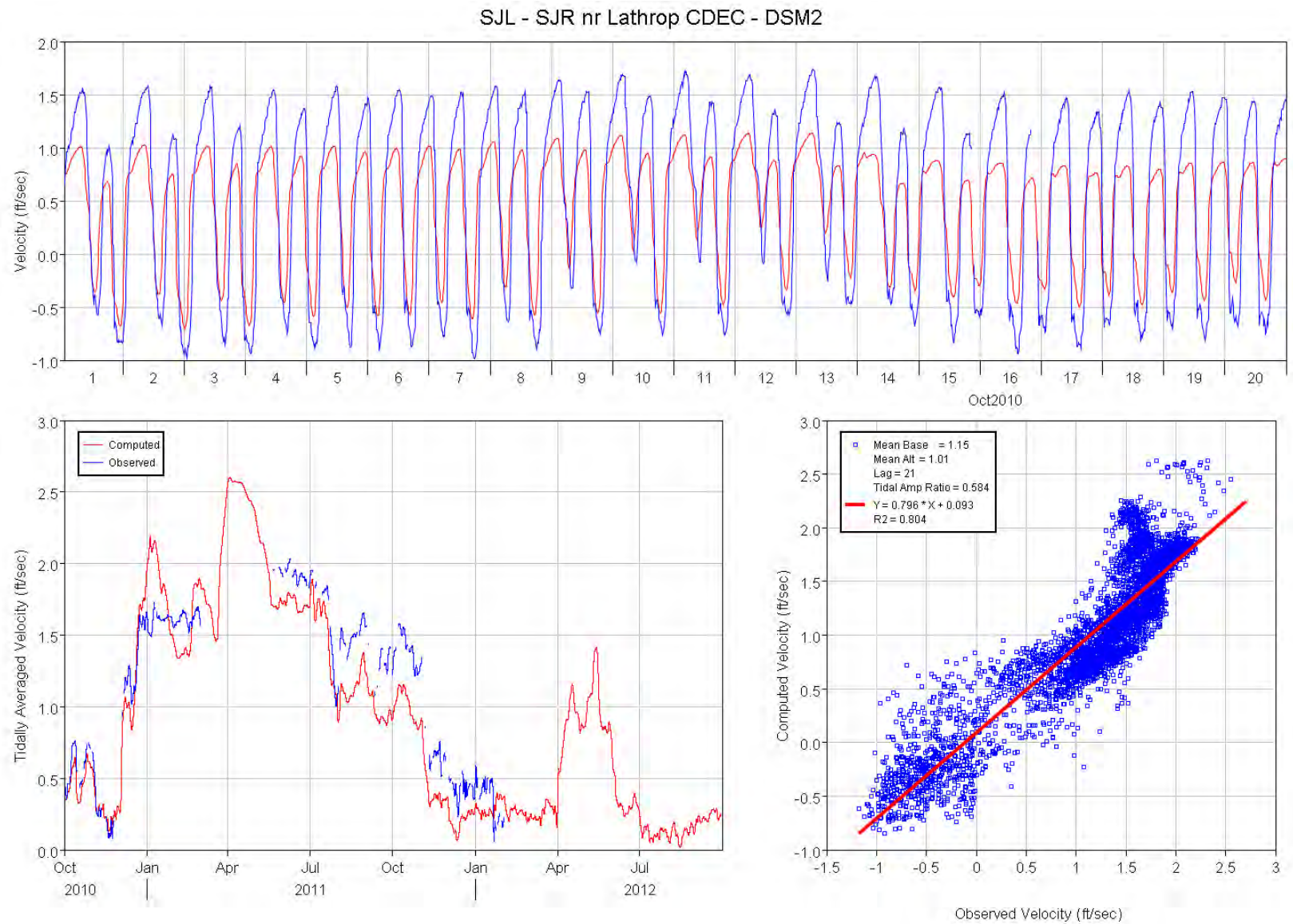


Figure 130 Computed (DSM2) and observed velocity comparison plots for SJR near Lathrop.



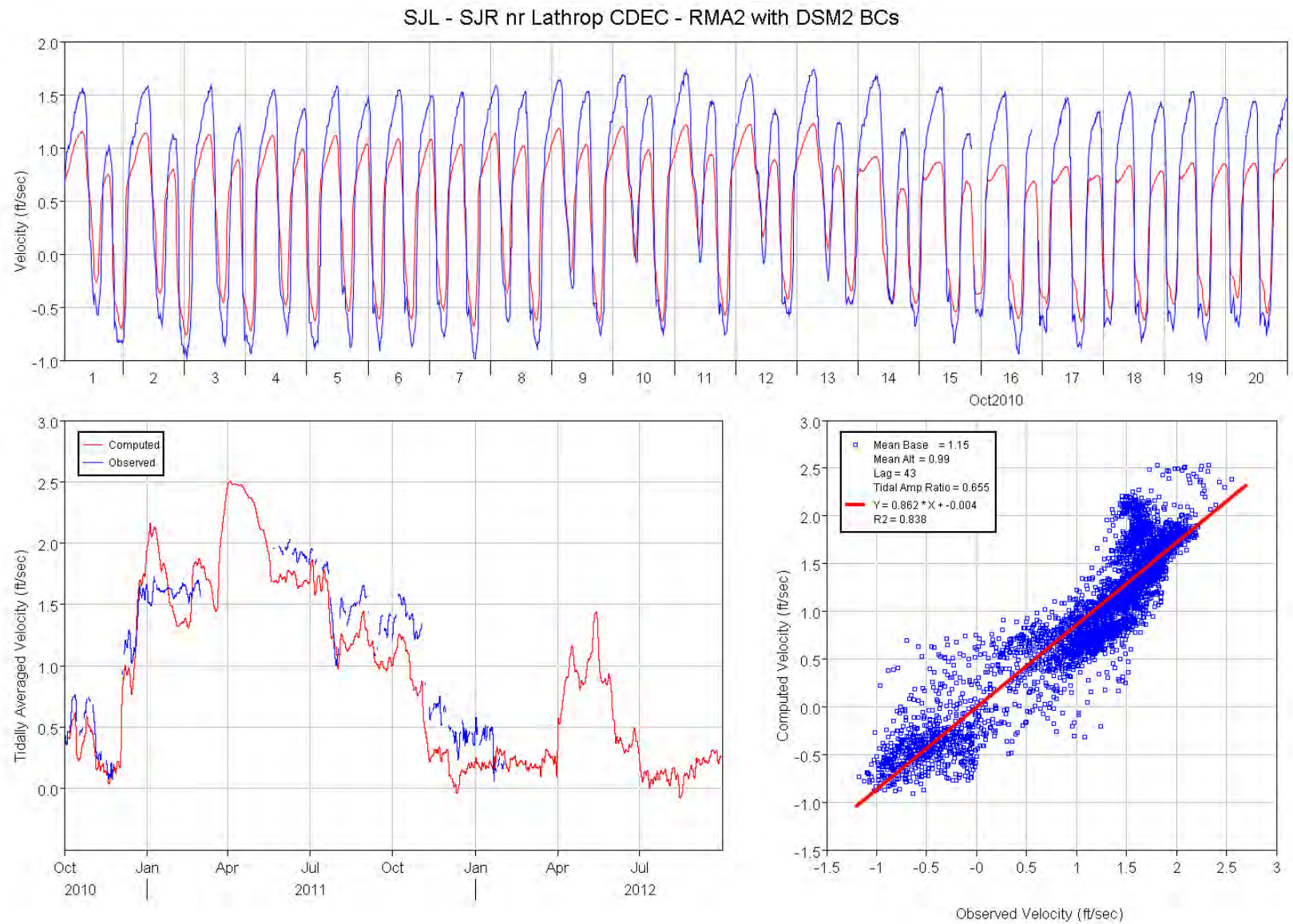


Figure 131 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for SJR near Lathrop.

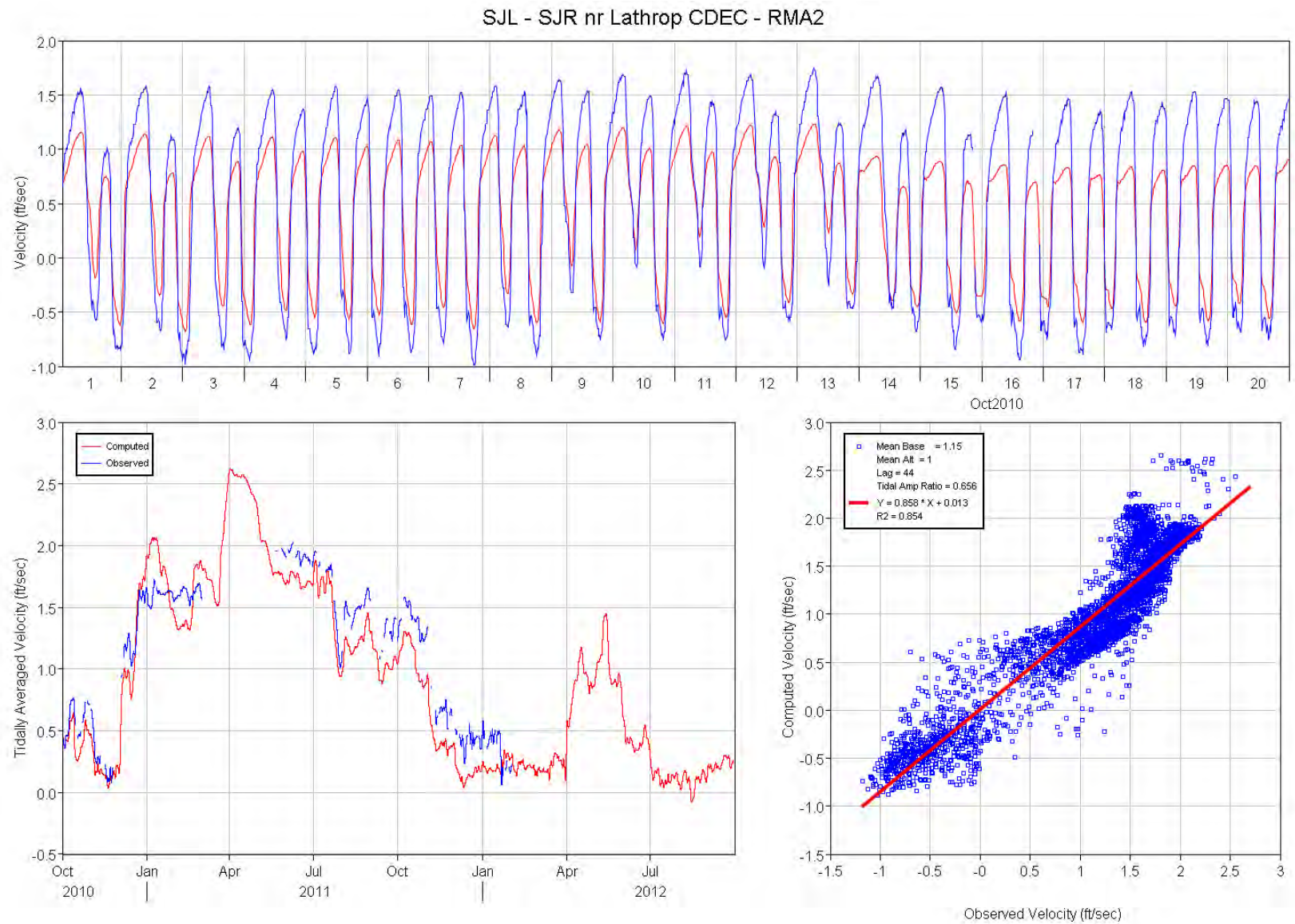


Figure 132 Computed (RMA2) and observed velocity comparison plots for SJR near Lathrop.



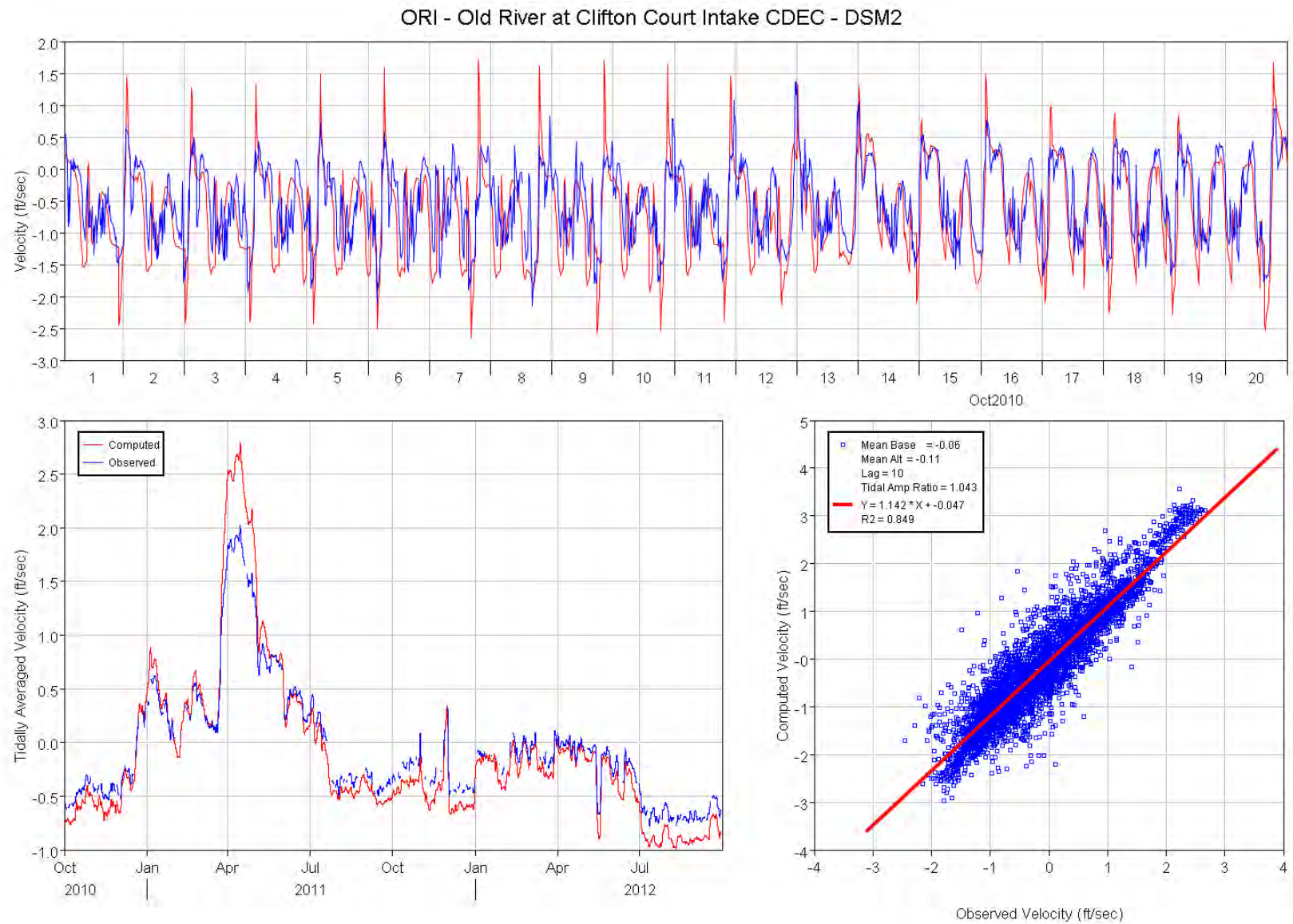


Figure 133 Computed (DSM2) and observed velocity comparison plots for Old River at Clifton Court Intake.



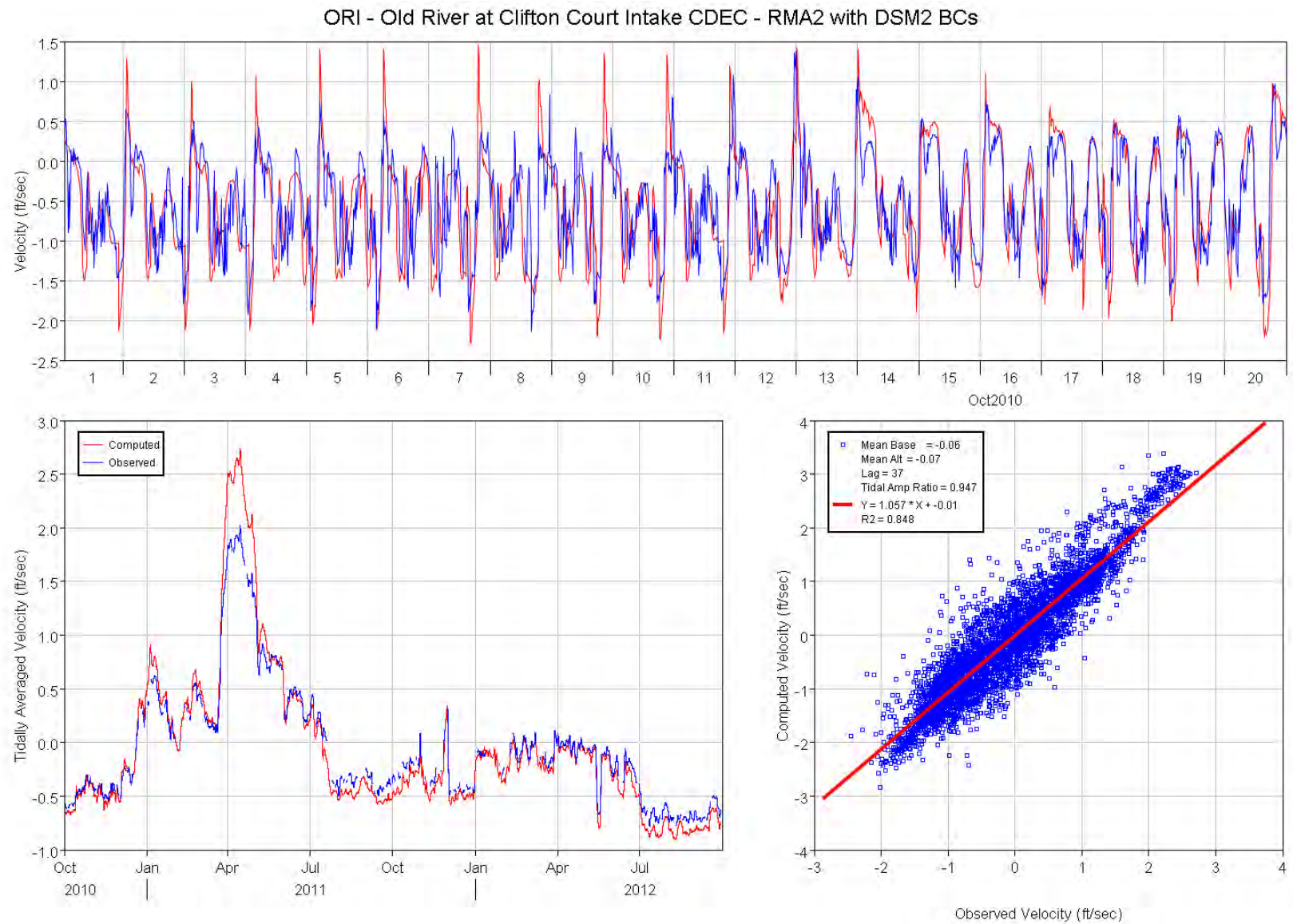


Figure 134 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for Old River at Clifton Court Intake.

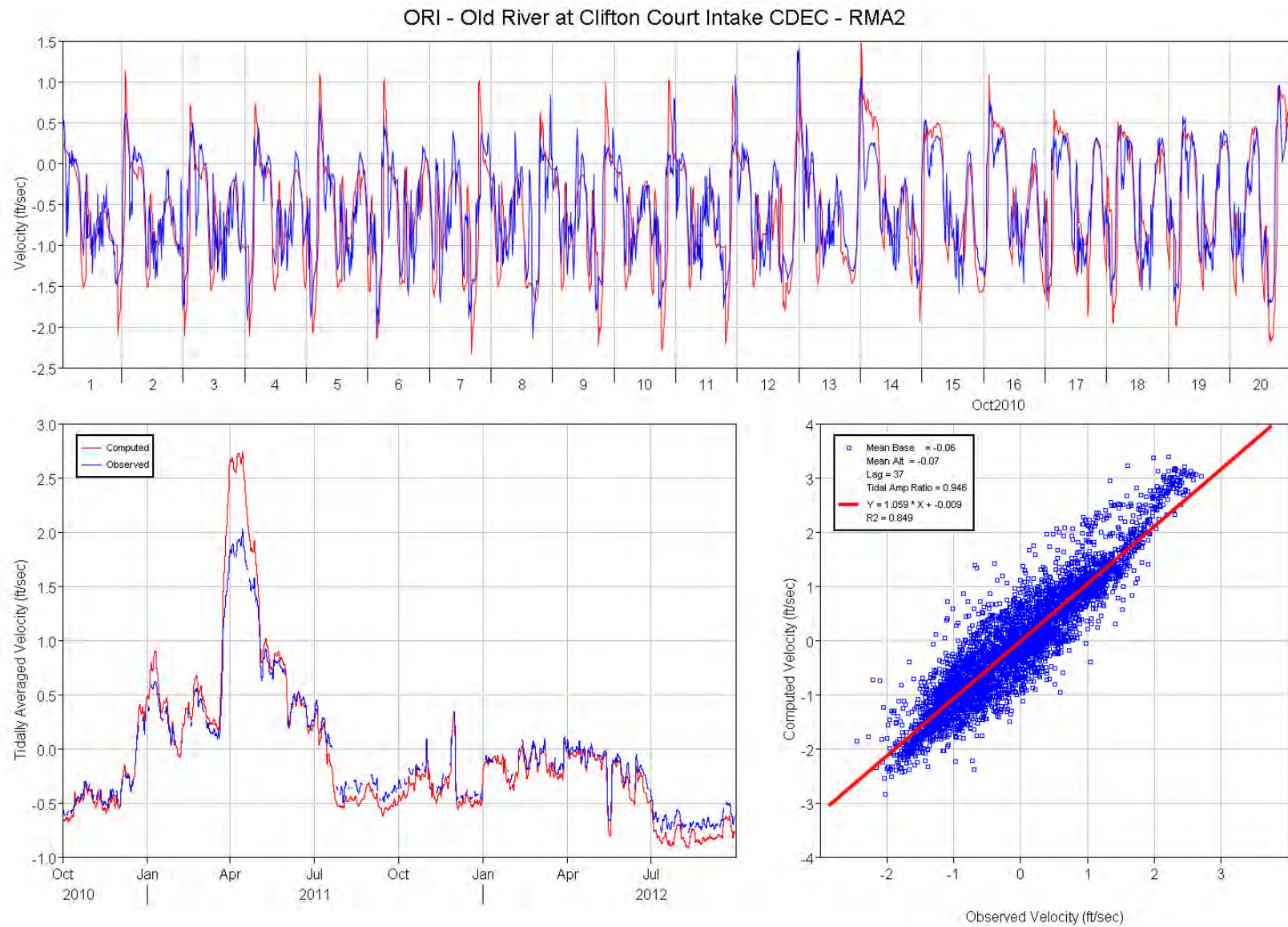


Figure 135 Computed (RMA2) and observed velocity comparison plots for Old River at Clifton Court Intake.



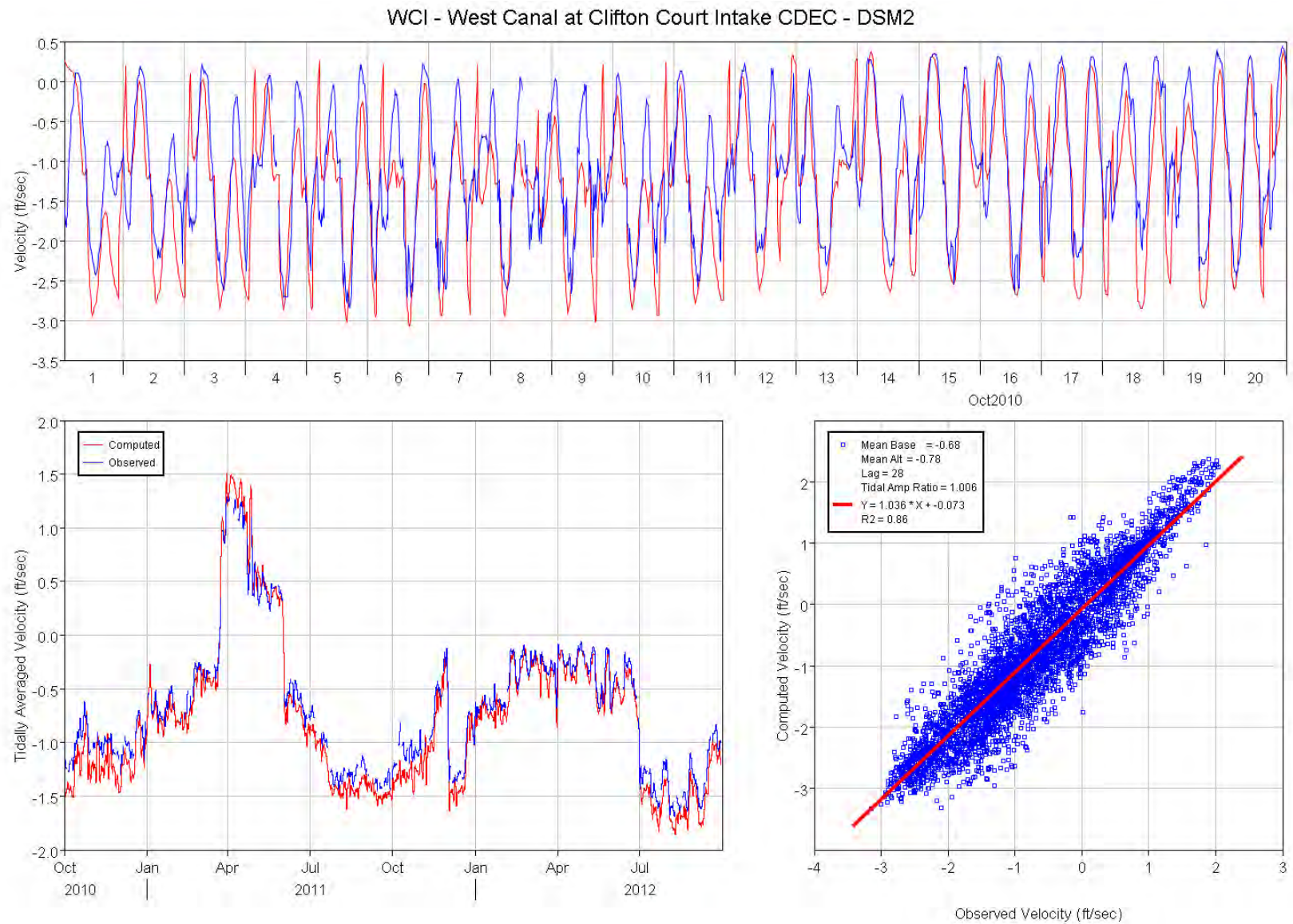


Figure 136 Computed (DSM2) and observed velocity comparison plots for West Canal at Clifton Court Intake.



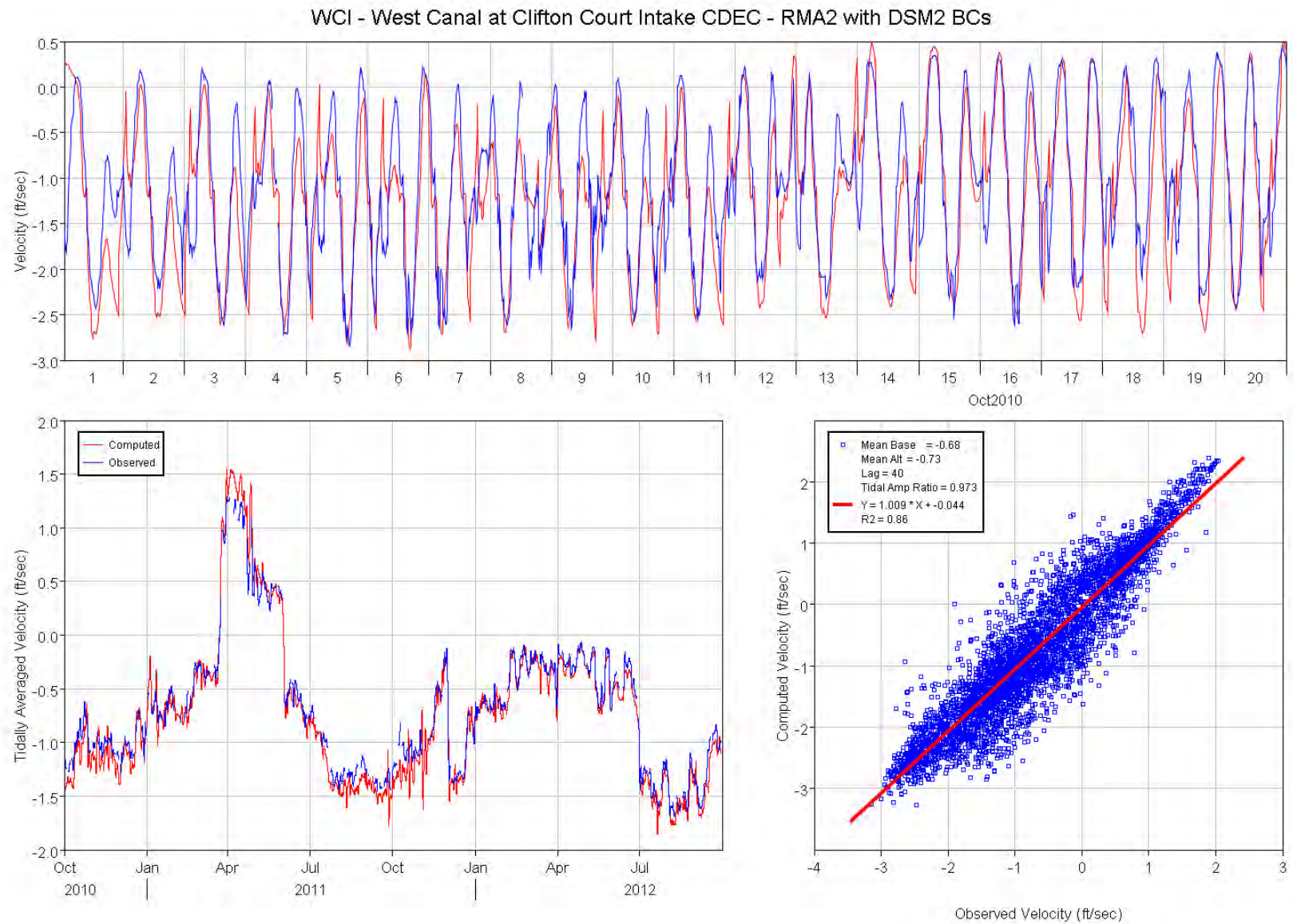


Figure 137 Computed (RMA2 with DSM2 BCs) and observed velocity comparison plots for West Canal at Clifton Court Intake.

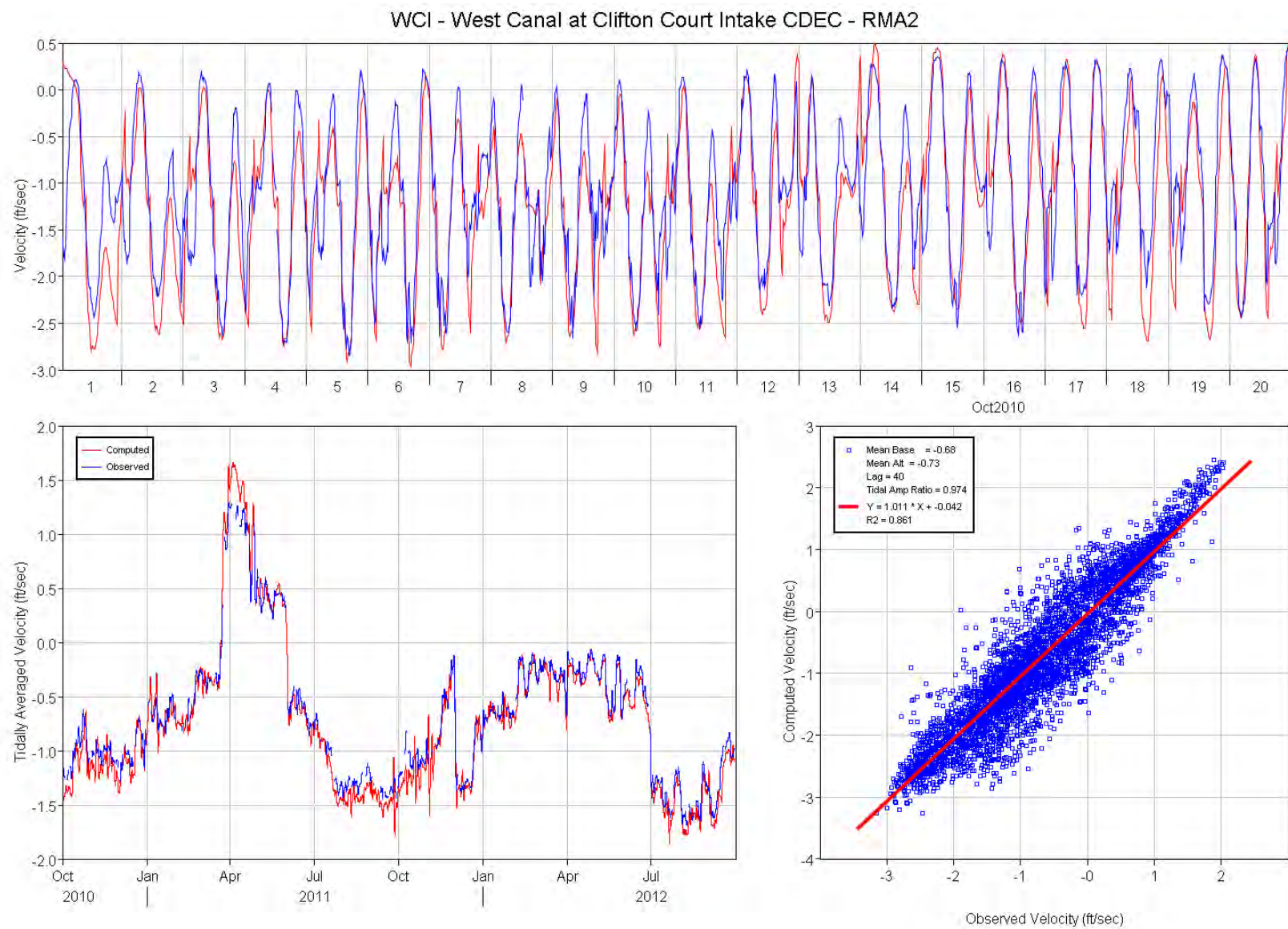


Figure 138 Computed (RMA2) and observed velocity comparison plots for West Canal at Clifton Court Intake.

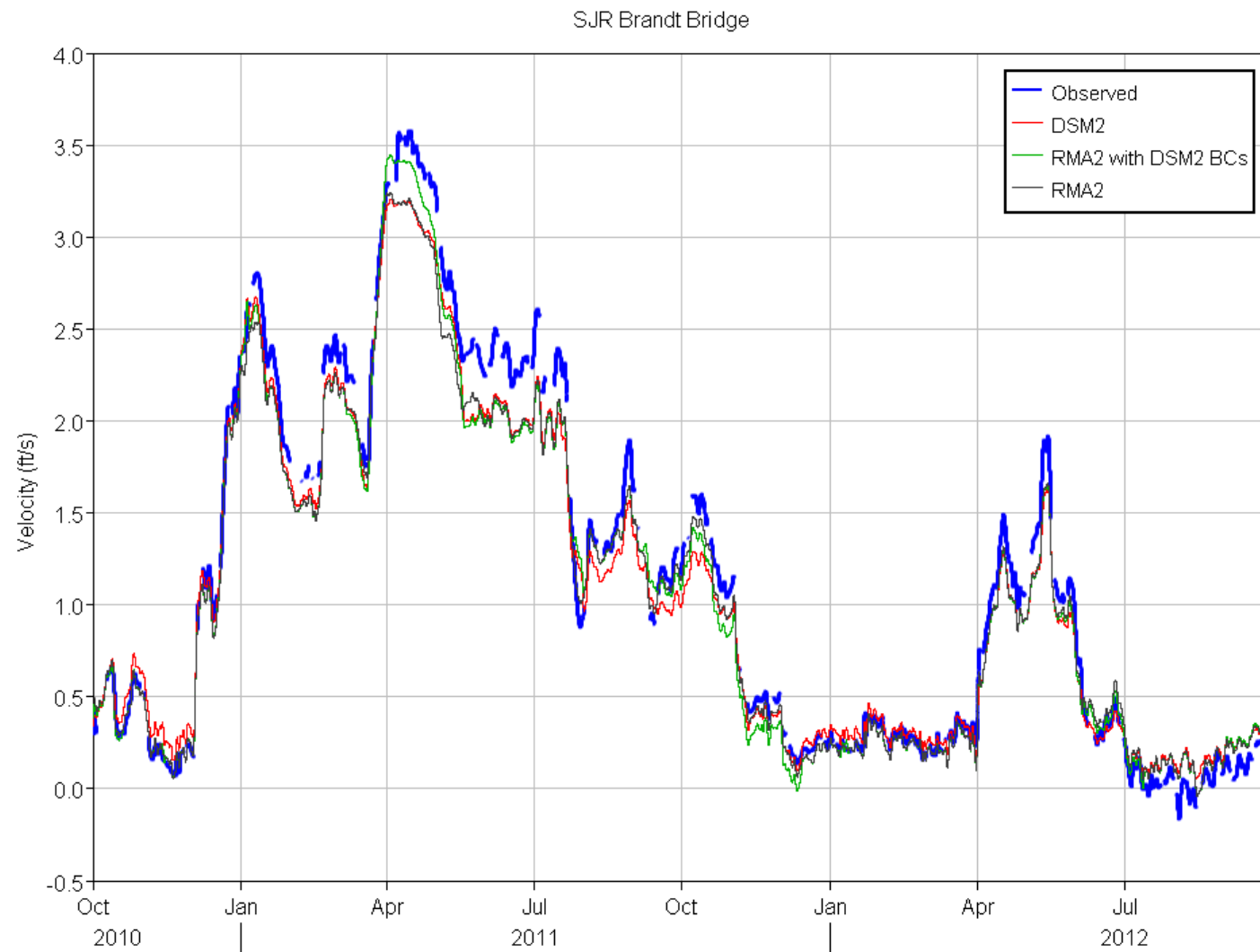


Figure 139 Tidally averaged observed and computed velocity for SJR at Brandt Bridge.



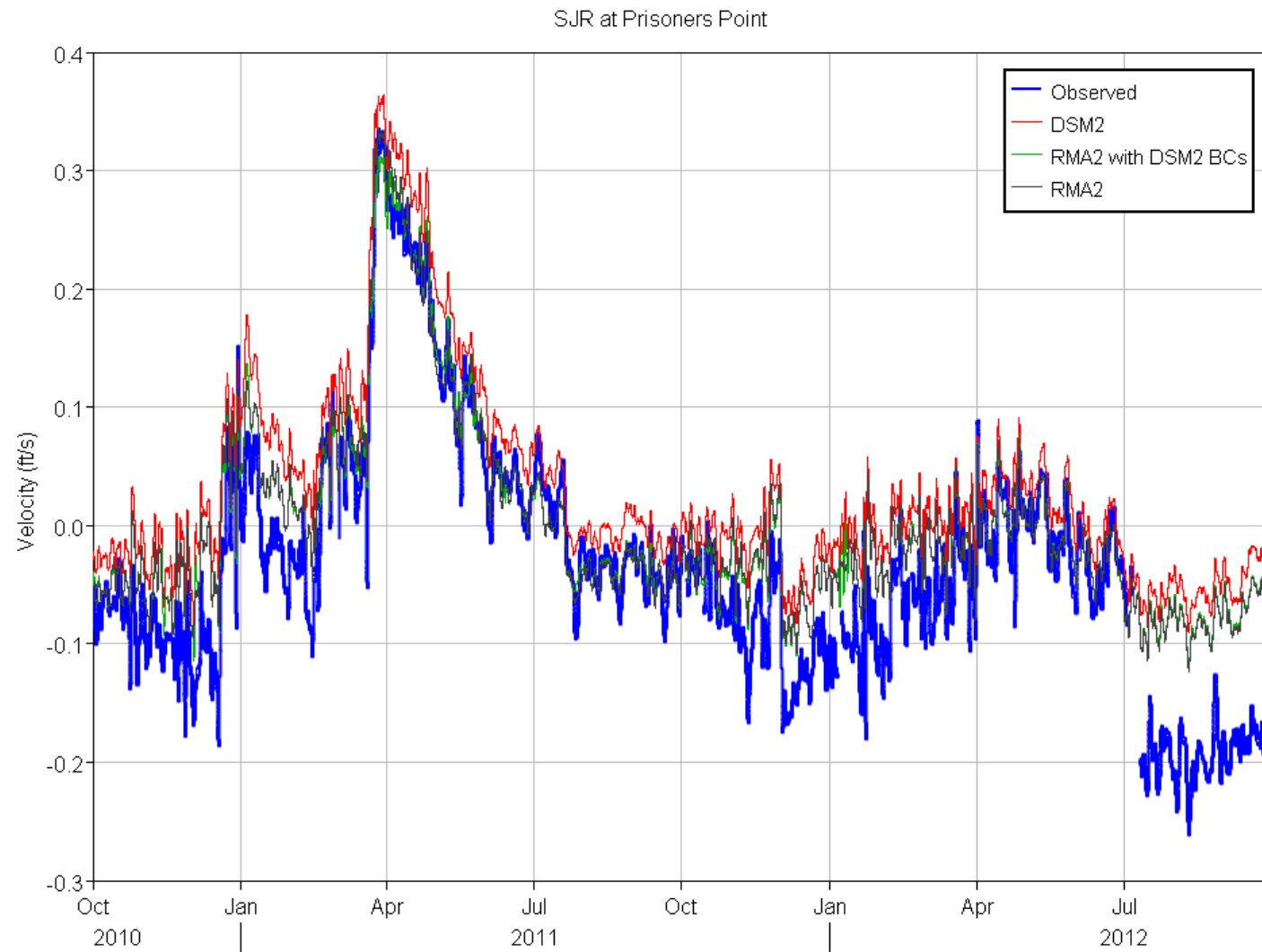


Figure 140 Tidally averaged observed and computed velocity for SJR at Prisoners Point.

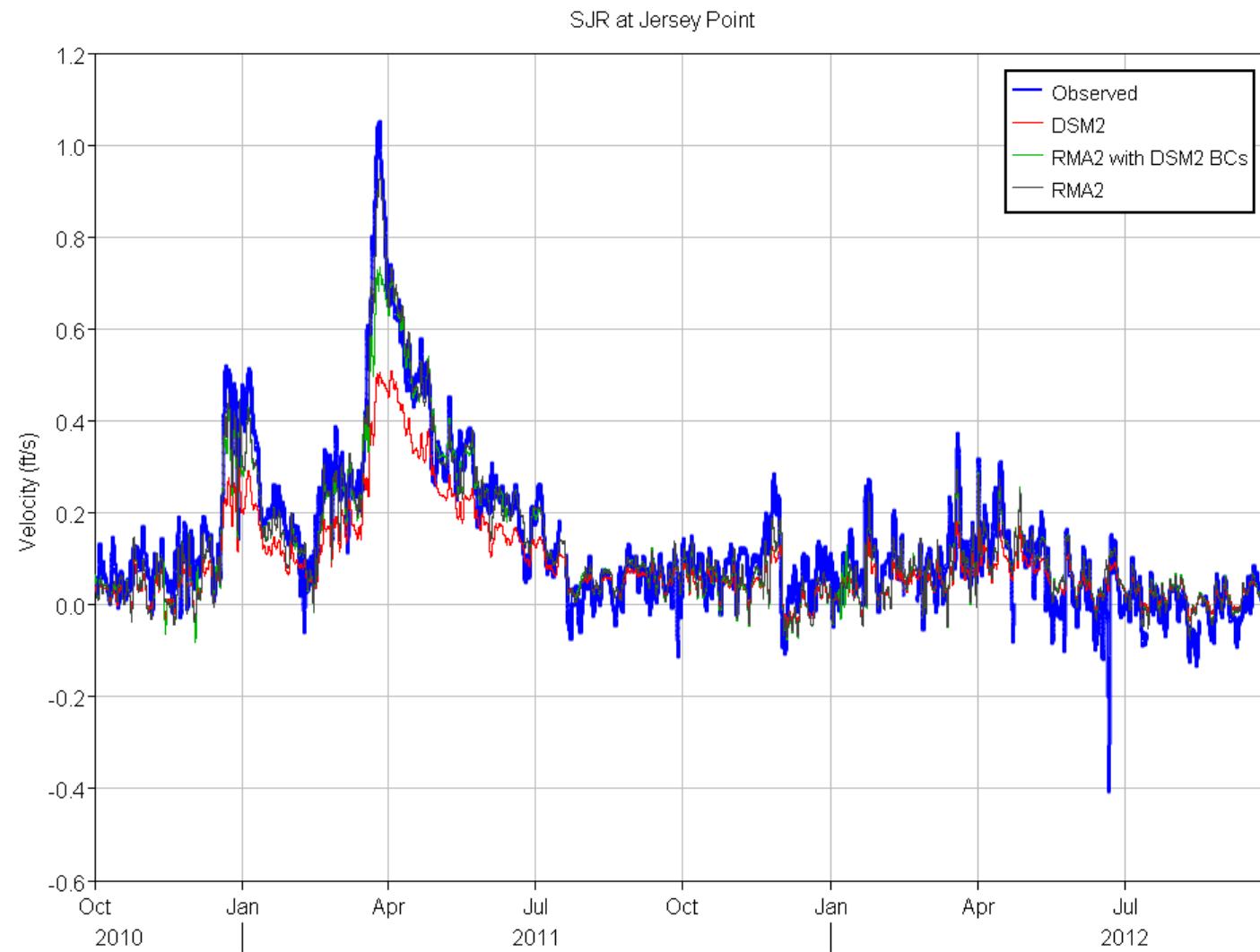


Figure 141 Tidally averaged observed and computed velocity for SJRW at Jersey Point.

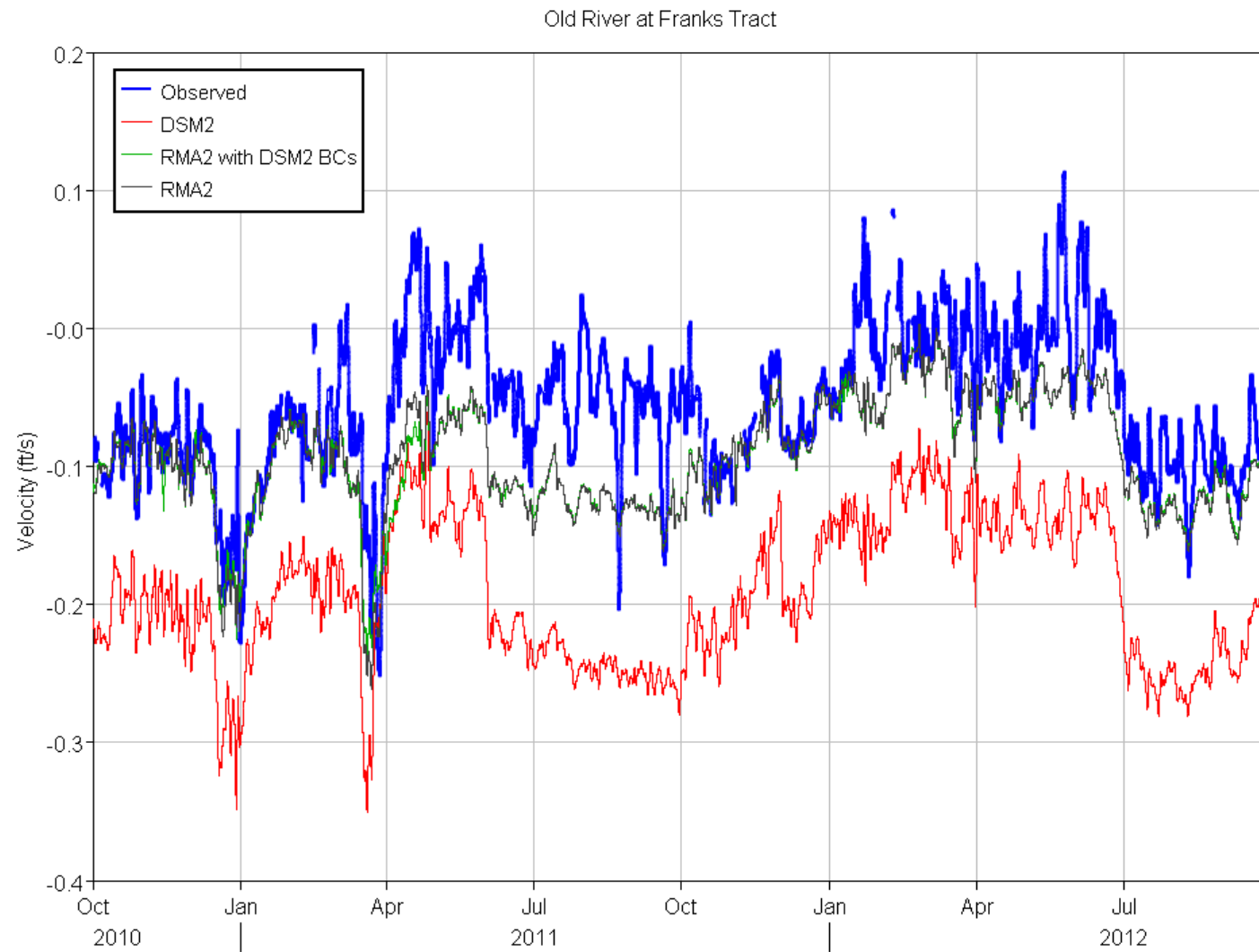


Figure 142 Tidally averaged observed and computed velocity for Old River at Franks Tract.



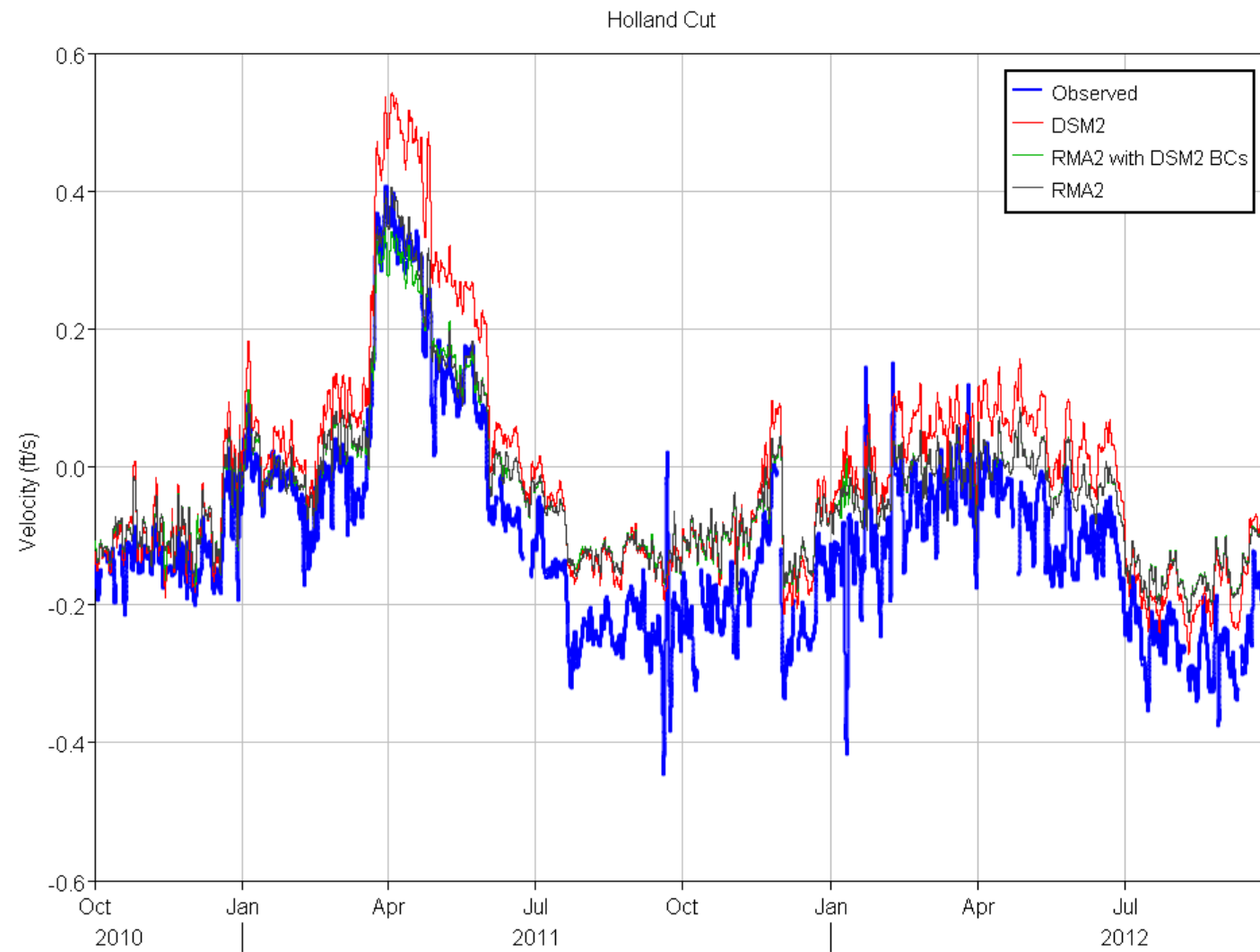


Figure 143 Tidally averaged observed and computed velocity for Holland Cut.

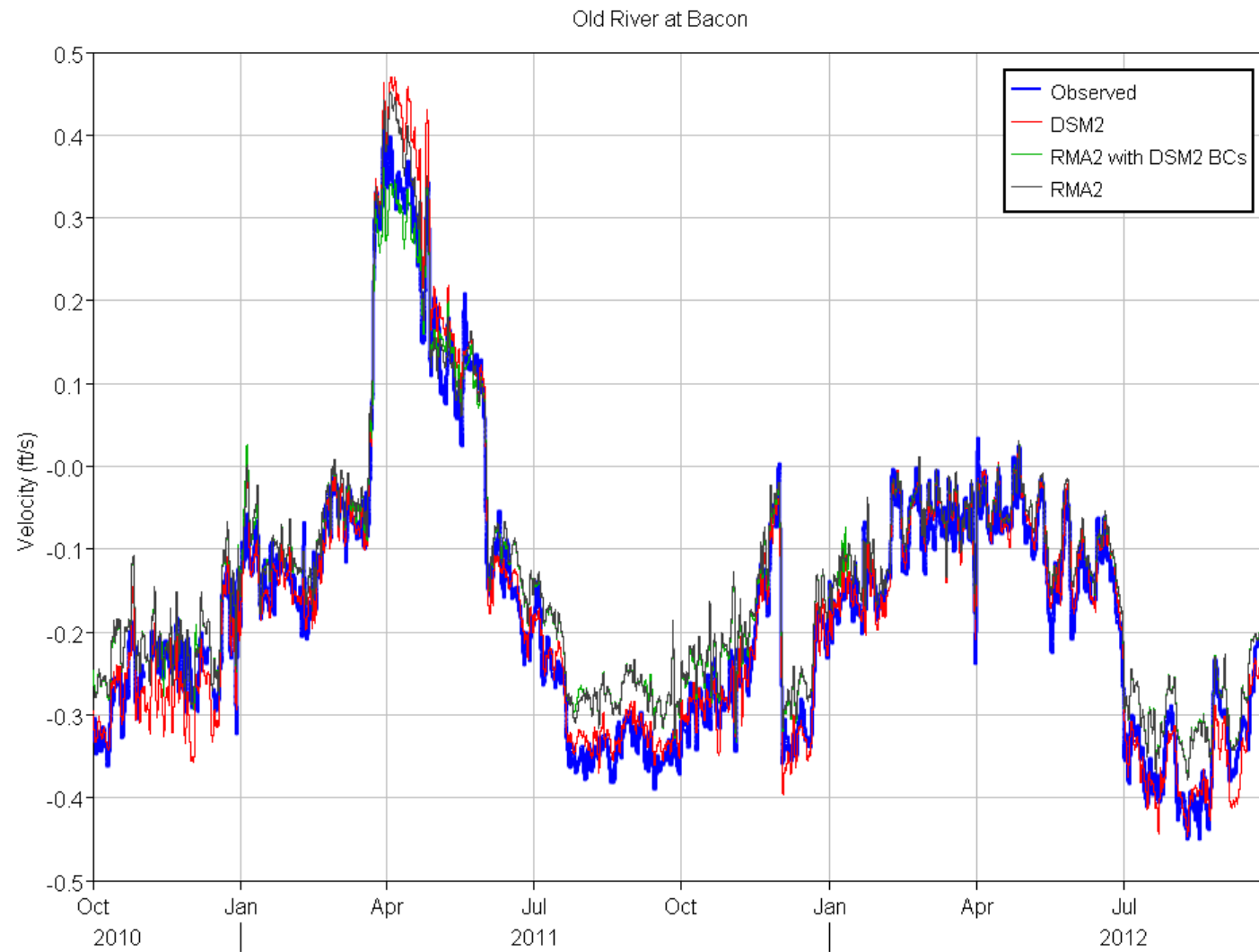


Figure 144 Tidally averaged observed and computed velocity for Old River at Bacon.

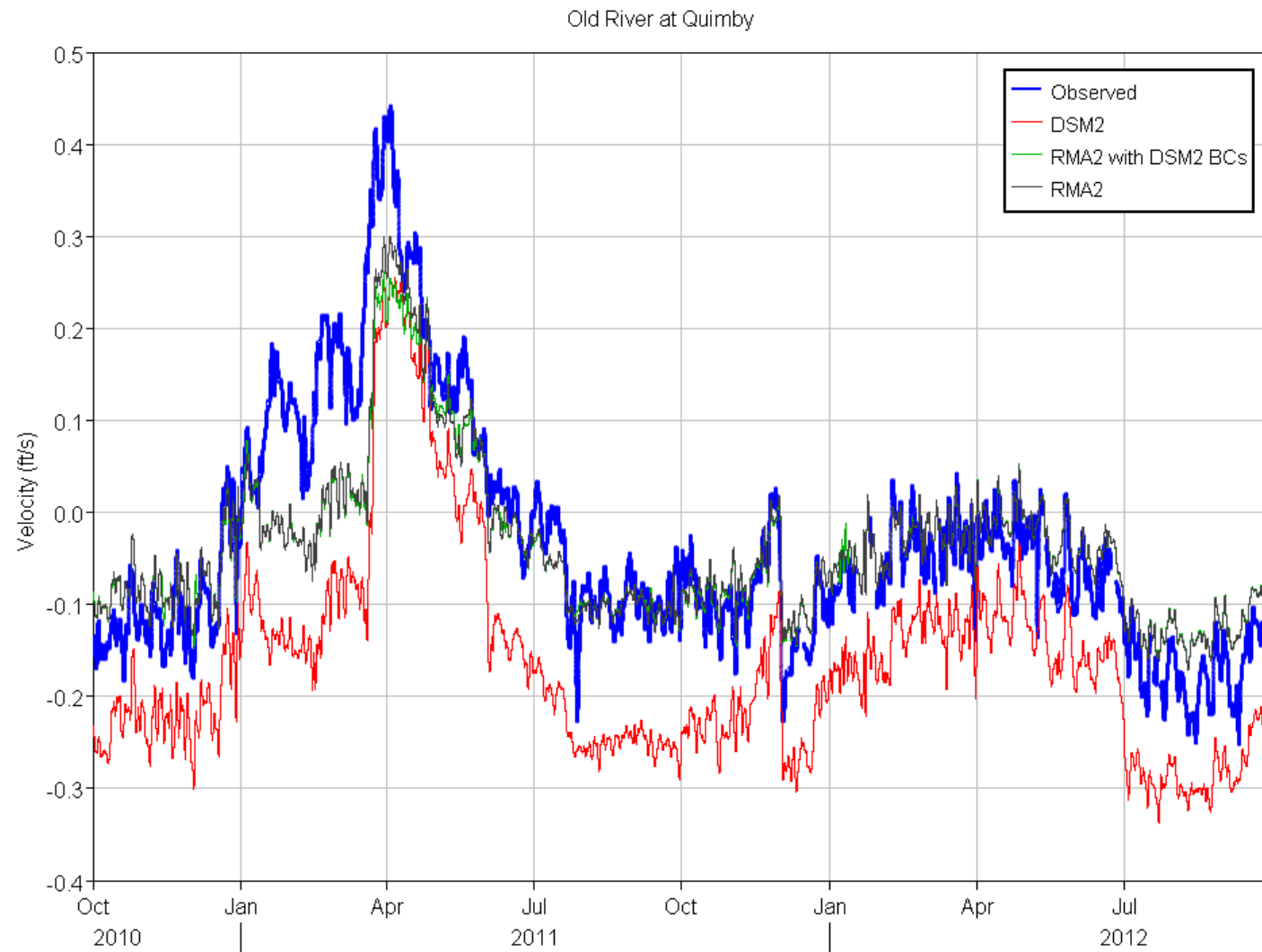


Figure 145 Tidally averaged observed and computed velocity for Old River at Quimby.



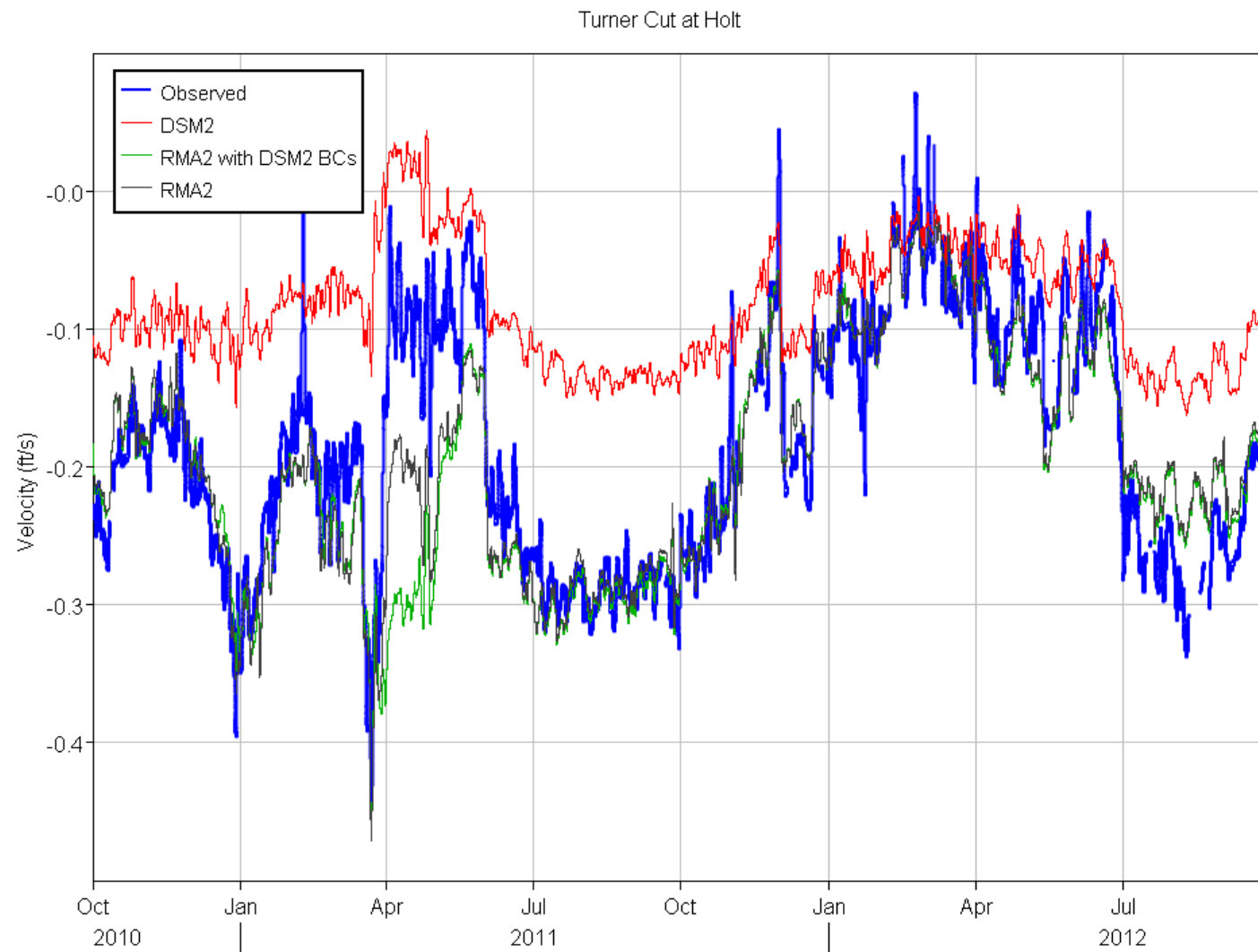


Figure 146 Tidally averaged observed and computed velocity for Turner Cut at Holt.

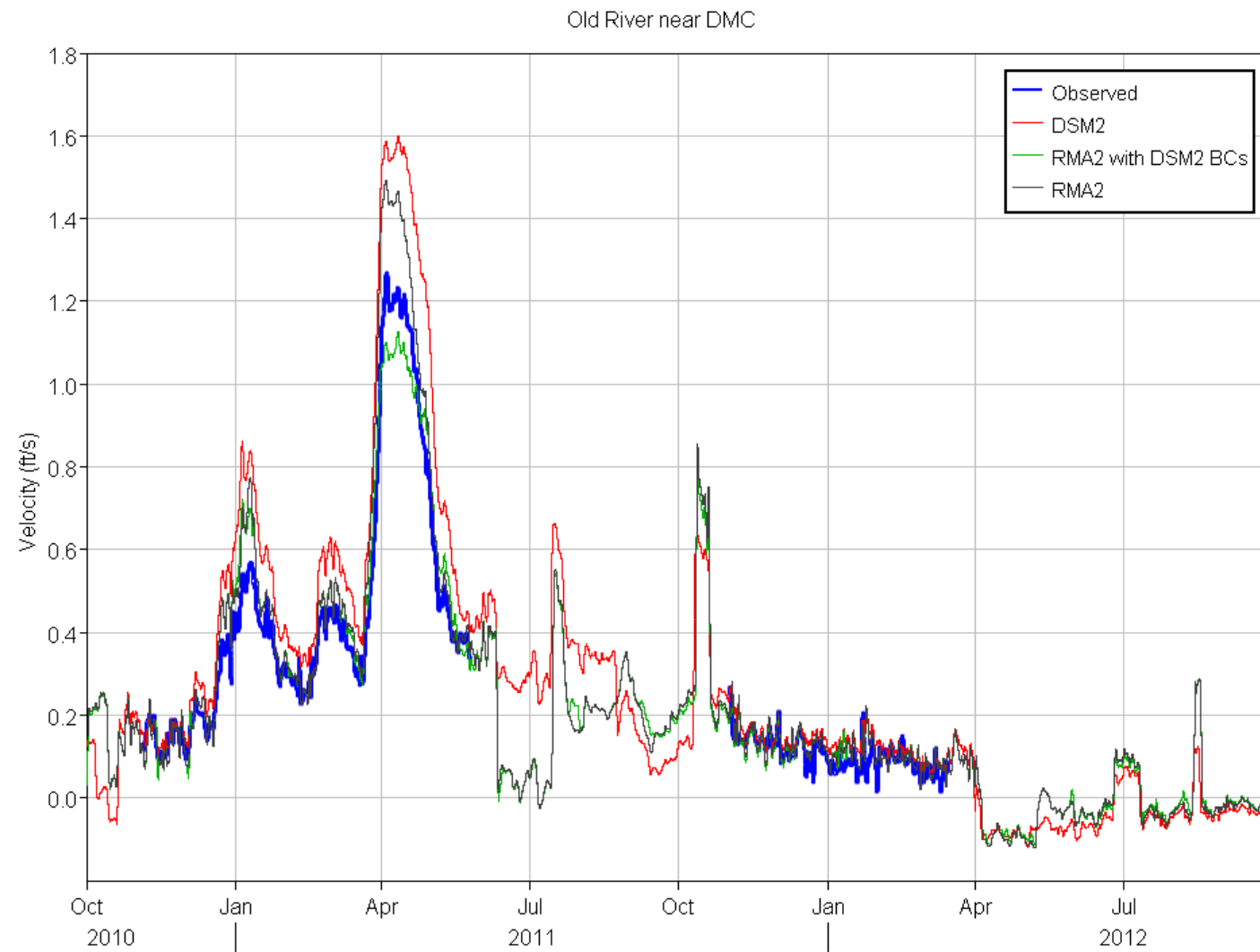


Figure 147 Tidally averaged observed and computed velocity for Old River near DMC.

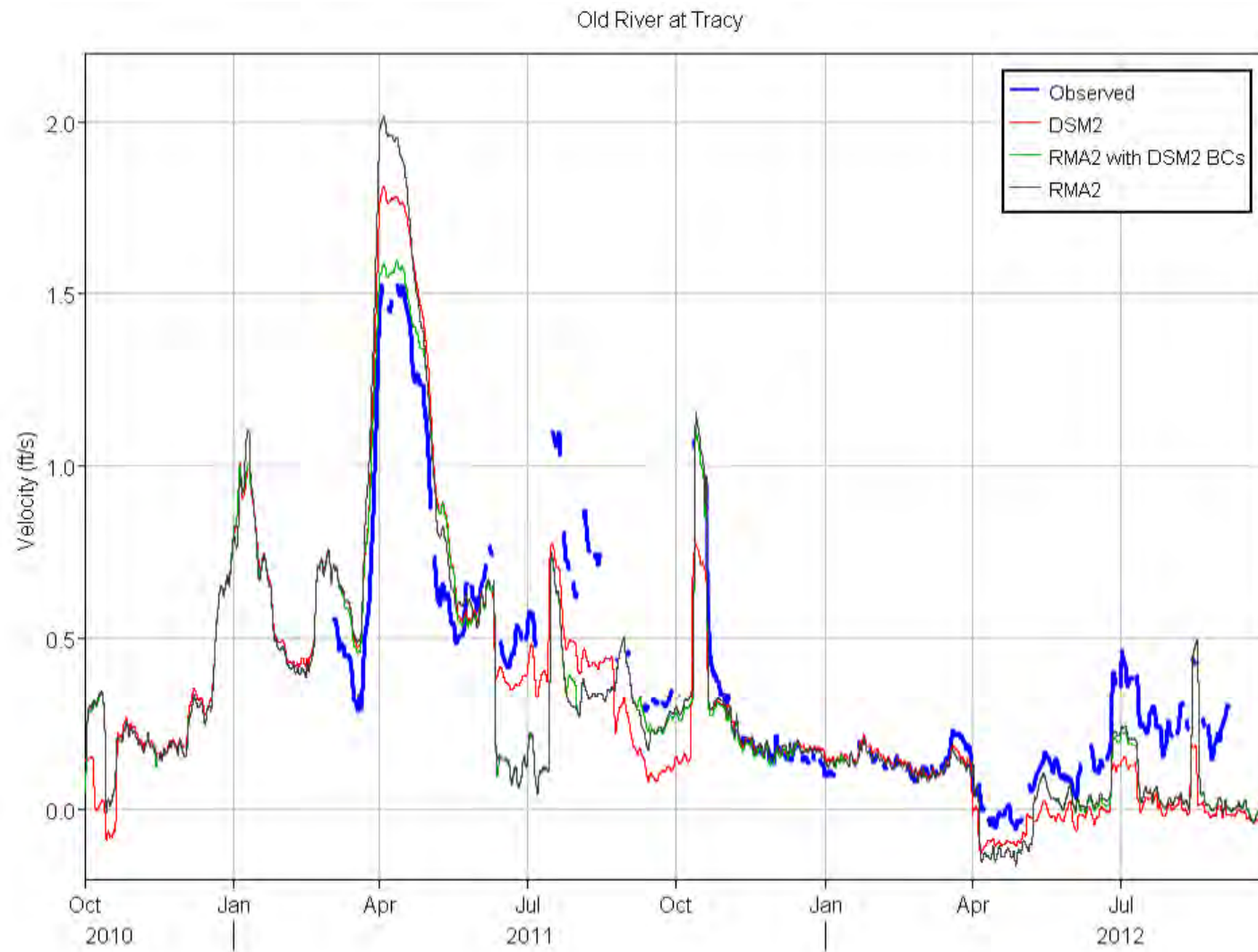


Figure 148 Tidally averaged observed and computed velocity for Old River at Tracy.



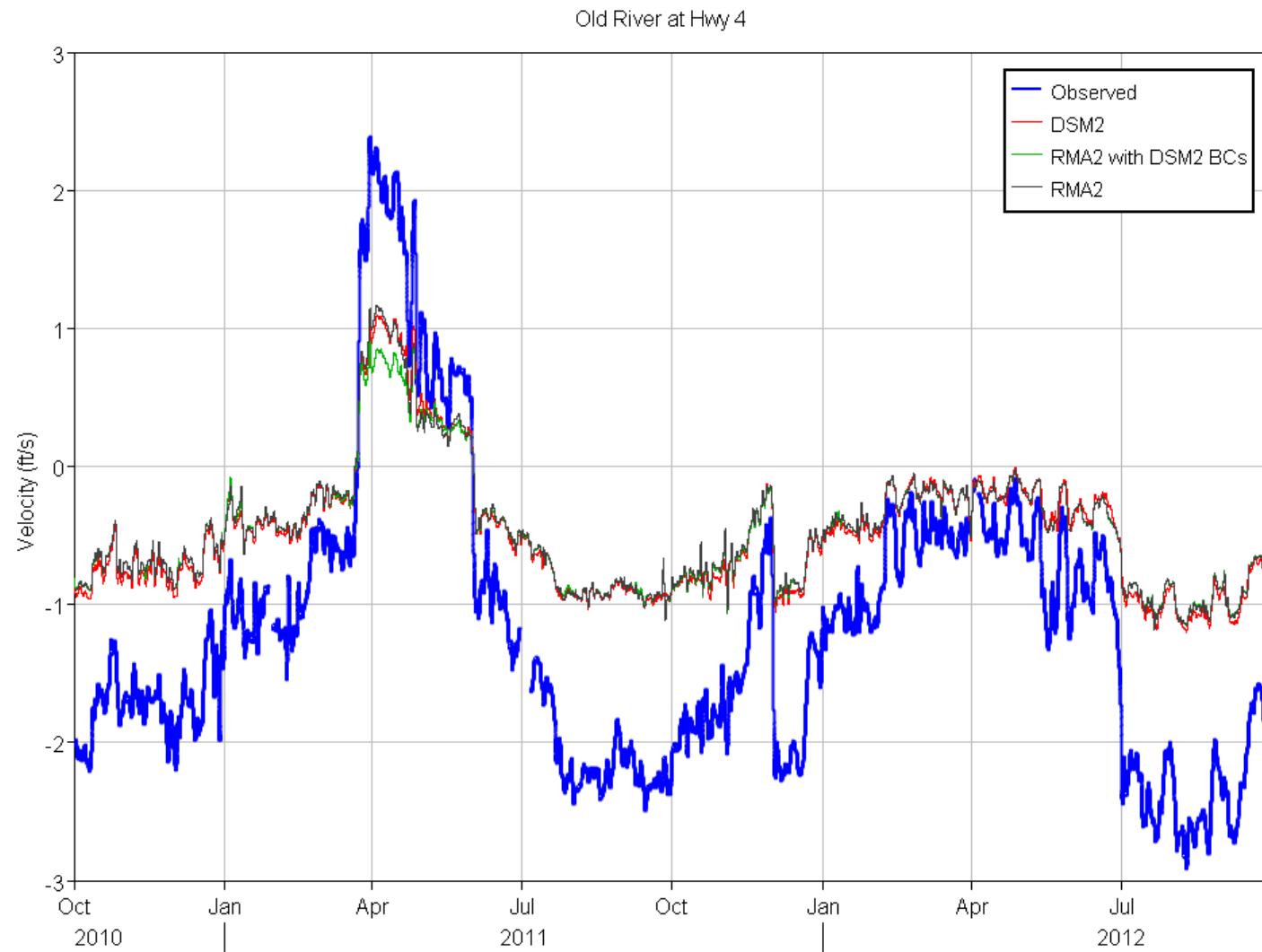


Figure 149 Tidally averaged observed and computed velocity for Old River at Hwy 4.

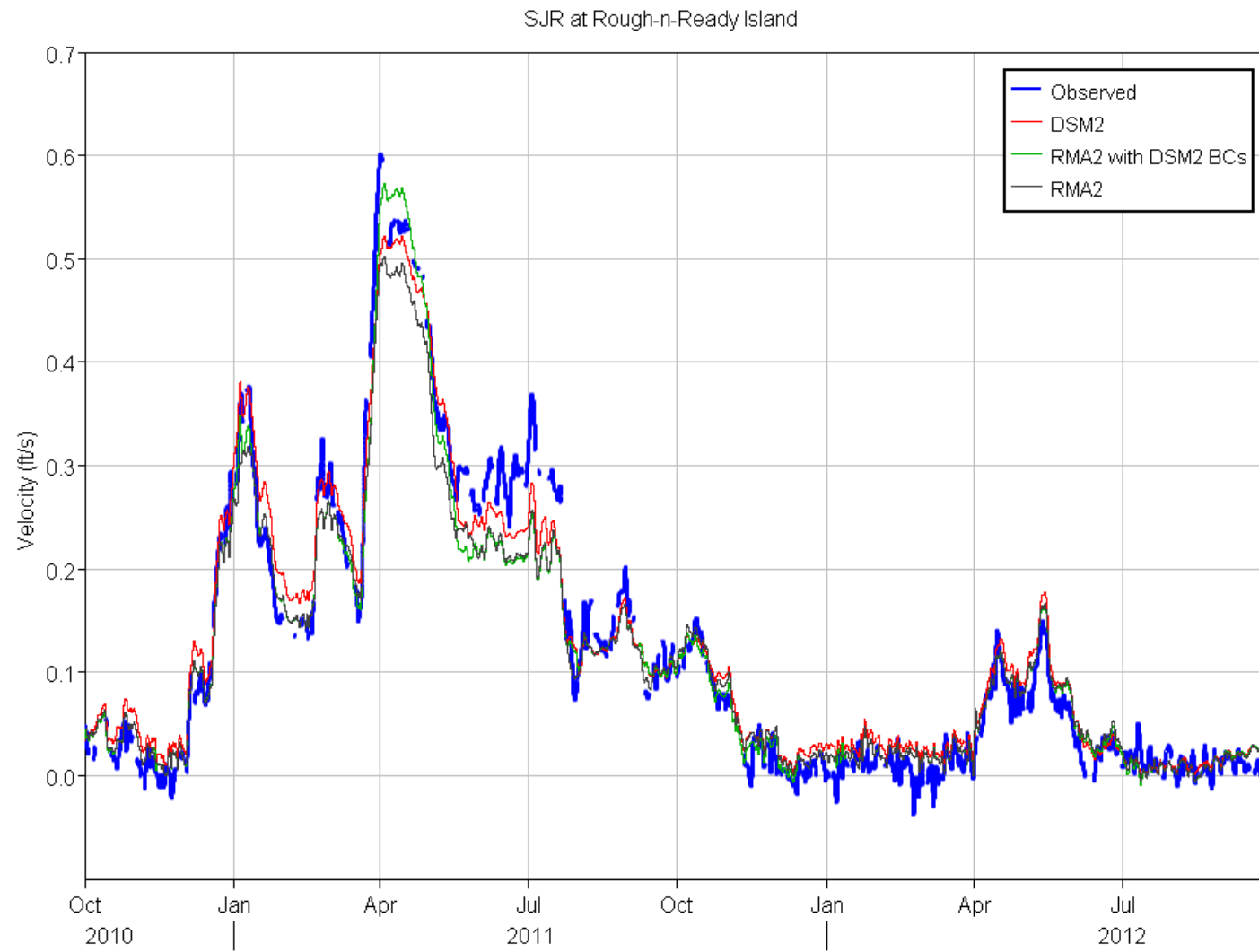


Figure 150 Tidally averaged observed and computed velocity for SJR at Rough-n-Ready Island.

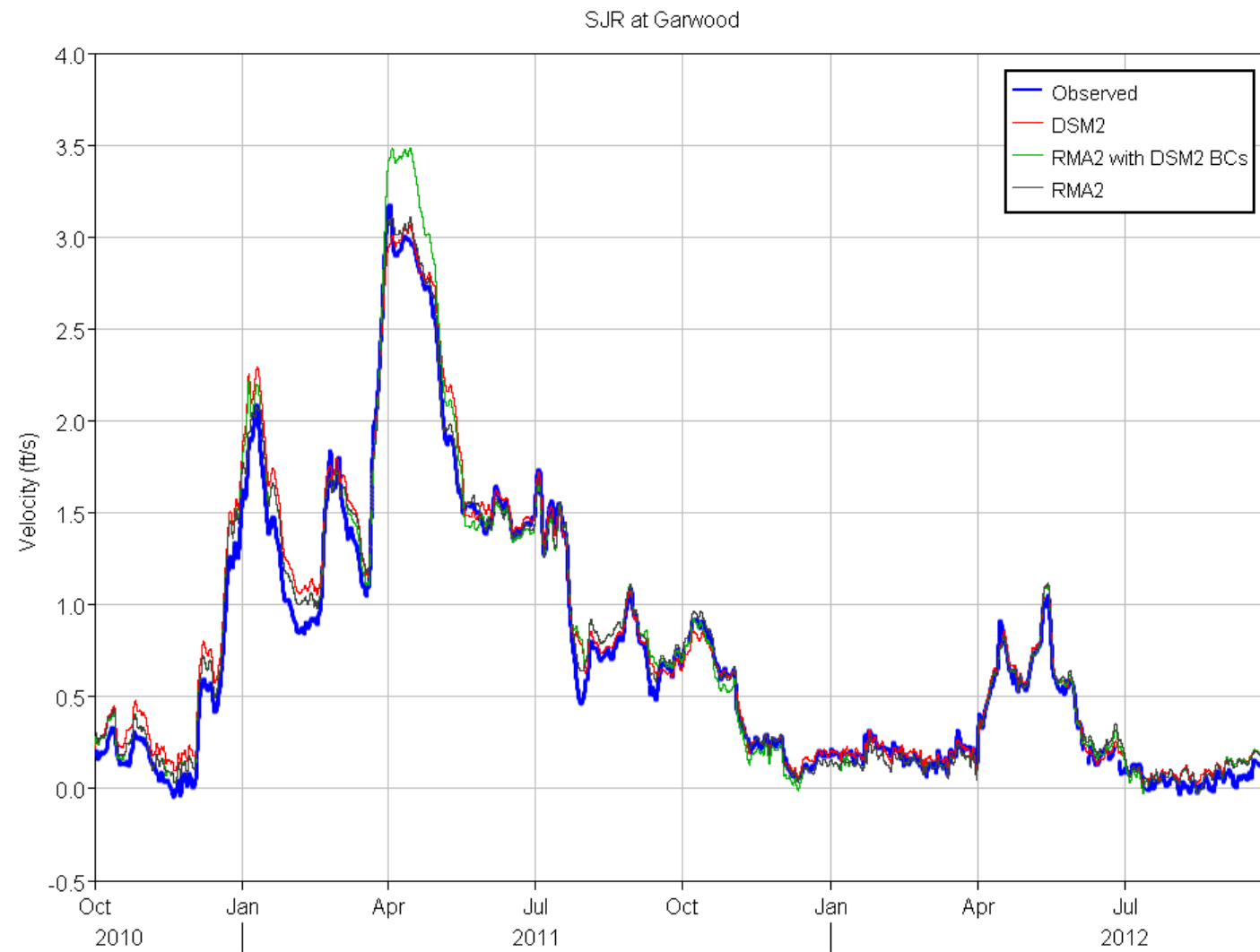


Figure 151 Tidally averaged observed and computed velocity for SJR at Garwood.



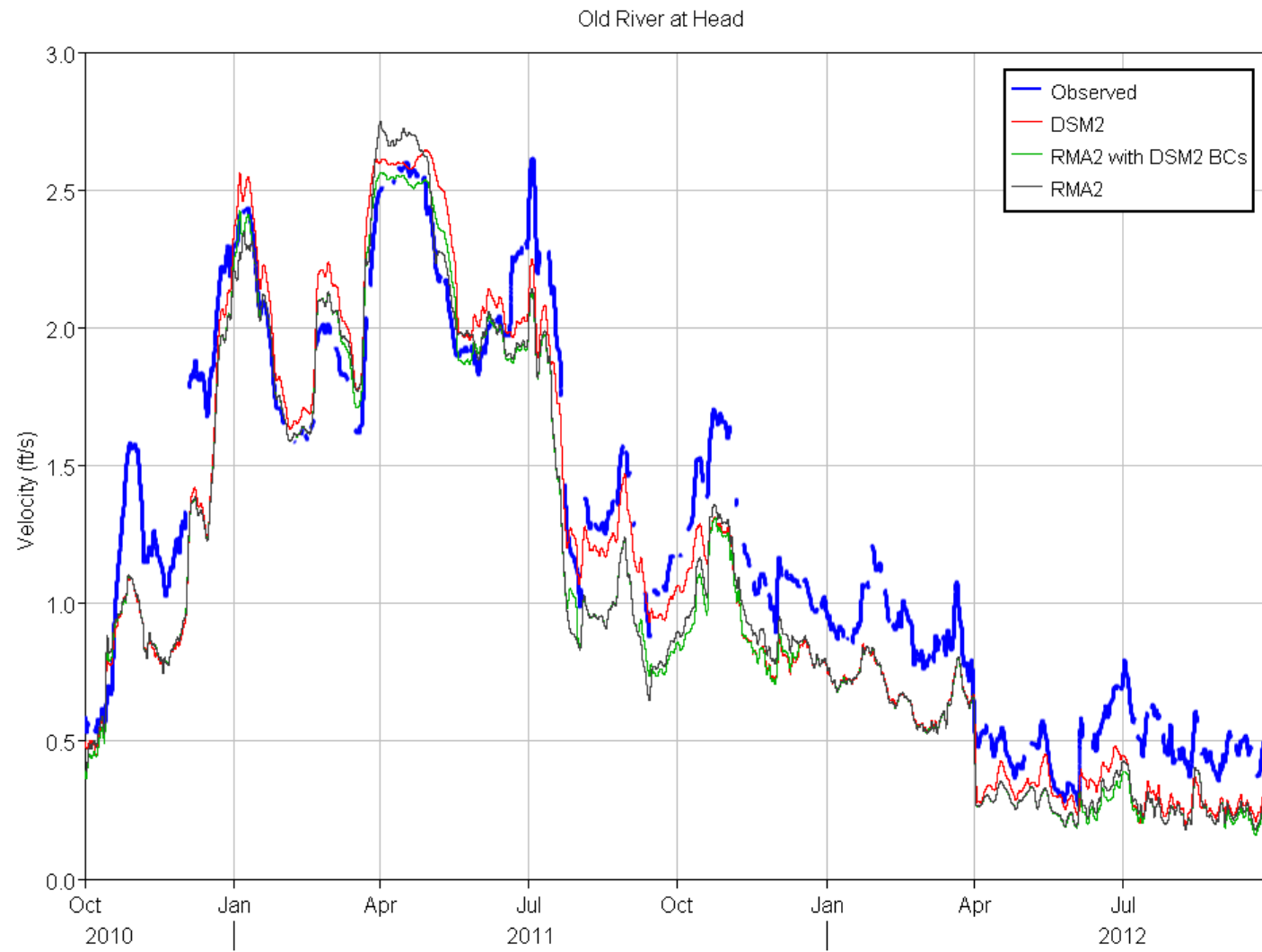


Figure 152 Tidally averaged observed and computed velocity for Old River at Head.

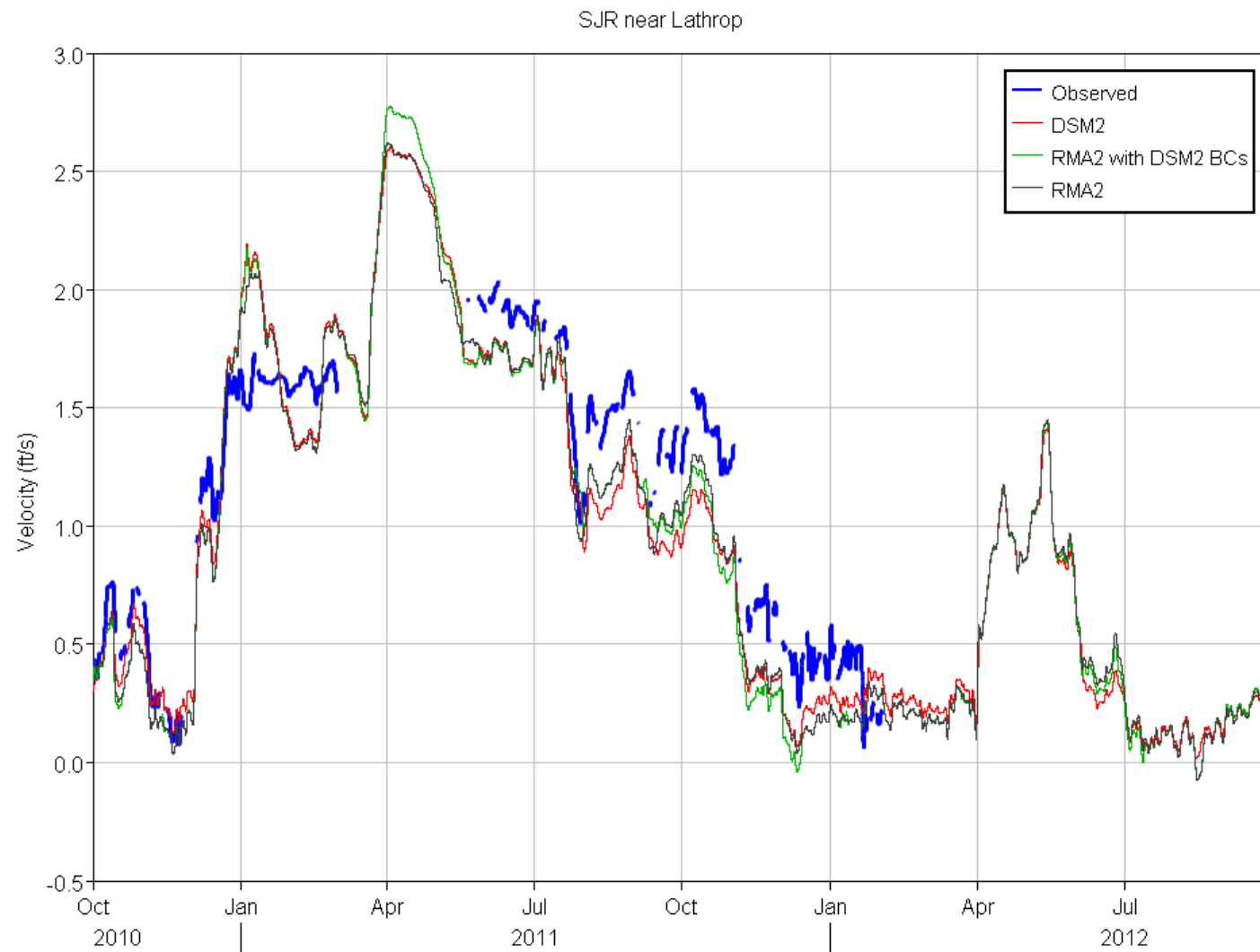


Figure 153 Tidally averaged observed and computed velocity for SJR near Lathrop.

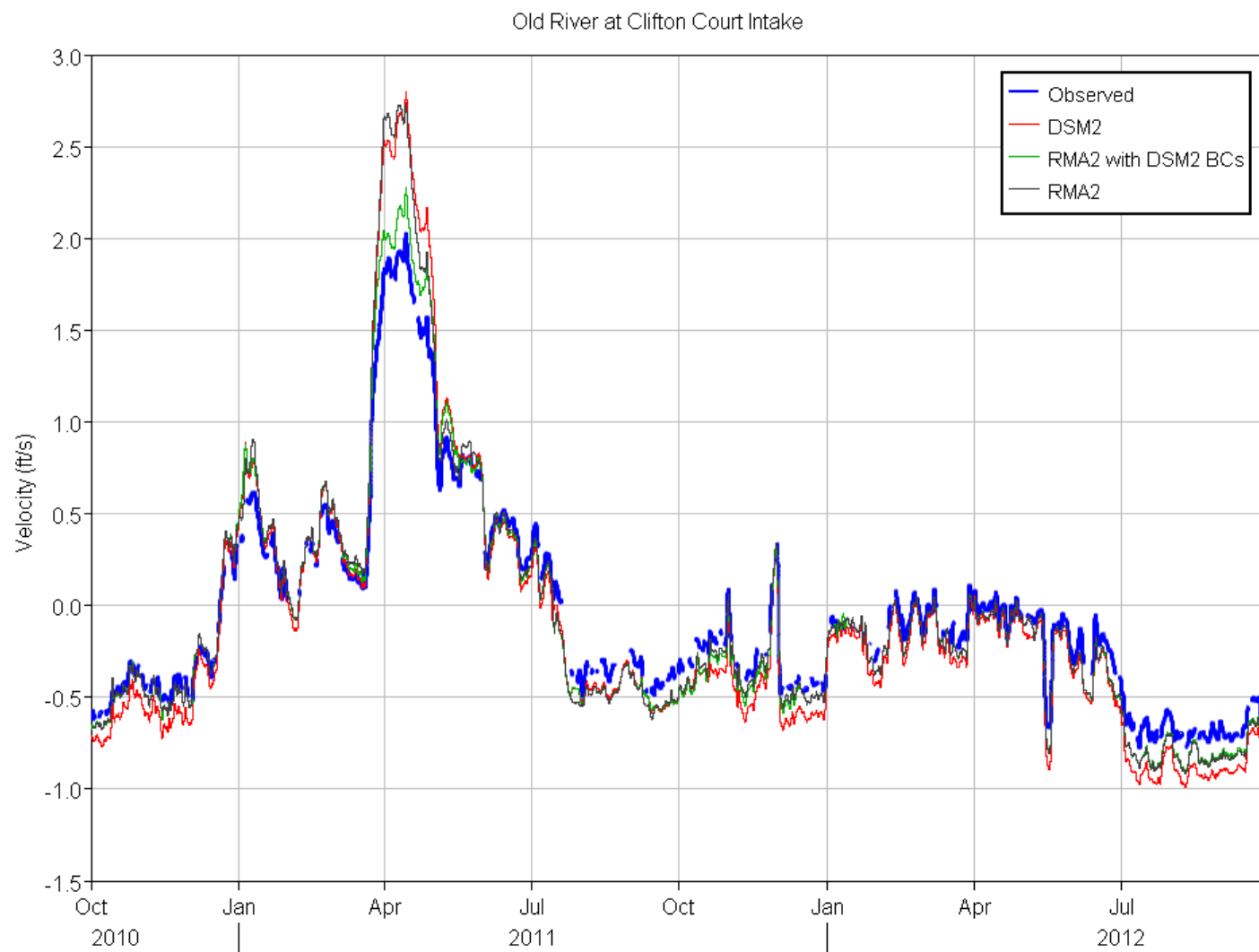


Figure 154 Tidally averaged observed and computed velocity for Old River at Clifton Court Intake.



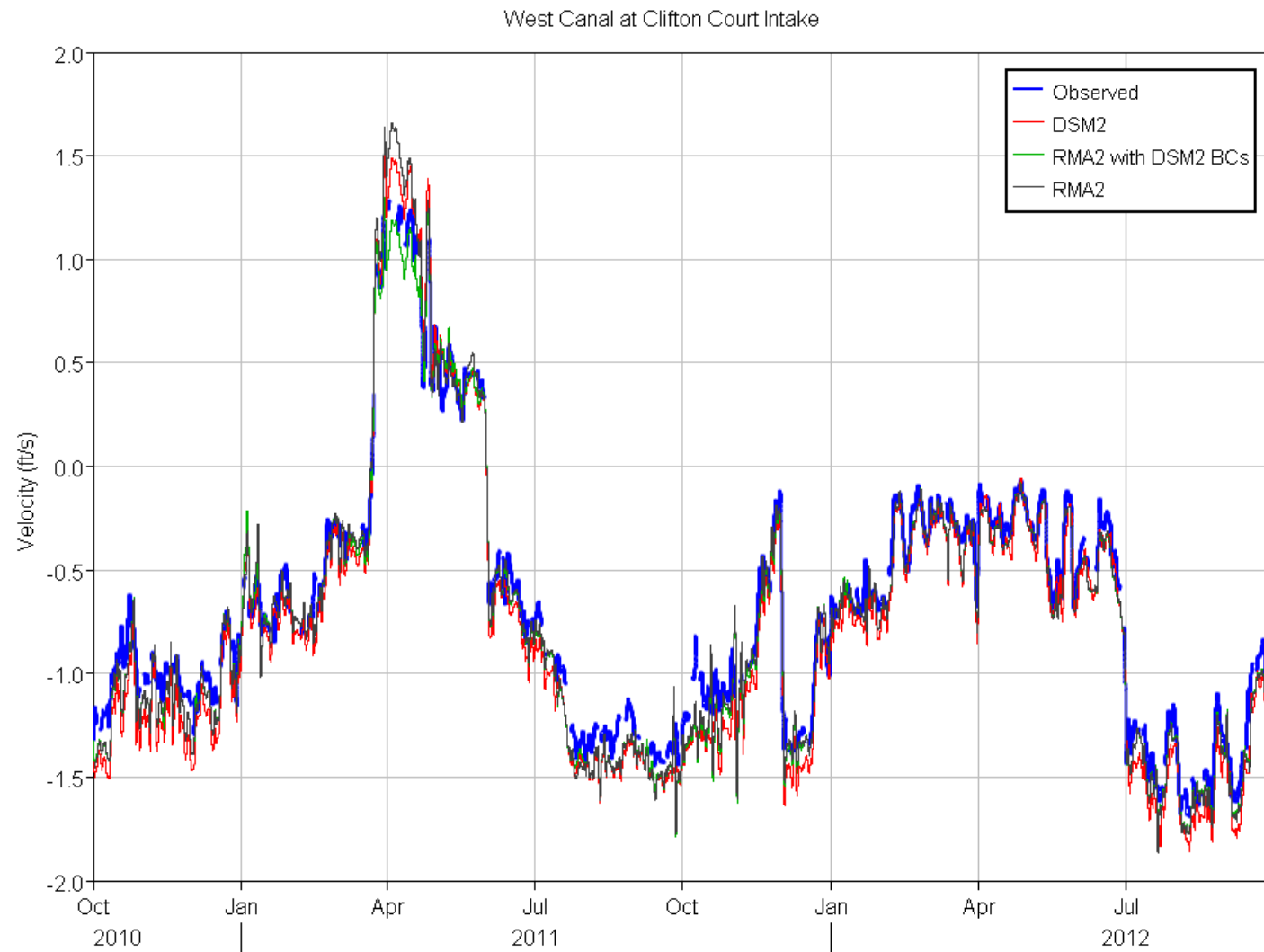


Figure 155 Tidally averaged observed and computed velocity for West Canal at Clifton Court Intake.

## Stage Results Comparison

In Figure 157 through Figure 220 computed stage results from the three model simulations are compared with observed data from CDEC and WDL (data sources are noted in plot titles). [Error metrics](#) from these plots are summarized by location in Table 6. Plot locations are shown in Figure 156. WDL data were used where available. CDEC data are likely to contain uncorrected time shifts which can result in apparent larger lag errors.

Table 7 summarizes stage results for each model by error metric (percent difference from observed, lag, amplitude ratio and  $R^2$ ) and model skill. Table cells are color coded for a quick assessment of goodness of fit with observed data, ranging from green for better fit to red for worse fit. For stage, a skill accuracy greater than 0.975 is considered accurate, 0.95-0.975 is considered acceptable and a skill accuracy below 0.95 is considered poor agreement. The average model skill for stage is 0.973 for DSM2 and 0.979 for RMA2.

DSM2 stage results average about 0.24 feet lower than RMA2 stage. The salinity coupling in RMA2 raises stages in the Delta by about a 0.3 feet. At most locations, a closer match with observed stage is achieved with the RMA2 coupled model.

Table 6 Stage error metrics summary. Asterisks after station names indicate that observed data are from CDEC, which can contain time shift errors.

	DSM2	RMA2 w DSM2 BC	RMA2
<b>SJR at Brandt Bridge</b>			
mean diff (ft)	-0.17	0.08	0.10
lag (minutes)	-22	7	7
ampRatio	0.980	0.909	0.908
slope	1.006	0.942	0.979
intercept	-0.2	0.4	0.2
R2	0.983	0.982	0.989
<b>SJR at Jersey Point*</b>			
mean diff (ft)	-0.05	0.16	0.16
lag (minutes)	16	18	18
ampRatio	0.991	0.996	0.996
slope	0.971	0.952	0.956
intercept	0.1	0.4	0.3
R2	0.941	0.923	0.927
<b>Middle River at Middle River</b>			
mean diff (ft)	-0.37	-0.11	-0.11
lag (minutes)	-17	-6	-5
ampRatio	1.126	1.042	1.042
slope	1.088	0.994	0.999
intercept	-0.8	-0.1	-0.1
R2	0.980	0.967	0.971
<b>Old River at Hwy 4*</b>			
mean diff (ft)	-0.20	0.02	0.02
lag (minutes)	-12	14	14
ampRatio	1.133	0.993	0.992
slope	1.063	0.933	0.939
intercept	-0.5	0.3	0.3
R2	0.921	0.914	0.918
<b>Old River at Bacon</b>			
mean diff (ft)	-0.27	-0.02	-0.02
lag (minutes)	-21	-11	-10
ampRatio	1.130	1.049	1.049
slope	1.086	0.992	0.997
intercept	-0.6	0.0	0.0
R2	0.972	0.953	0.958
<b>SJR at Rough-n-Ready</b>			
mean diff (ft)	-0.33	-0.06	-0.06
lag (minutes)	-23	4	4
ampRatio	1.073	1.033	1.034
slope	1.045	0.994	0.999
intercept	-0.5	0.0	-0.1
R2	0.980	0.971	0.975

	DSM2	RMA2 w DSM2 BC	RMA2
<b>SJR at Garwood*</b>			
mean diff (ft)	-0.30	-0.02	-0.02
lag (minutes)	-27	2	3
ampRatio	1.095	1.041	1.040
slope	0.988	0.923	0.936
intercept	-0.2	0.3	0.3
R2	0.926	0.913	0.923
<b>Old River at Head</b>			
mean diff (ft)	0.18	0.15	0.19
lag (minutes)	-19	-1	-1
ampRatio	0.941	0.941	0.940
slope	1.000	0.901	0.928
intercept	0.2	0.8	0.6
R2	0.984	0.984	0.992
<b>SJR nr Lathrop</b>			
mean diff (ft)	0.12	0.19	0.23
lag (minutes)	-10	5	5
ampRatio	0.952	0.940	0.937
slope	0.989	0.919	0.947
intercept	0.2	0.7	0.6
R2	0.985	0.985	0.993
<b>Old River at Tracy</b>			
mean diff (ft)	0.00	0.44	0.44
lag (minutes)	-17	38	39
ampRatio	0.968	0.727	0.726
slope	0.924	0.982	0.979
intercept	0.3	0.5	0.5
R2	0.921	0.840	0.844
<b>Antioch</b>			
mean diff (ft)	-0.25	0.01	0.01
lag (minutes)	-10	1	2
ampRatio	1.092	1.007	1.007
slope	1.071	0.986	0.988
intercept	-0.5	0.1	0.1
R2	0.988	0.978	0.982

	DSM2	RMA2 w DSM2 BC	RMA2
<b>Middle River at Tracy</b>			
mean diff (ft)	-0.16	0.15	0.11
lag (minutes)	-32	-6	-7
ampRatio	1.061	0.889	0.915
slope	1.024	0.877	0.901
intercept	-0.3	0.7	0.5
R2	0.935	0.867	0.919
<b>Old R at Clifton Court Ferry</b>			
mean diff (ft)	0.03	0.23	0.23
lag (minutes)	-27	7	7
ampRatio	1.081	0.948	0.947
slope	1.046	0.932	0.939
intercept	-0.1	0.5	0.5
R2	0.934	0.928	0.929
<b>Old River at DMC ds barr</b>			
mean diff (ft)	0.01	0.18	0.18
lag (minutes)	-25	7	8
ampRatio	1.032	0.904	0.904
slope	1.046	0.922	0.930
intercept	-0.2	0.5	0.4
R2	0.936	0.927	0.928
<b>SJR at Venice Island</b>			
mean diff (ft)	-0.52	-0.28	-0.28
lag (minutes)	-15	-1	-1
ampRatio	1.098	1.033	1.033
slope	1.058	0.981	0.986
intercept	-0.8	-0.2	-0.2
R2	0.978	0.963	0.967
<b>SJR at Rindge Pump</b>			
mean diff (ft)	-0.39	-0.14	-0.14
lag (minutes)	-22	0	0
ampRatio	1.087	1.030	1.030
slope	1.056	0.991	0.995
intercept	-0.6	-0.1	-0.1
R2	0.982	0.971	0.975



**Table 7 Summary of stage error metrics and model skill, with shading ranging from green for better fit to red for worse fit. Asterisks after station names indicate that observed data are from CDEC, which can contain time shift errors.**

Station	% diff from observed			lag (minutes)			ampRatio			R2			Model Skill		
	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2	DSM2	RMA2 w DSM2 BC	RMA2
SJR at Brandt Bridge	-3.1%	1.4%	1.9%	-22	7	7	0.980	0.909	0.908	0.983	0.982	0.989	0.992	0.994	0.996
SJR at Jersey Point*	-1.2%	3.9%	3.8%	16	18	18	0.991	0.996	0.996	0.941	0.923	0.927	0.981	0.971	0.972
Middle River at Middle River	-8.5%	-2.5%	-2.5%	-17	-6	-5	1.126	1.042	1.042	0.980	0.967	0.971	0.962	0.989	0.990
Old River at Hwy 4*	-4.8%	0.5%	0.4%	-12	14	14	1.133	0.993	0.992	0.921	0.914	0.918	0.967	0.975	0.976
Old River at Bacon Island	-6.3%	-0.4%	-0.4%	-21	-11	-10	1.130	1.049	1.049	0.972	0.953	0.958	0.970	0.987	0.988
SJR at Rough-n-Ready Island	-7.5%	-1.3%	-1.3%	-23	4	4	1.073	1.033	1.034	0.980	0.971	0.975	0.968	0.992	0.993
SJR at Garwood*	-6.6%	-0.5%	-0.3%	-27	2	3	1.095	1.041	1.040	0.926	0.913	0.923	0.957	0.977	0.980
Old River at Head	2.9%	2.4%	3.0%	-19	-1	-1	0.941	0.941	0.940	0.984	0.984	0.992	0.995	0.993	0.995
SJR near Lathrop	1.9%	2.9%	3.6%	-10	5	5	0.952	0.940	0.937	0.985	0.985	0.993	0.996	0.993	0.996
Old River at Tracy	0.0%	10.2%	10.1%	-17	38	39	0.968	0.727	0.726	0.921	0.840	0.844	0.978	0.897	0.898
Antioch	-5.9%	0.3%	0.2%	-10	1	2	1.092	1.007	1.007	0.988	0.978	0.982	0.985	0.995	0.995
Middle River at Tracy	-3.7%	3.6%	2.6%	-32	-6	-7	1.061	0.889	0.915	0.935	0.867	0.919	0.966	0.957	0.974
Old River at Clifton Court Ferry	0.7%	6.1%	6.1%	-27	7	7	1.081	0.948	0.947	0.934	0.928	0.929	0.972	0.969	0.970
Old River at DMC d/s of barrier	0.2%	4.8%	4.8%	-25	7	8	1.032	0.904	0.904	0.936	0.927	0.928	0.976	0.973	0.973
SJR at Venice Island	-11.4%	-6.0%	-6.0%	-15	-1	-1	1.098	1.033	1.033	0.978	0.963	0.967	0.938	0.974	0.975
SJR at Rindge Pump	-8.7%	-3.1%	-3.1%	-22	0	0	1.087	1.030	1.030	0.982	0.971	0.975	0.961	0.989	0.990
<b>Average of absolute values</b>	4.6%	3.1%	3.2%	20	8	8	1.053	0.968	0.969	0.959	0.942	0.949	0.973	0.977	0.979



Figure 156 Stage comparison plot locations.

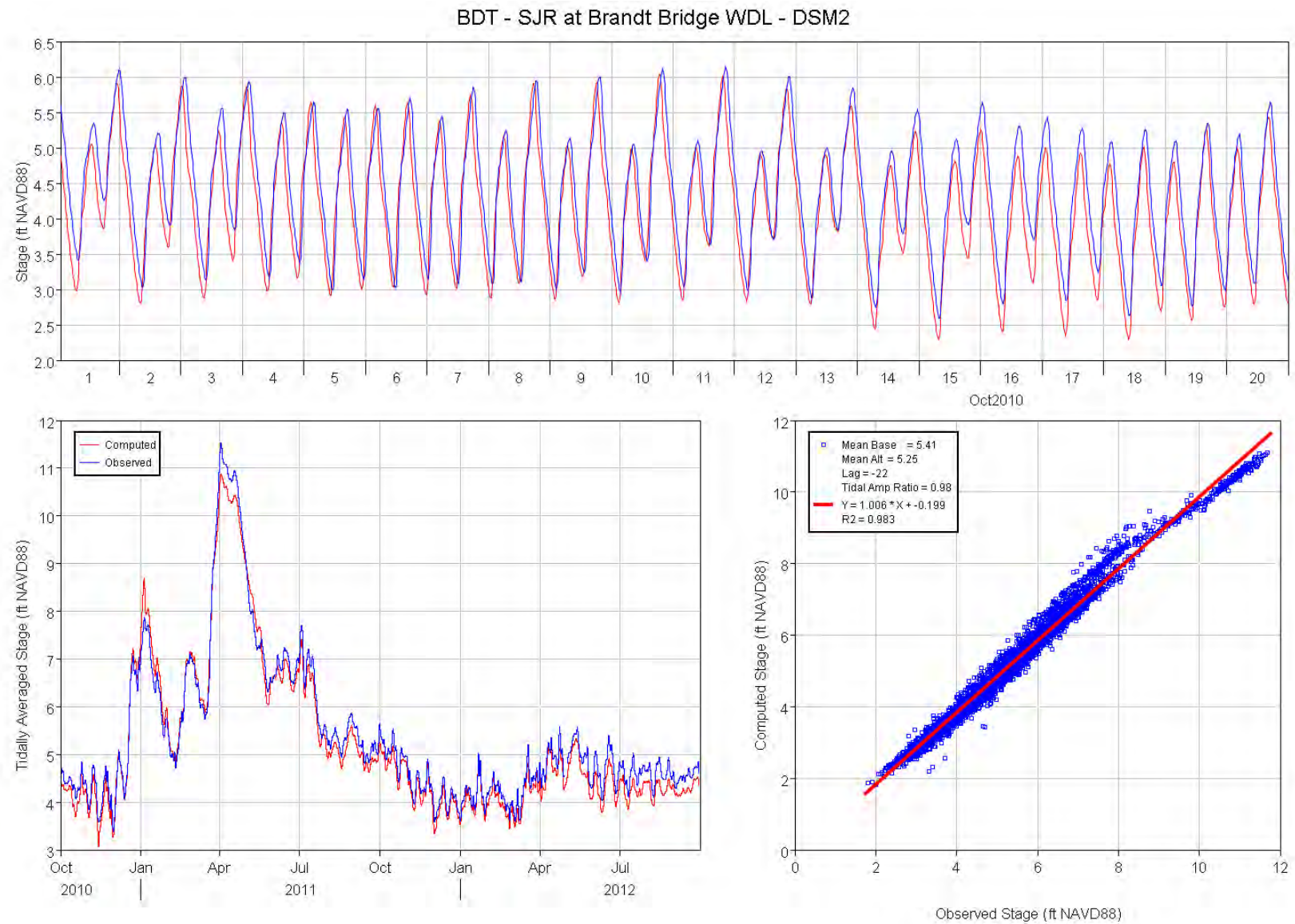


Figure 157 Computed (DSM2) and observed stage comparison plots for San Joaquin River at Brandt Bridge.



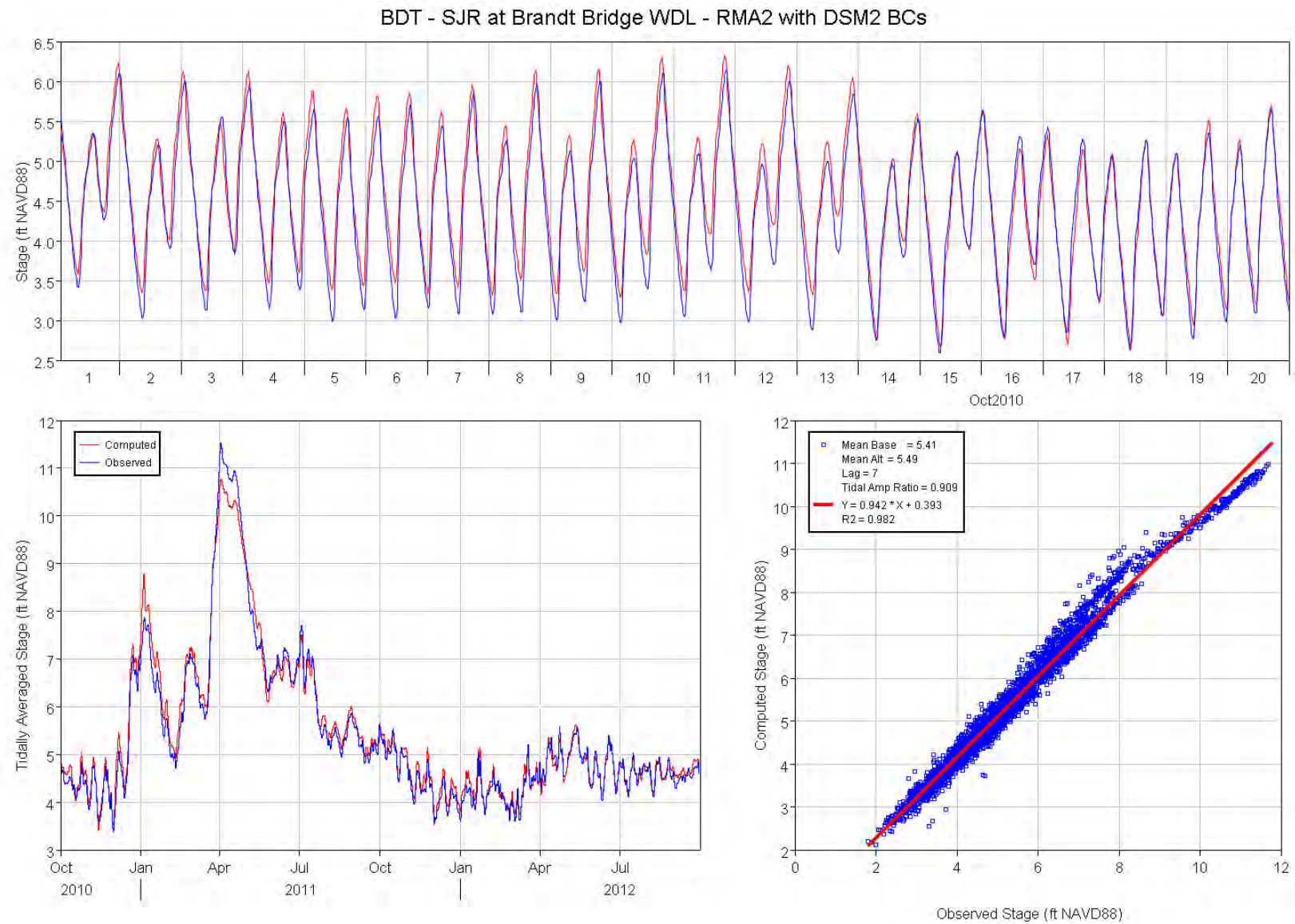


Figure 158 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for San Joaquin River at Brandt Bridge.



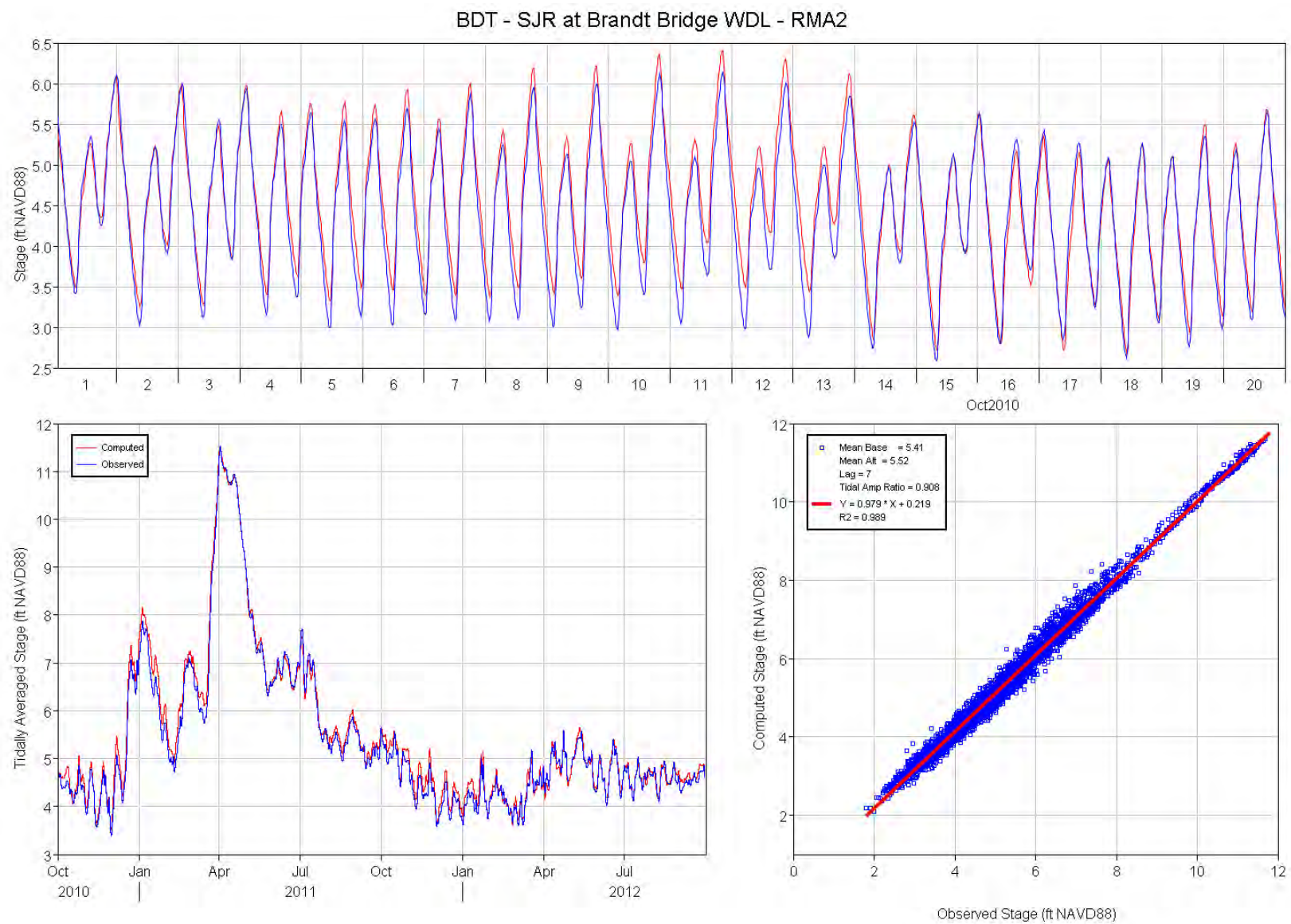


Figure 159 Computed (RMA2) and observed stage comparison plots for San Joaquin River at Brandt Bridge.

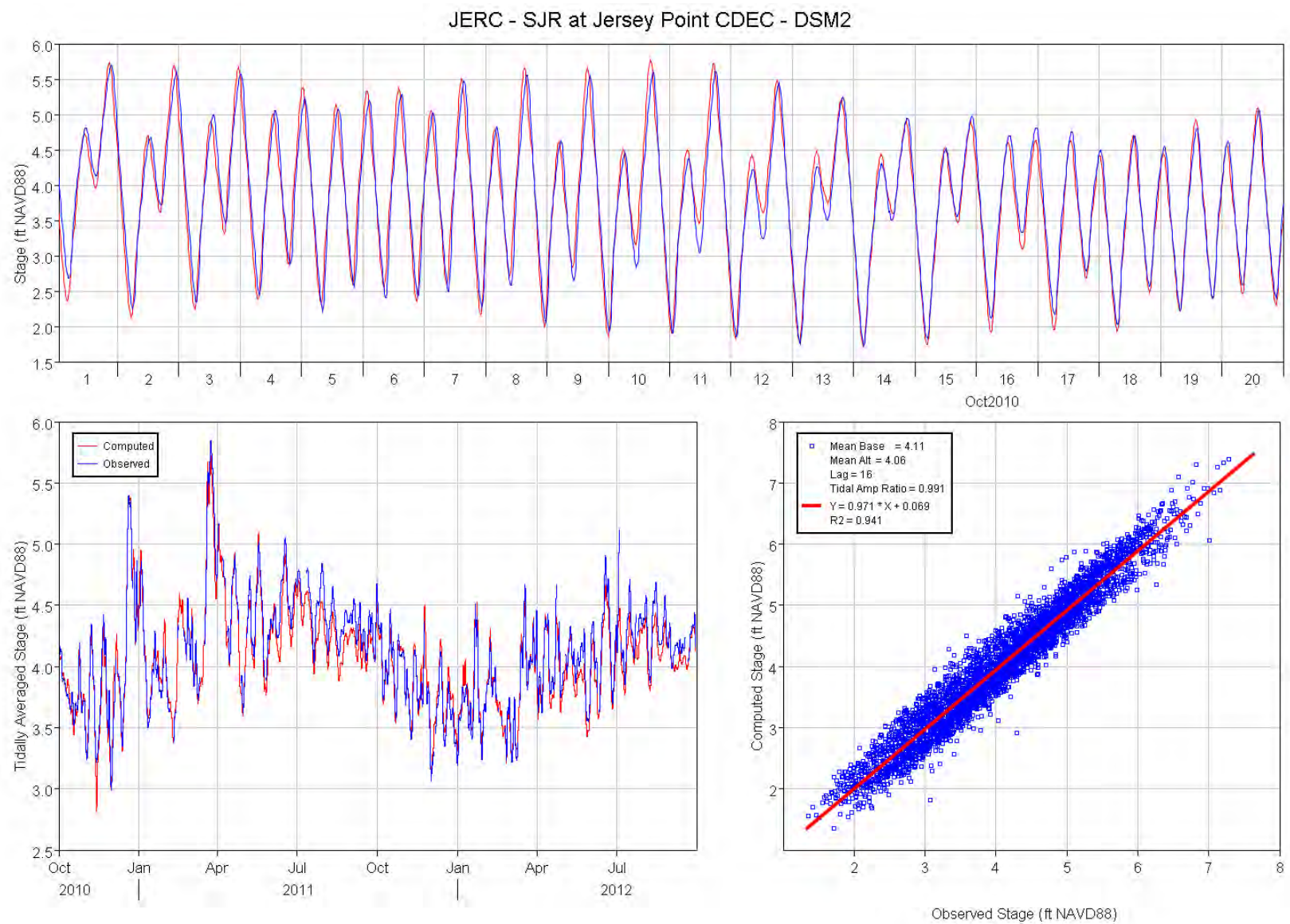


Figure 160 Computed (DSM2) and observed stage comparison plots for San Joaquin River at Jersey Point.



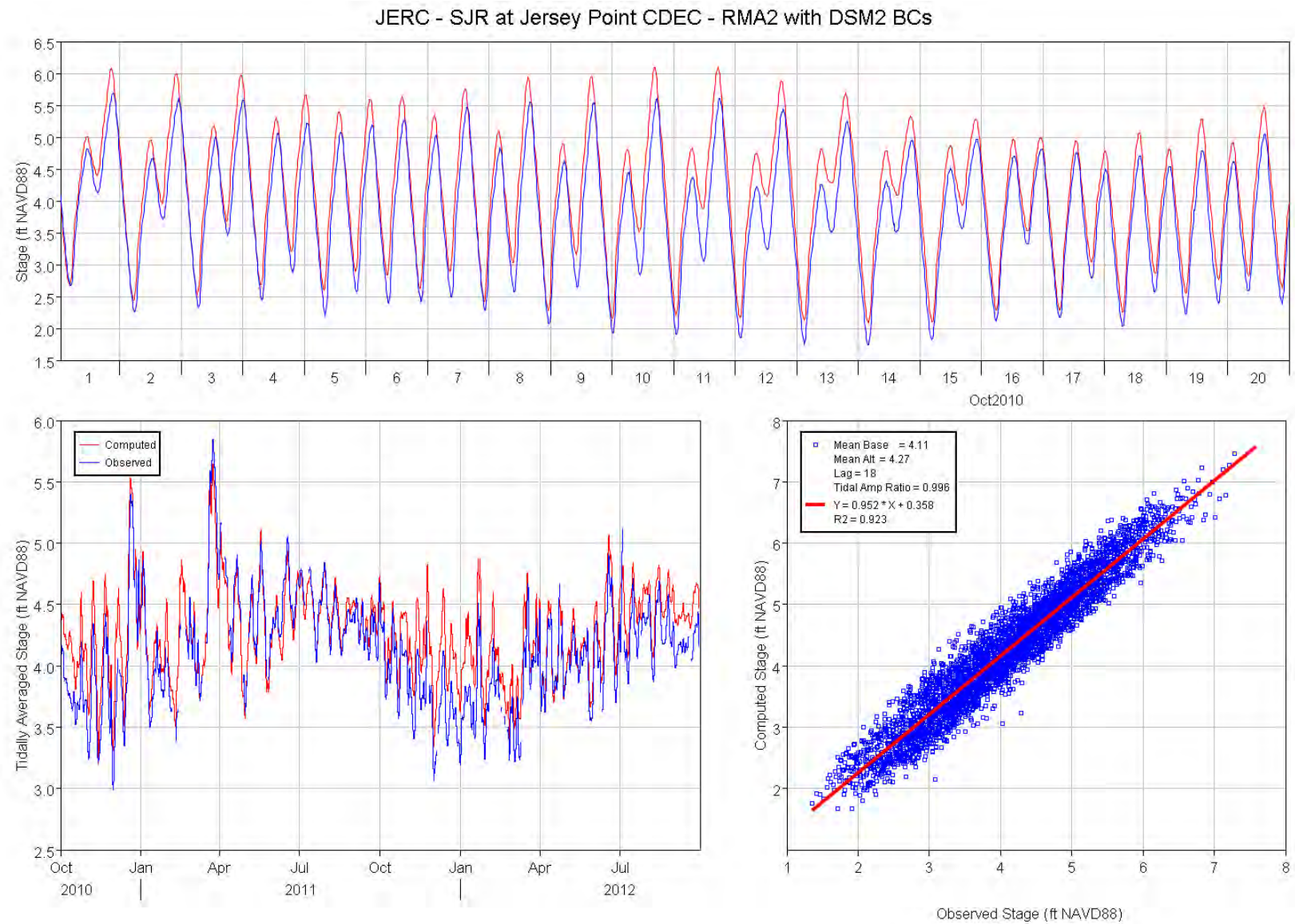


Figure 161 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for San Joaquin River at Jersey Point.

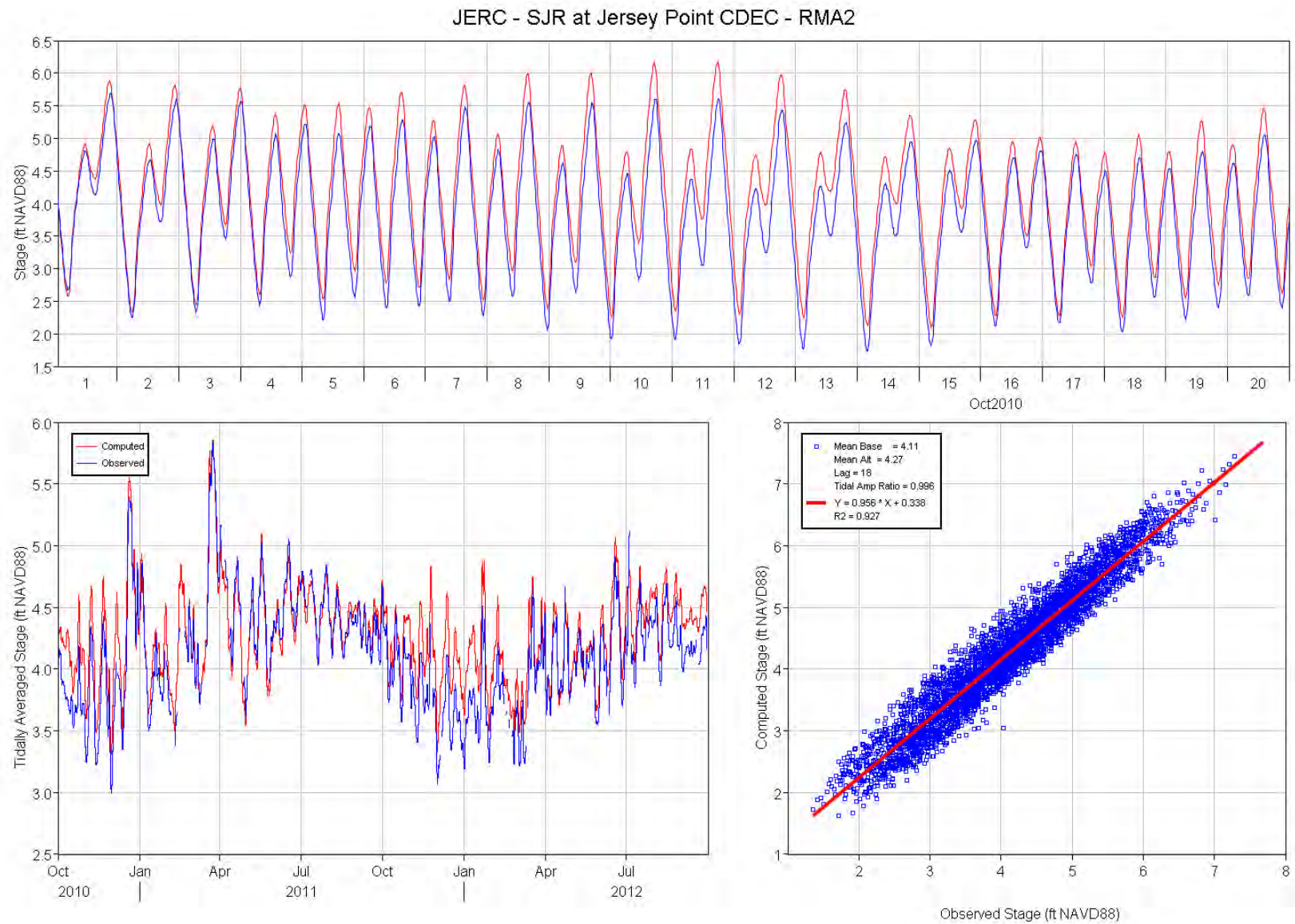


Figure 162 Computed (RMA2) and observed stage comparison plots for San Joaquin River at Jersey Point.



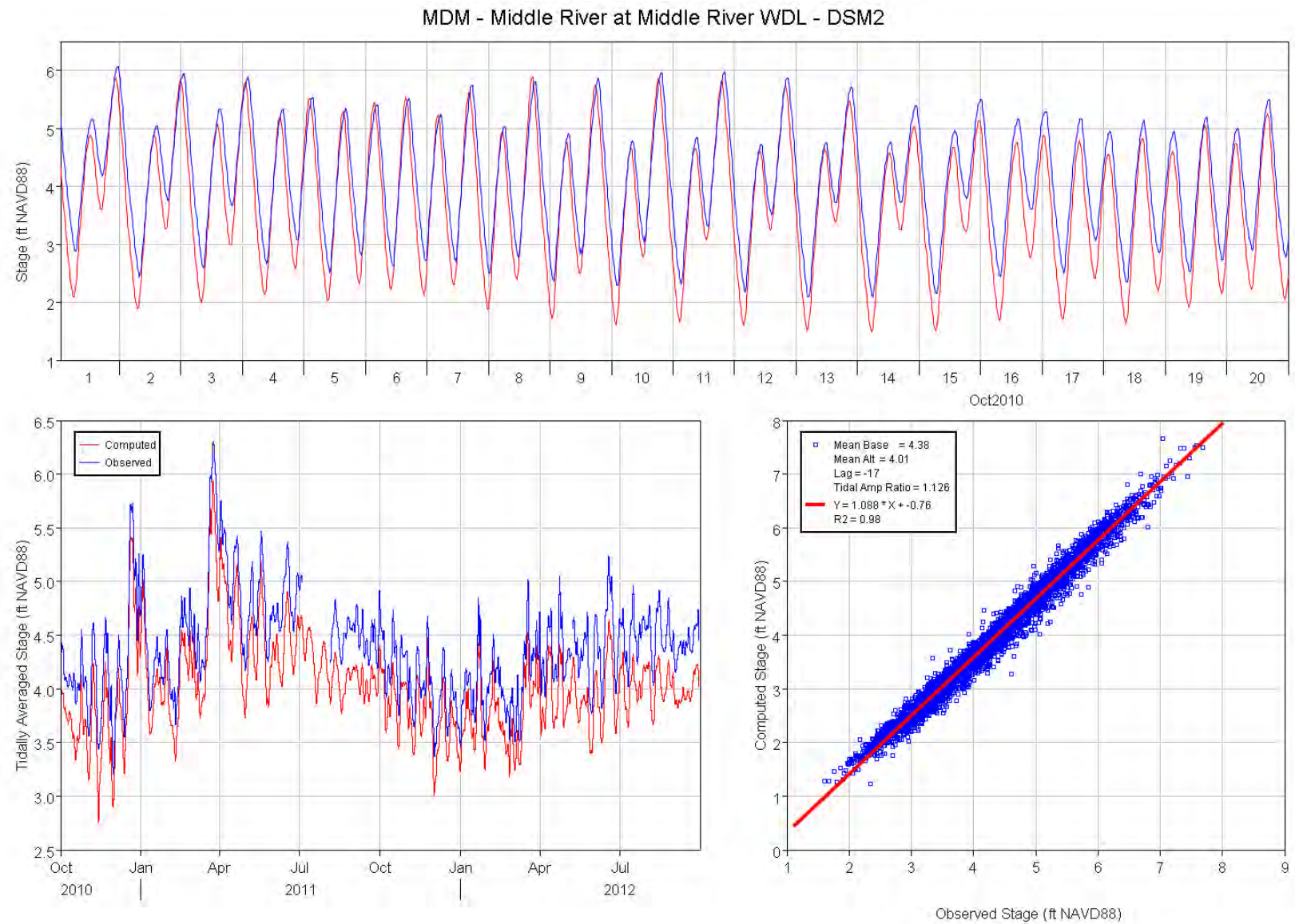


Figure 163 Computed (DSM2) and observed stage comparison plots for Middle River at Middle River.

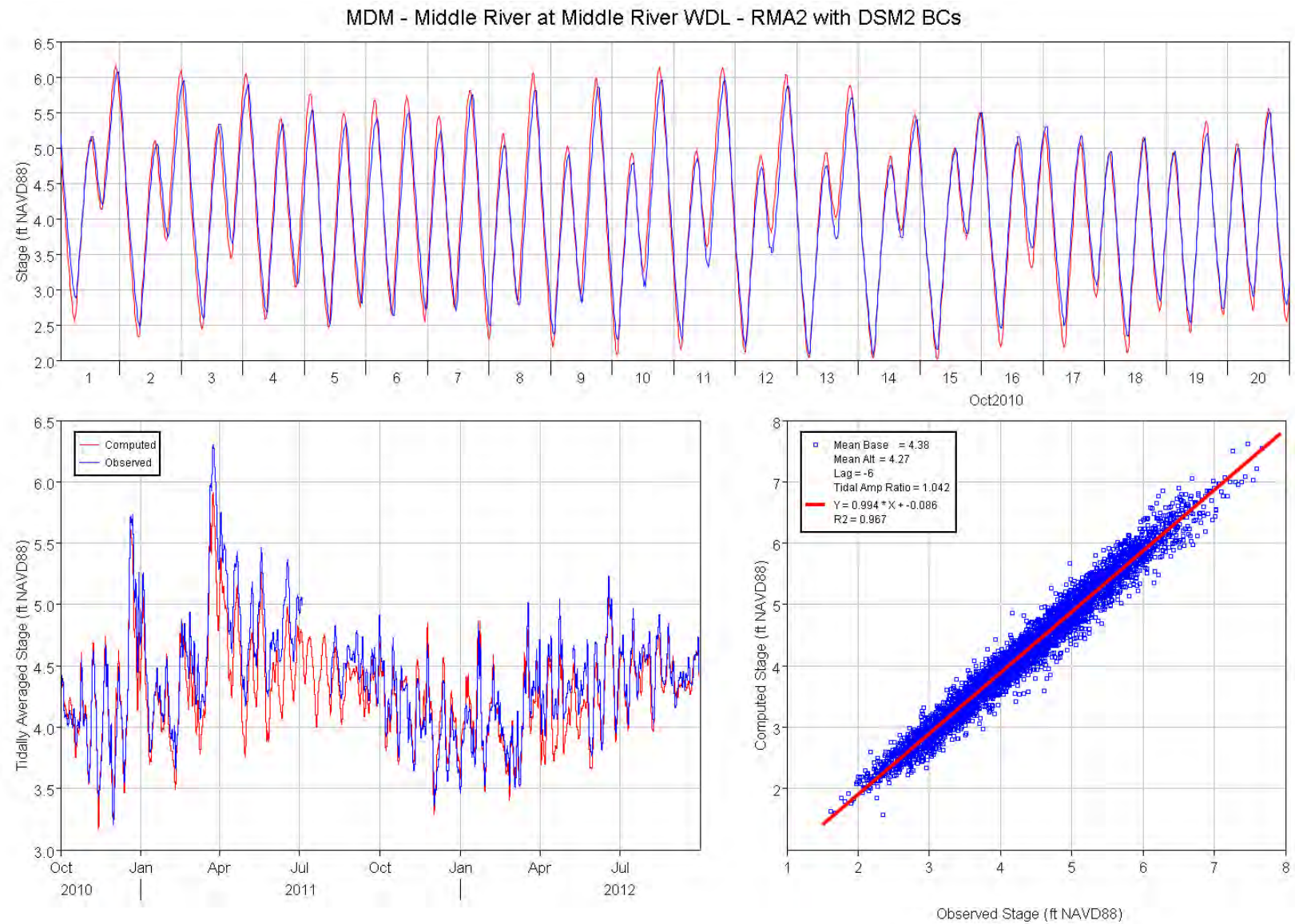


Figure 164 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Middle River at Middle River.



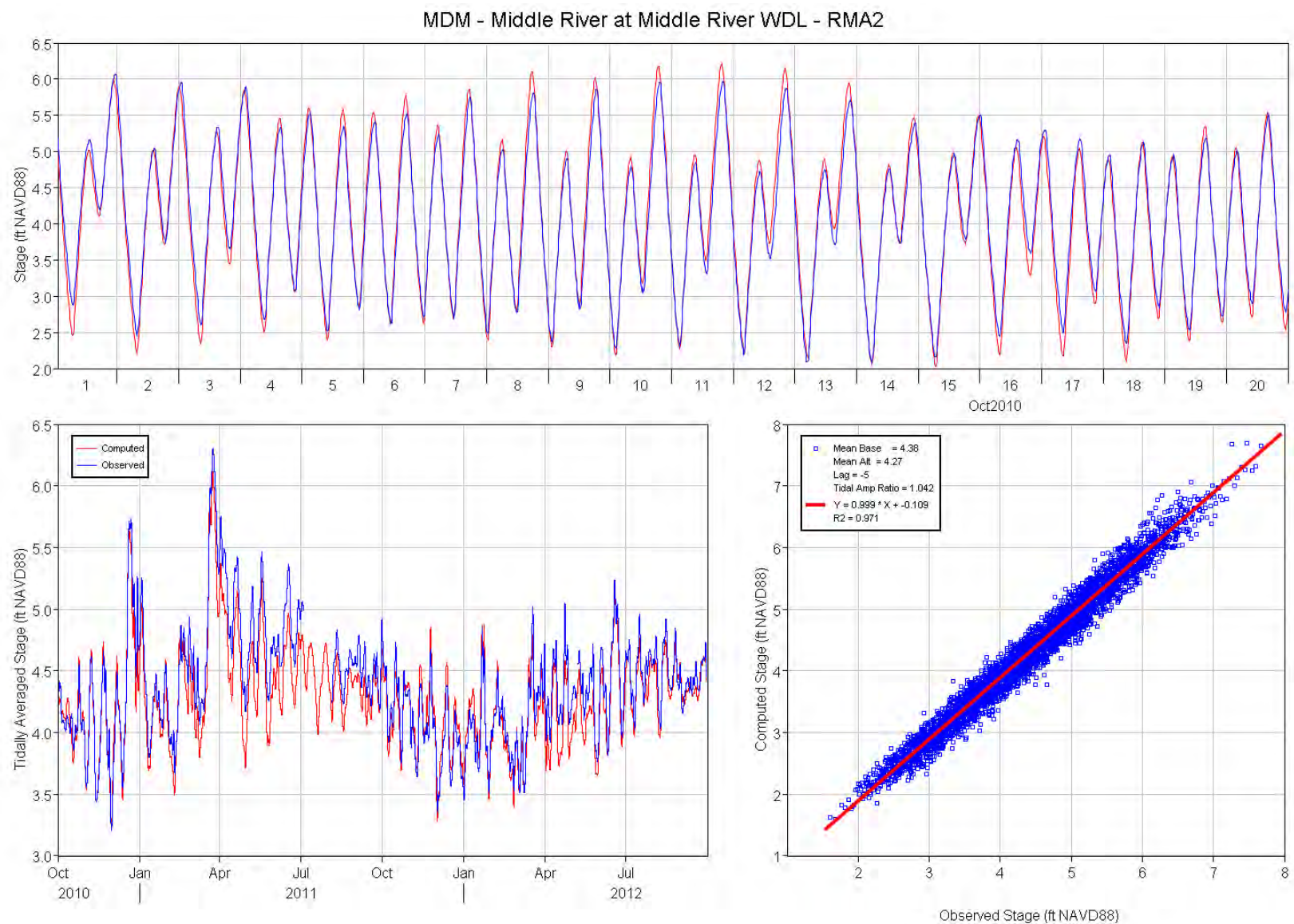


Figure 165 Computed (RMA2) and observed stage comparison plots for Middle River at Middle River.



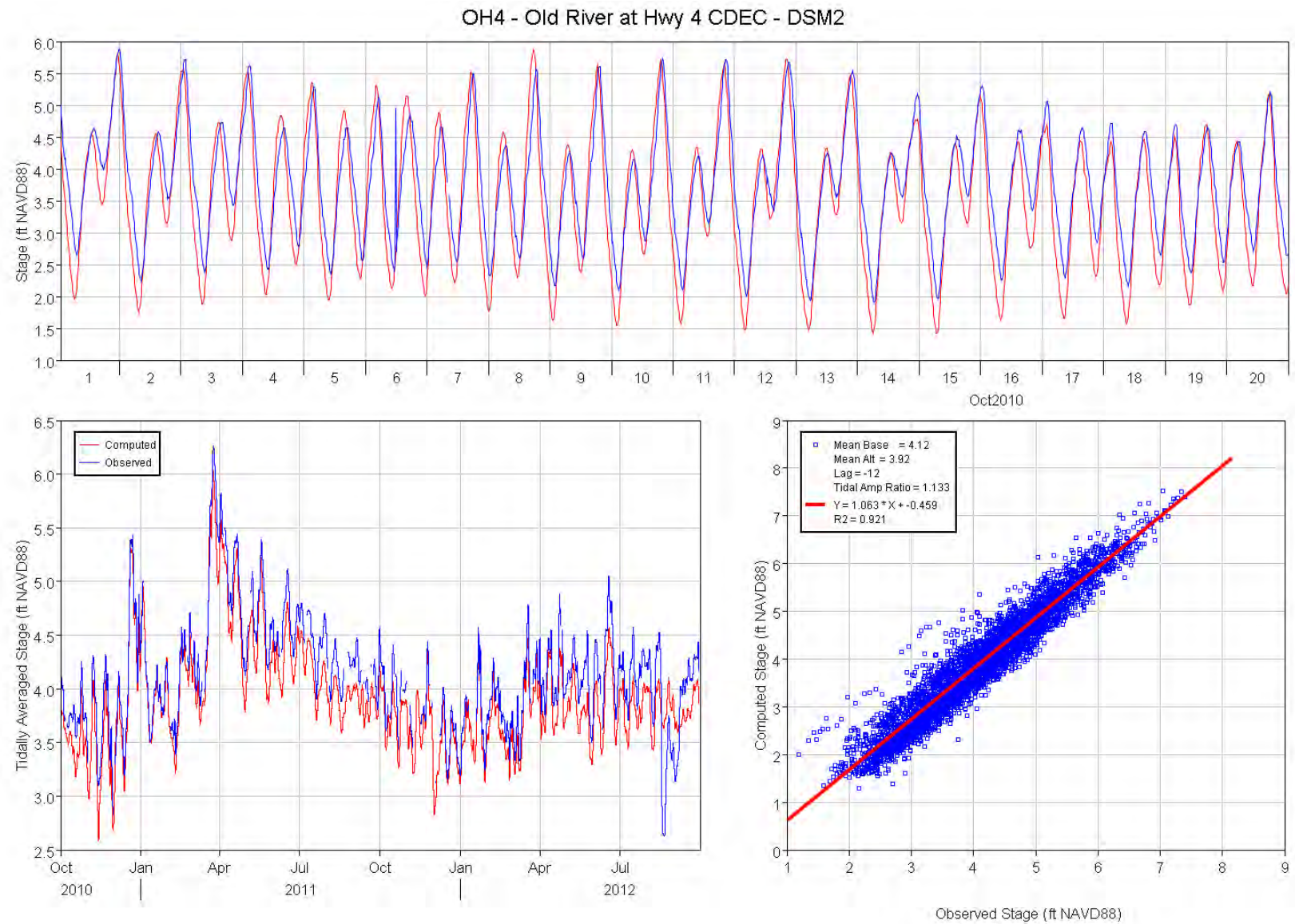


Figure 166 Computed (DSM2) and observed stage comparison plots for Old River at Hwy 4.

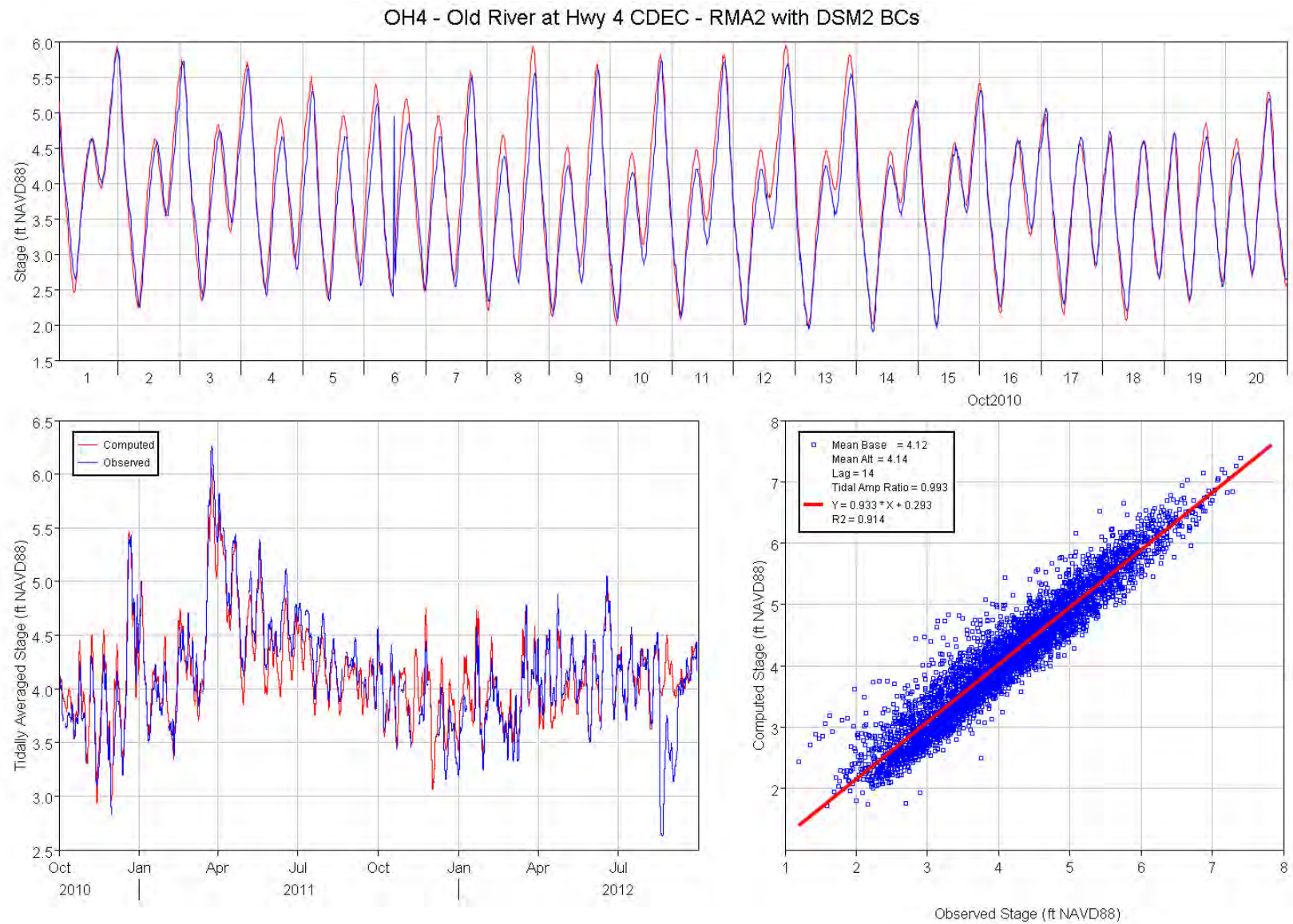


Figure 167 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Hwy 4.



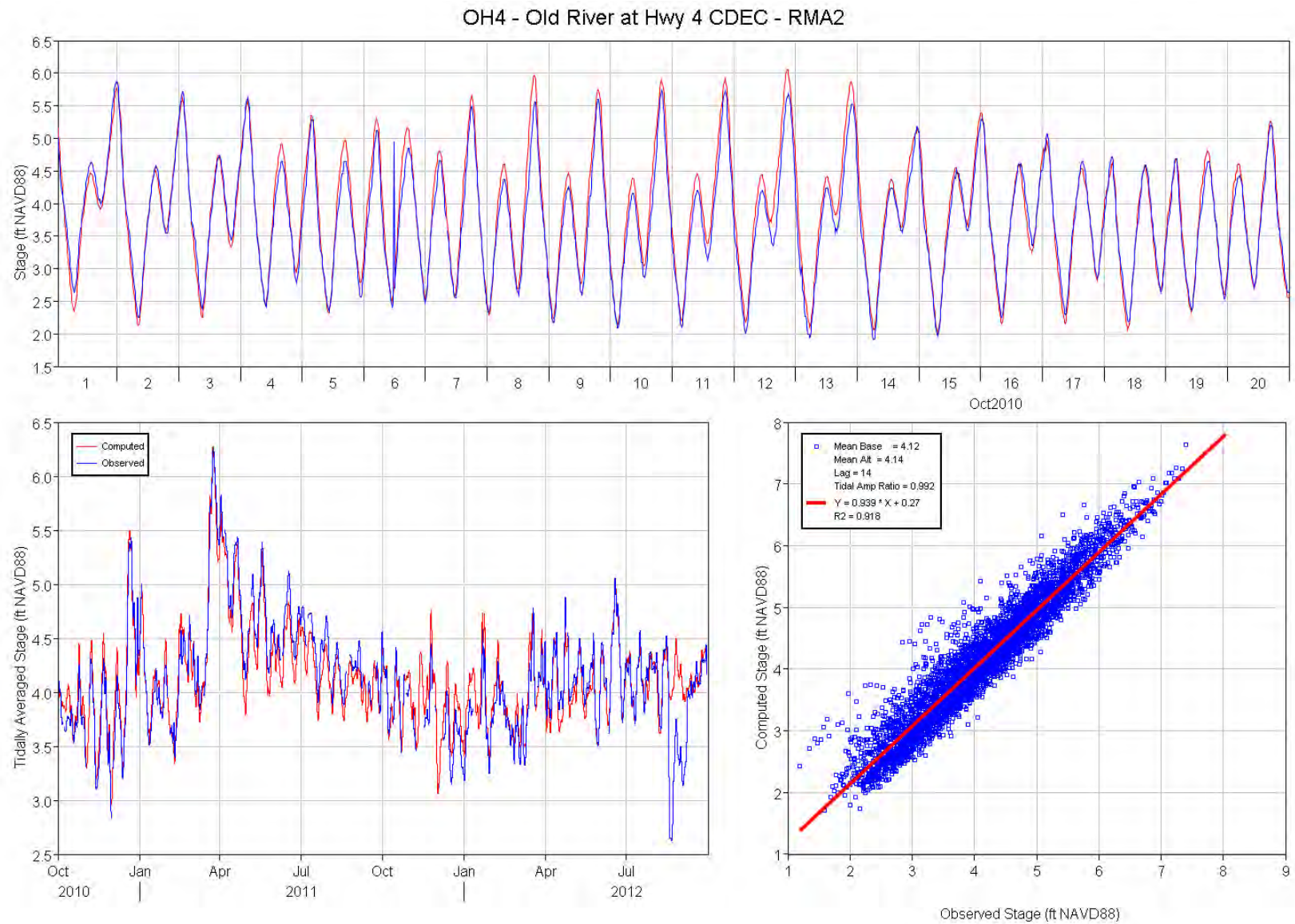


Figure 168 Computed (RMA2) and observed stage comparison plots for Old River at Hwy 4.



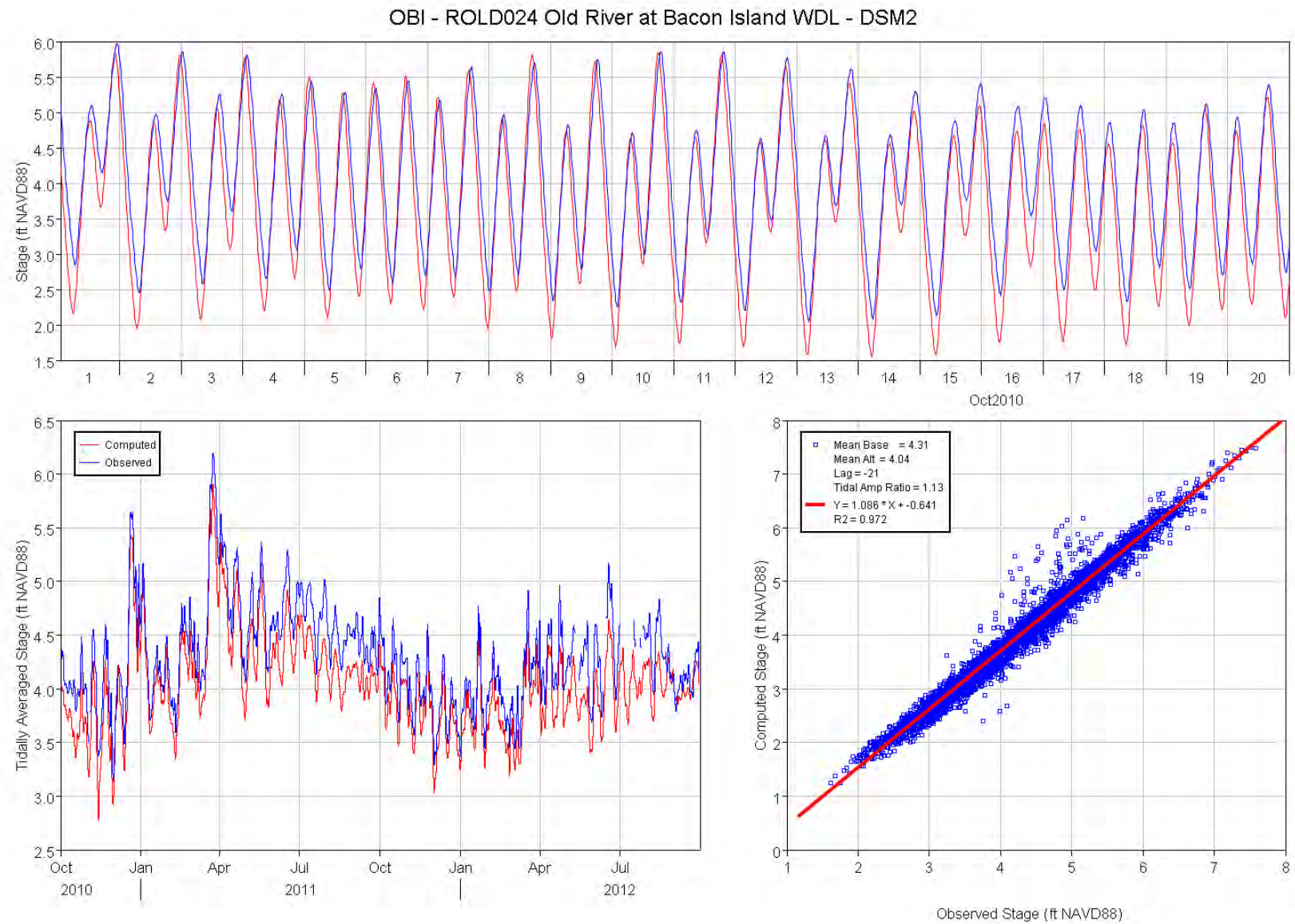


Figure 169 Computed (DSM2) and observed stage comparison plots for Old River at Bacon Island.

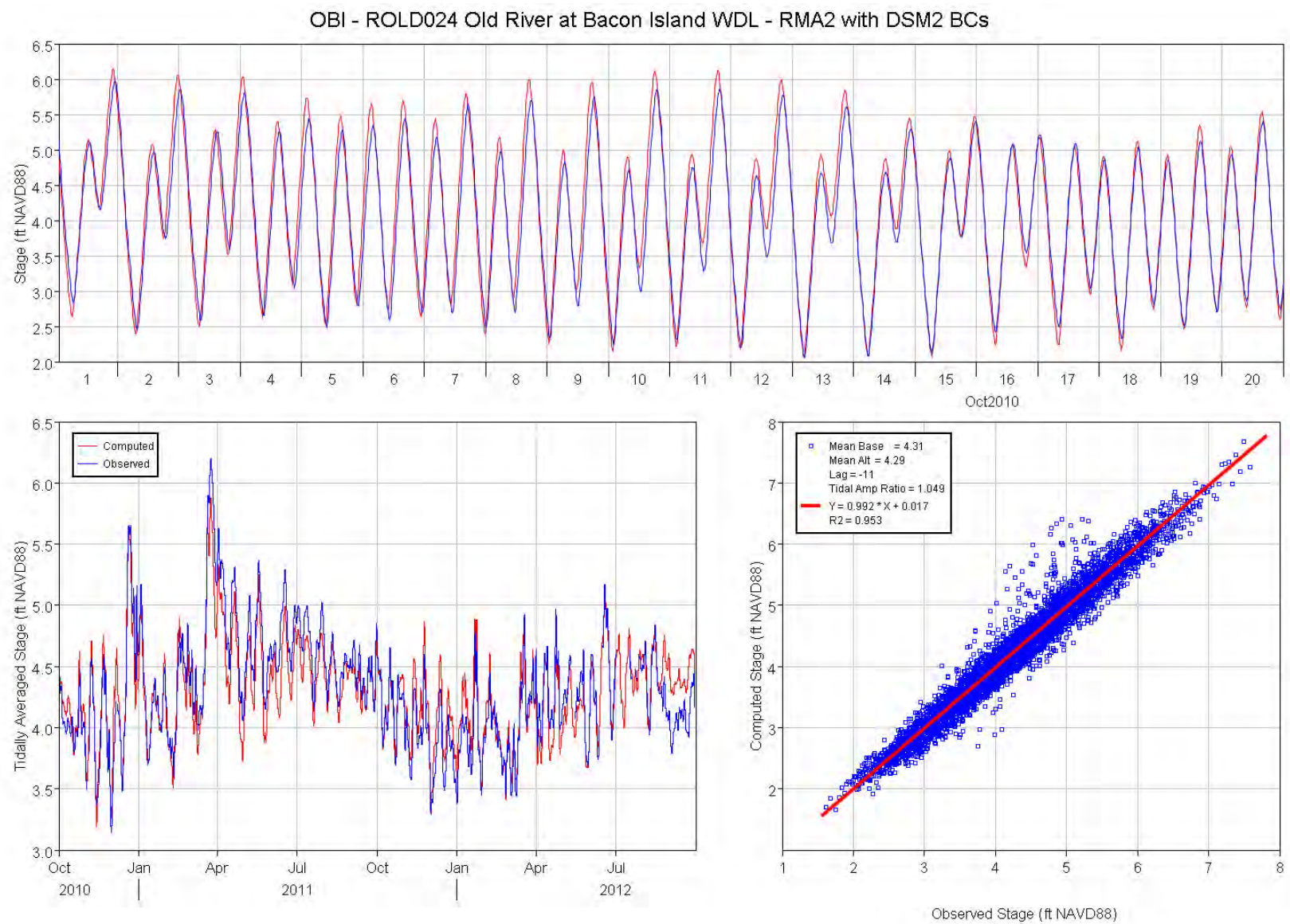


Figure 170 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Bacon Island.



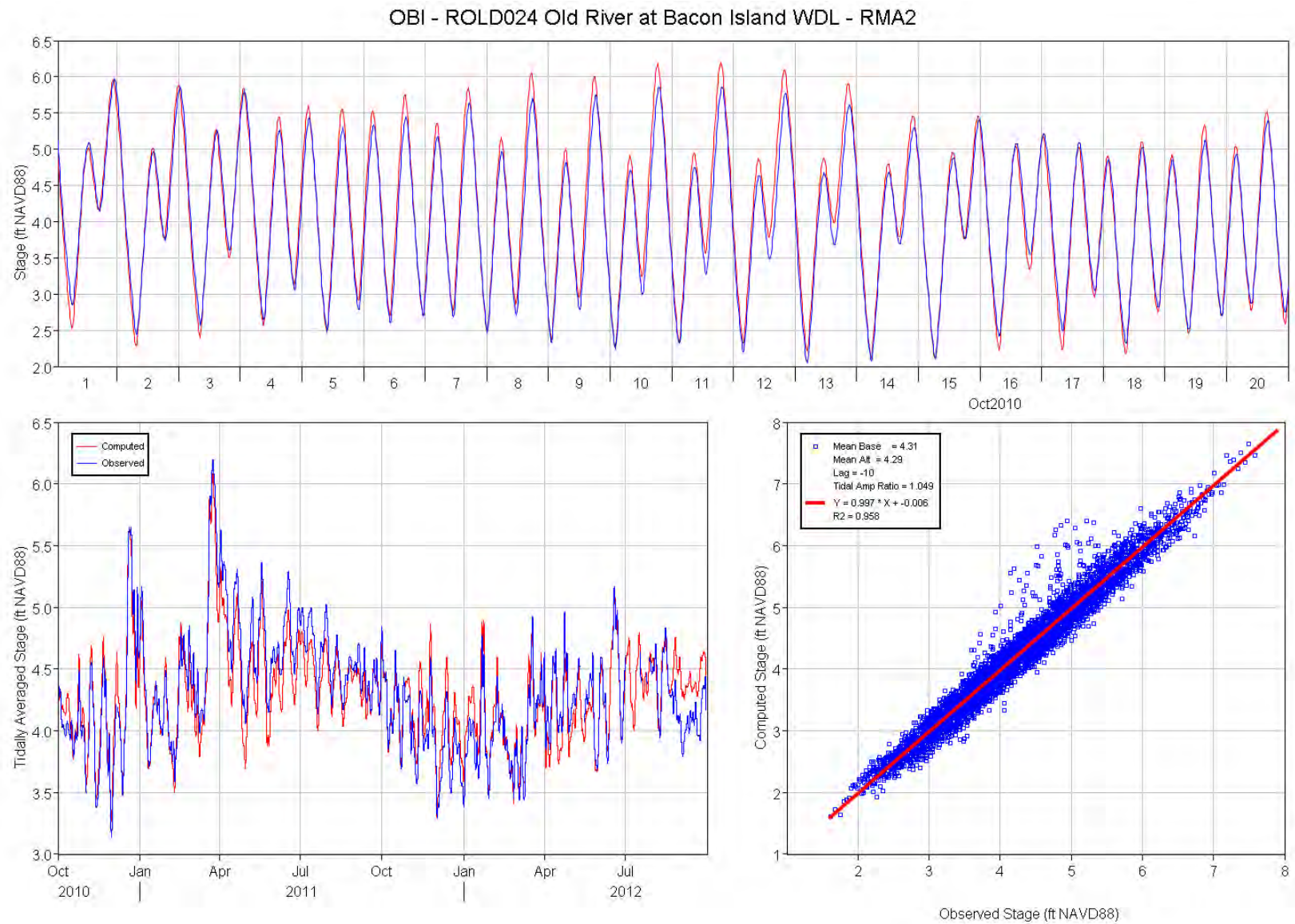


Figure 171 Computed (RMA2) and observed stage comparison plots for Old River at Bacon Island.



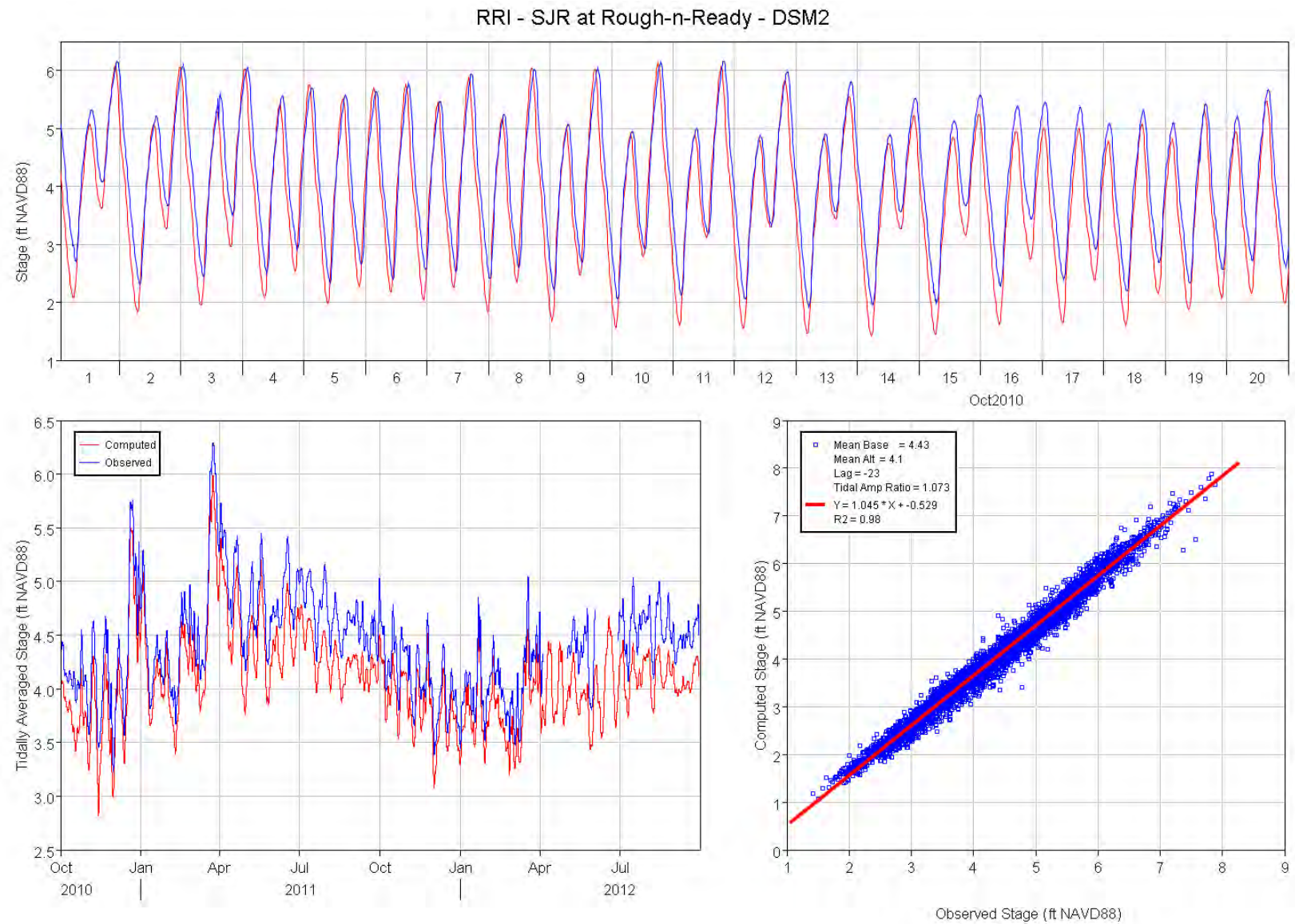


Figure 172 Computed (DSM2) and observed stage comparison plots for SJR at Rough-n-Ready.

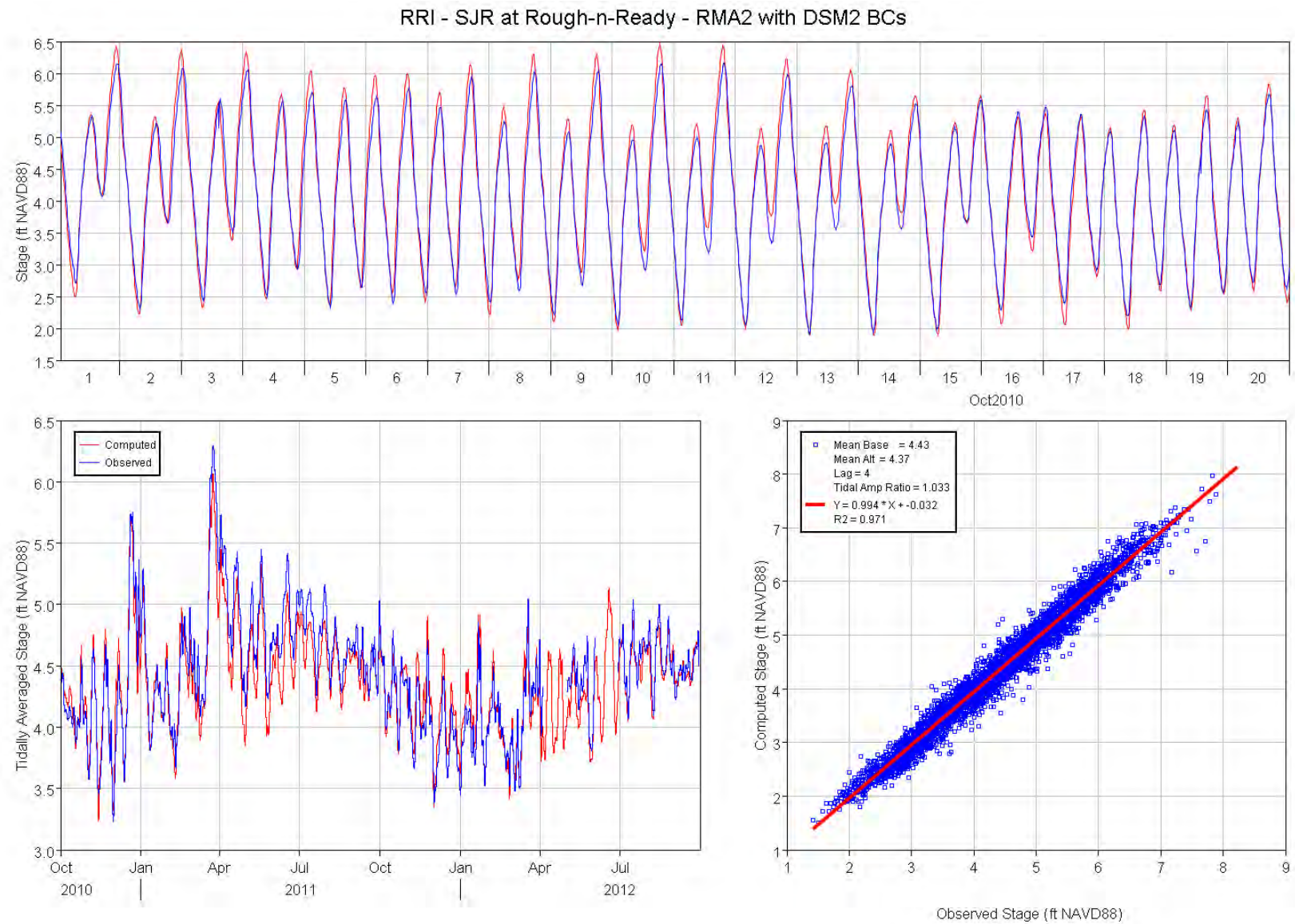


Figure 173 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR at Rough-n-Ready.



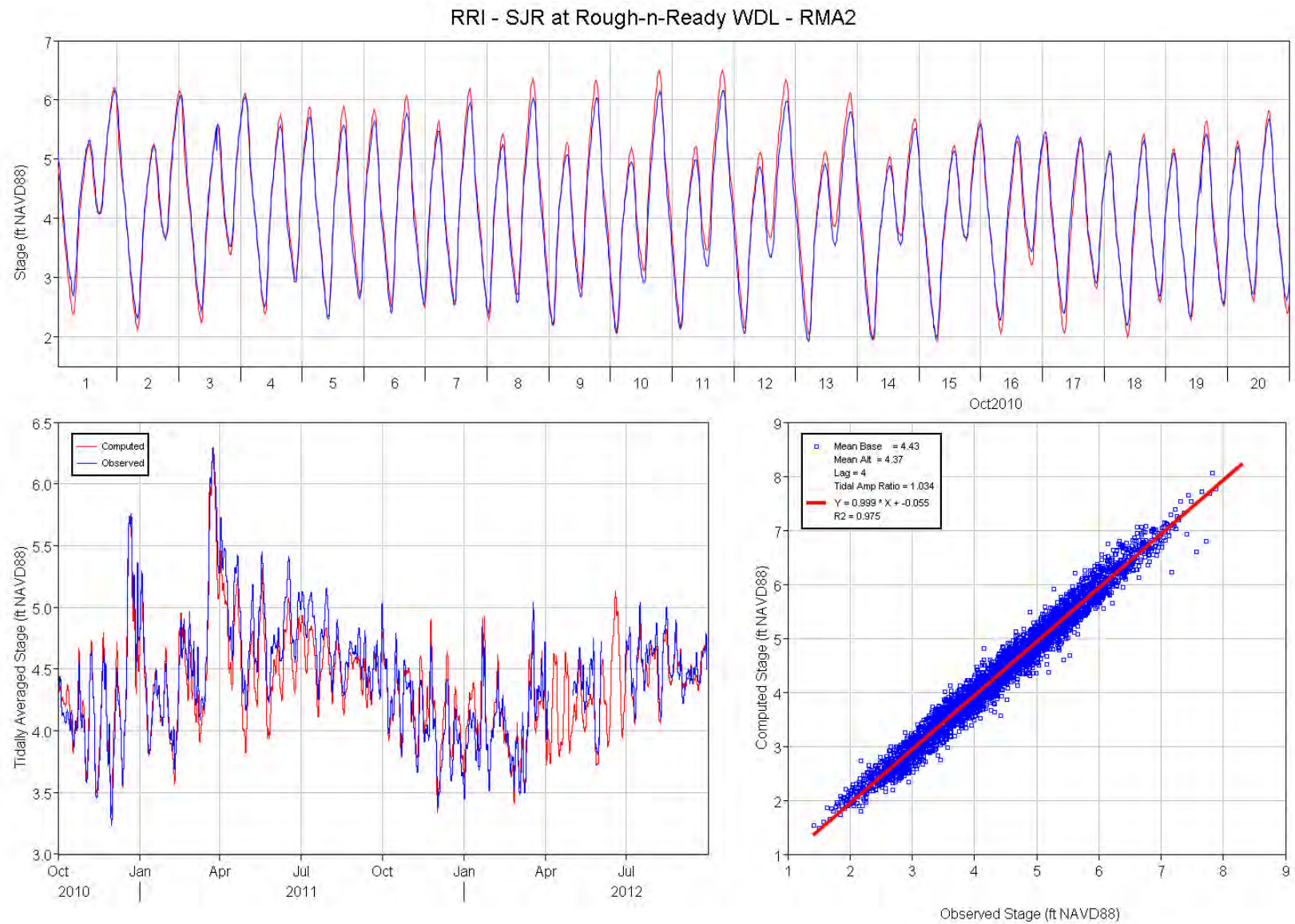


Figure 174 Computed (RMA2) and observed stage comparison plots for SJR at Rough-n-Ready.



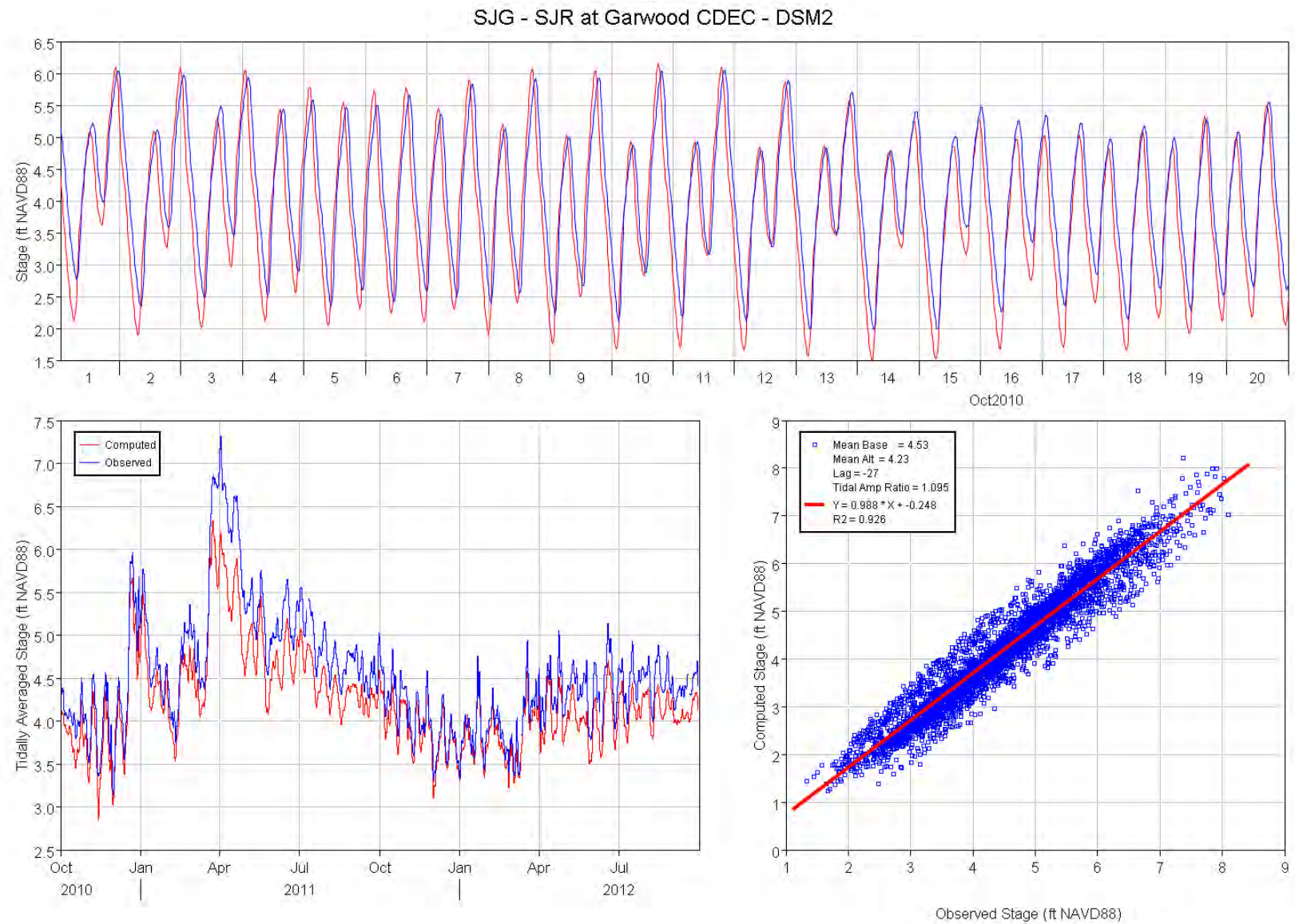


Figure 175 Computed (DSM2) and observed stage comparison plots for SJR at Garwood.

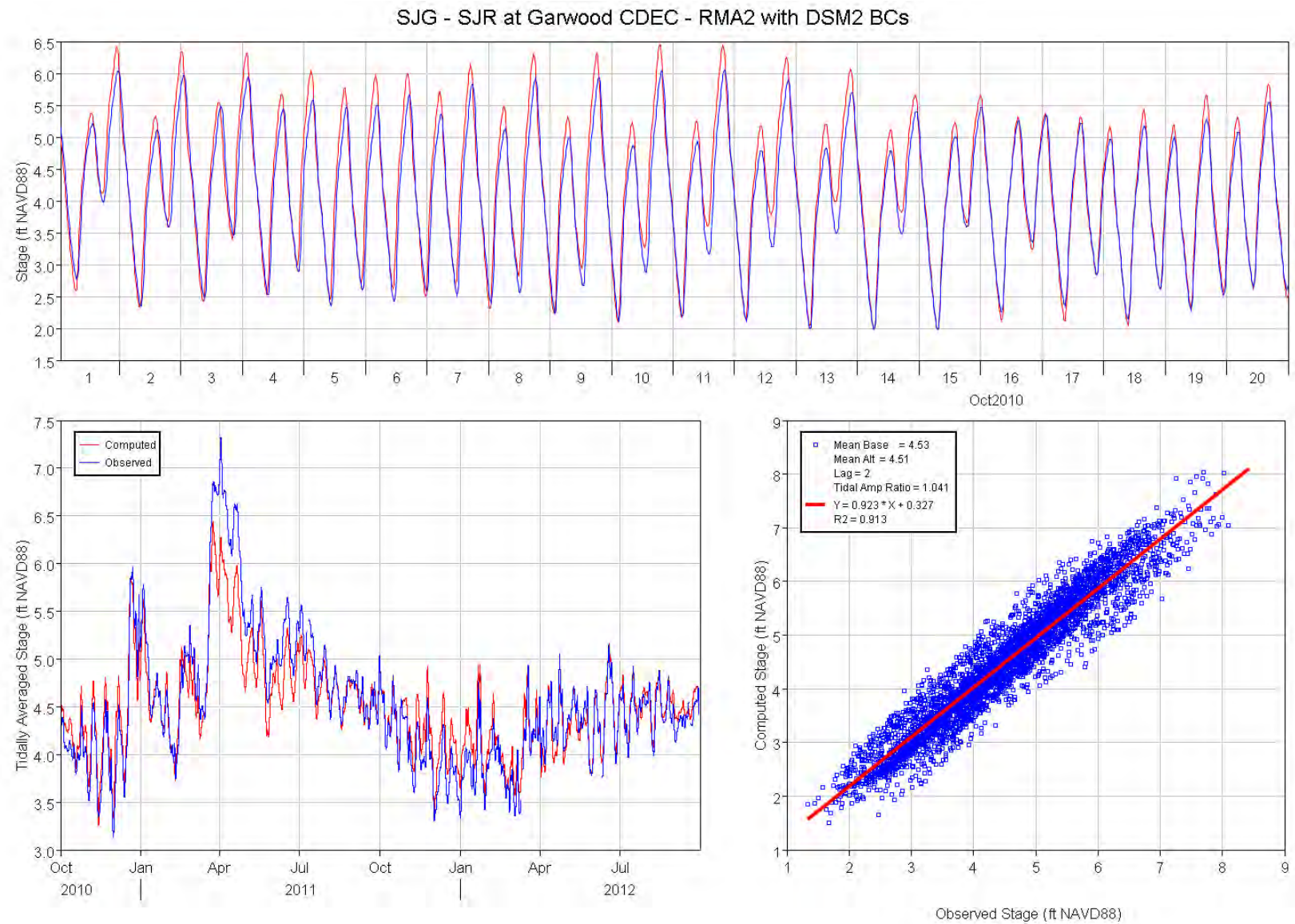


Figure 176 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR at Garwood.



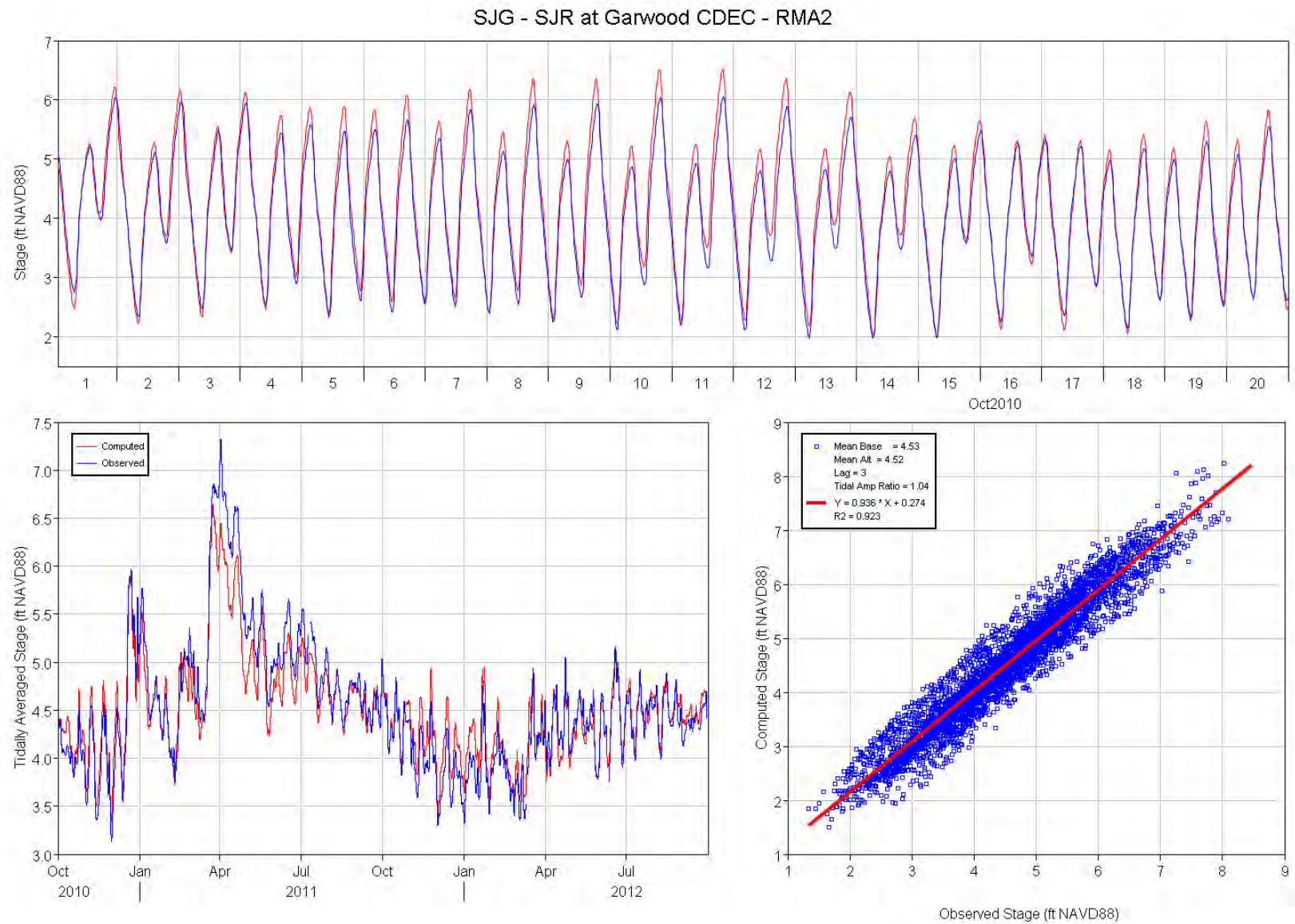


Figure 177 Computed (RMA2) and observed stage comparison plots for SJR at Garwood.



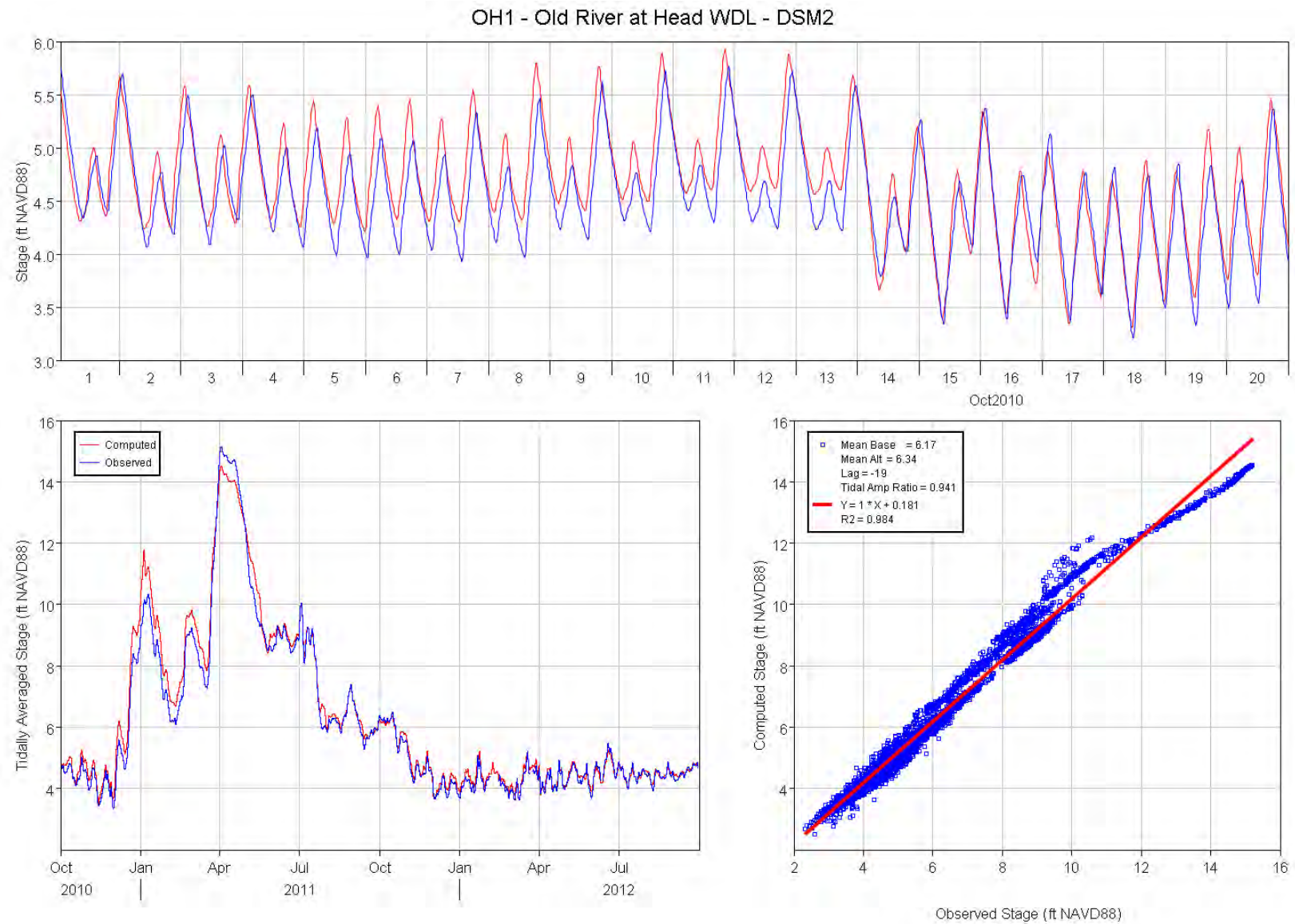


Figure 178 Computed (DSM2) and observed stage comparison plots for Old River at Head.

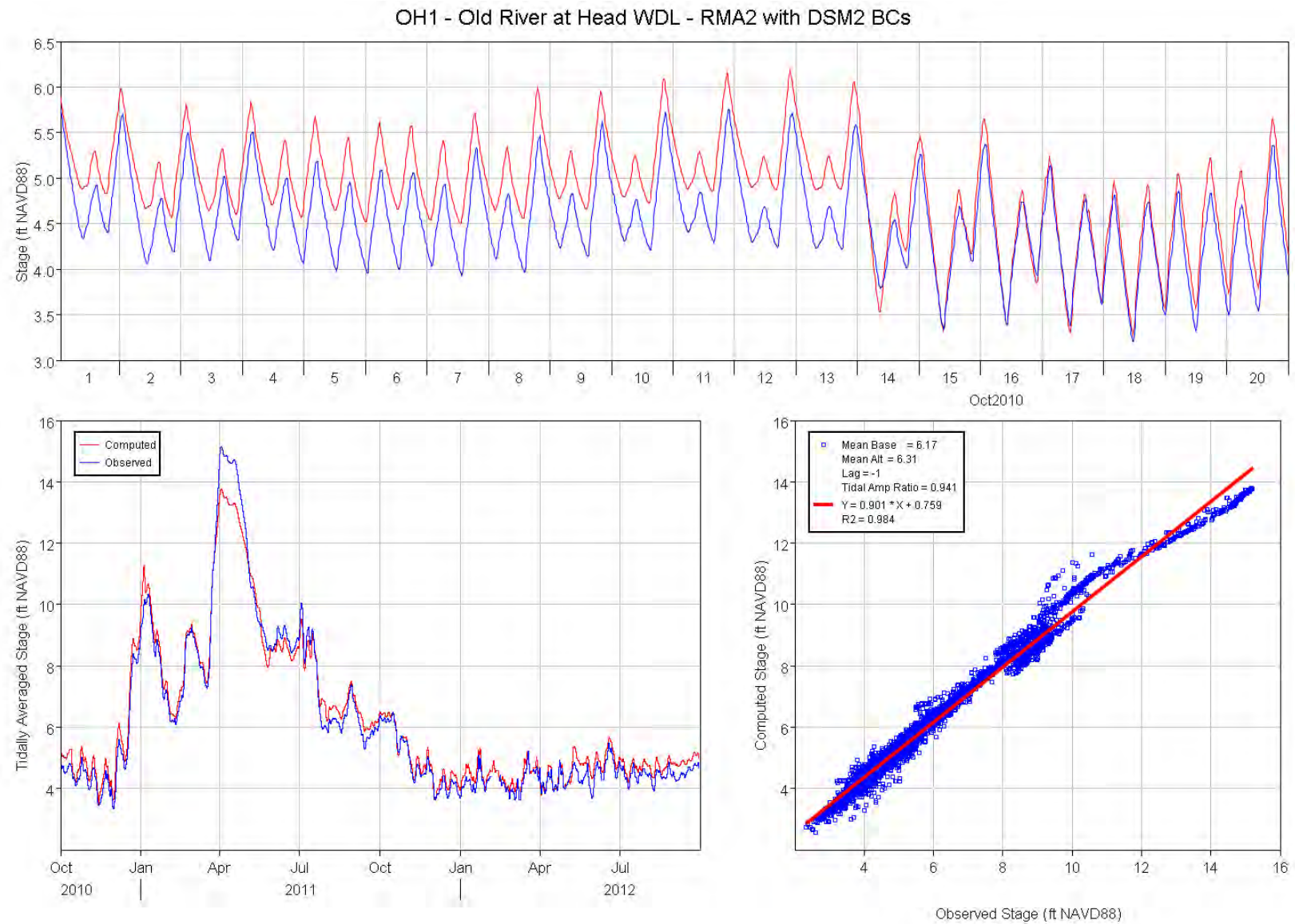


Figure 179 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Head.

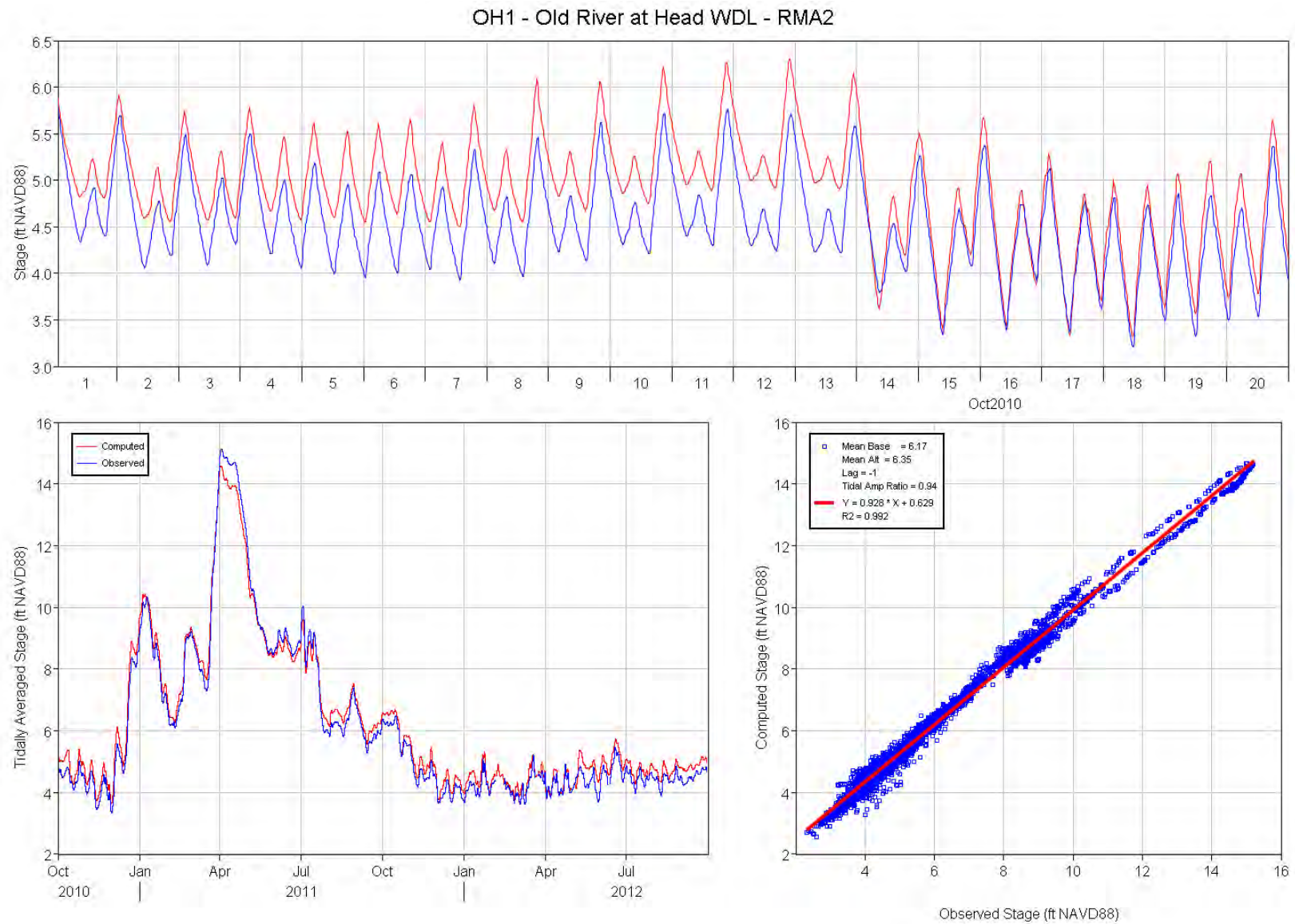


Figure 180 Computed (RMA2) and observed stage comparison plots for Old River at Head.



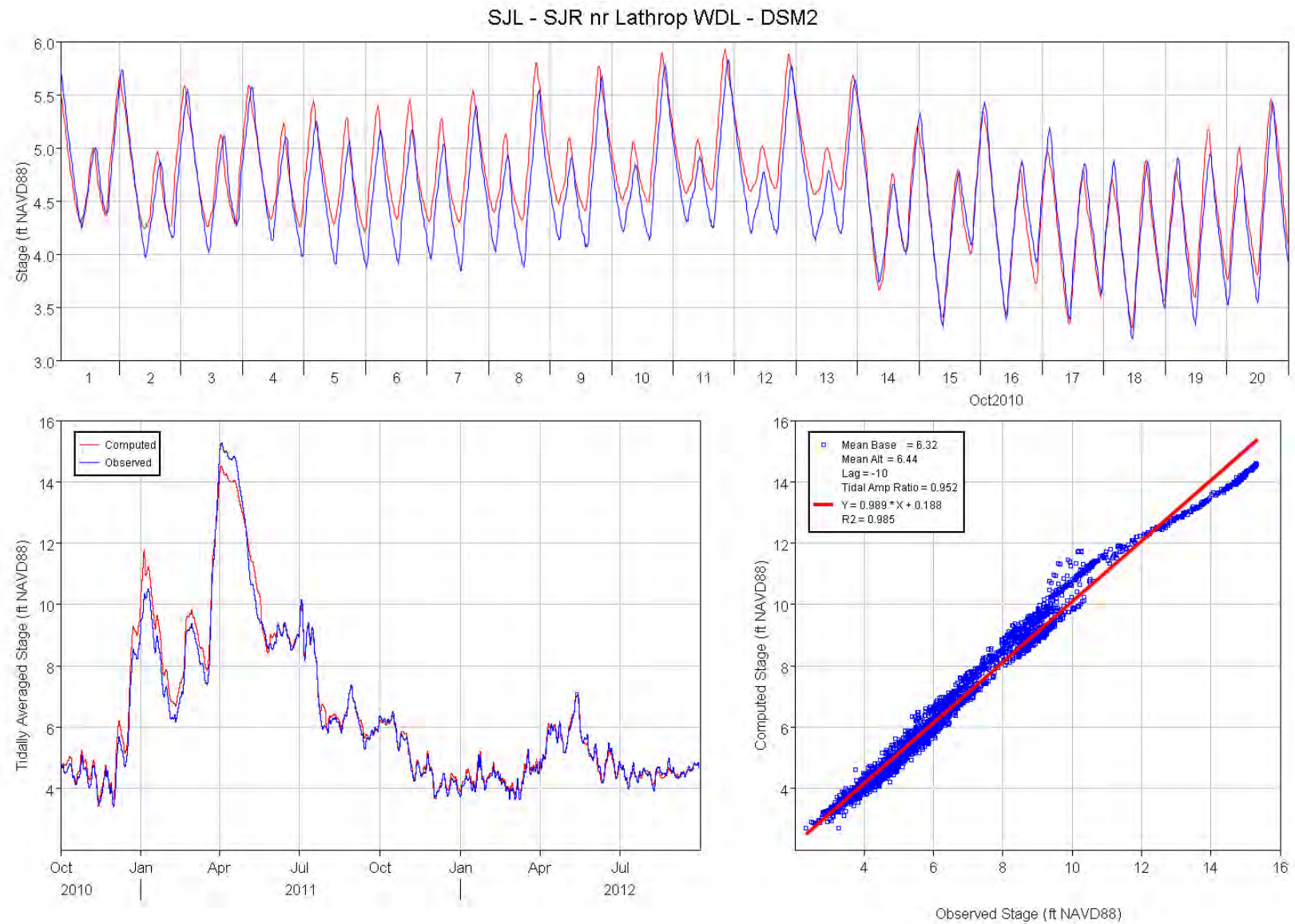


Figure 181 Computed (DSM2) and observed stage comparison plots for SJR near Lathrop.

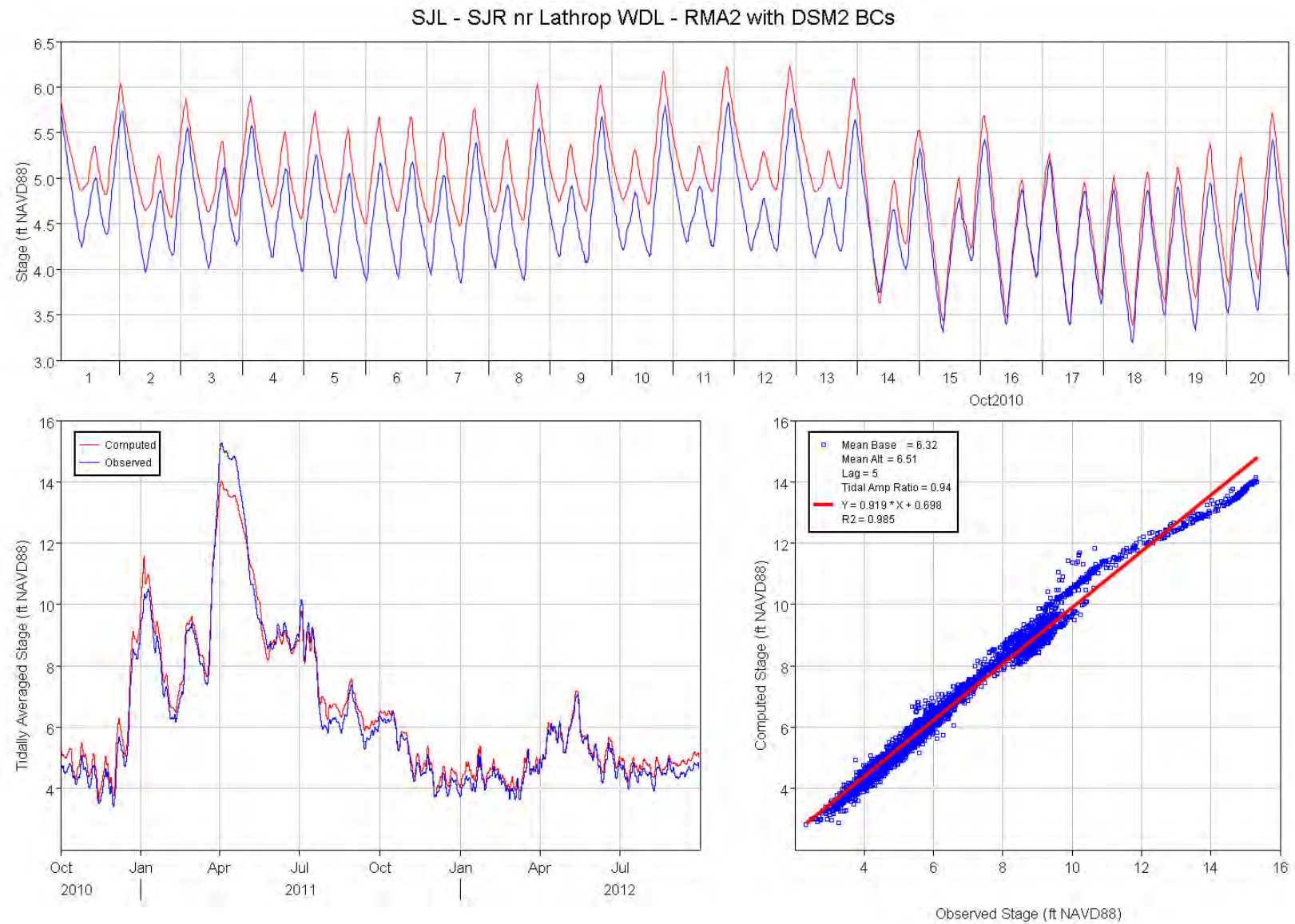


Figure 182 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR near Lathrop.

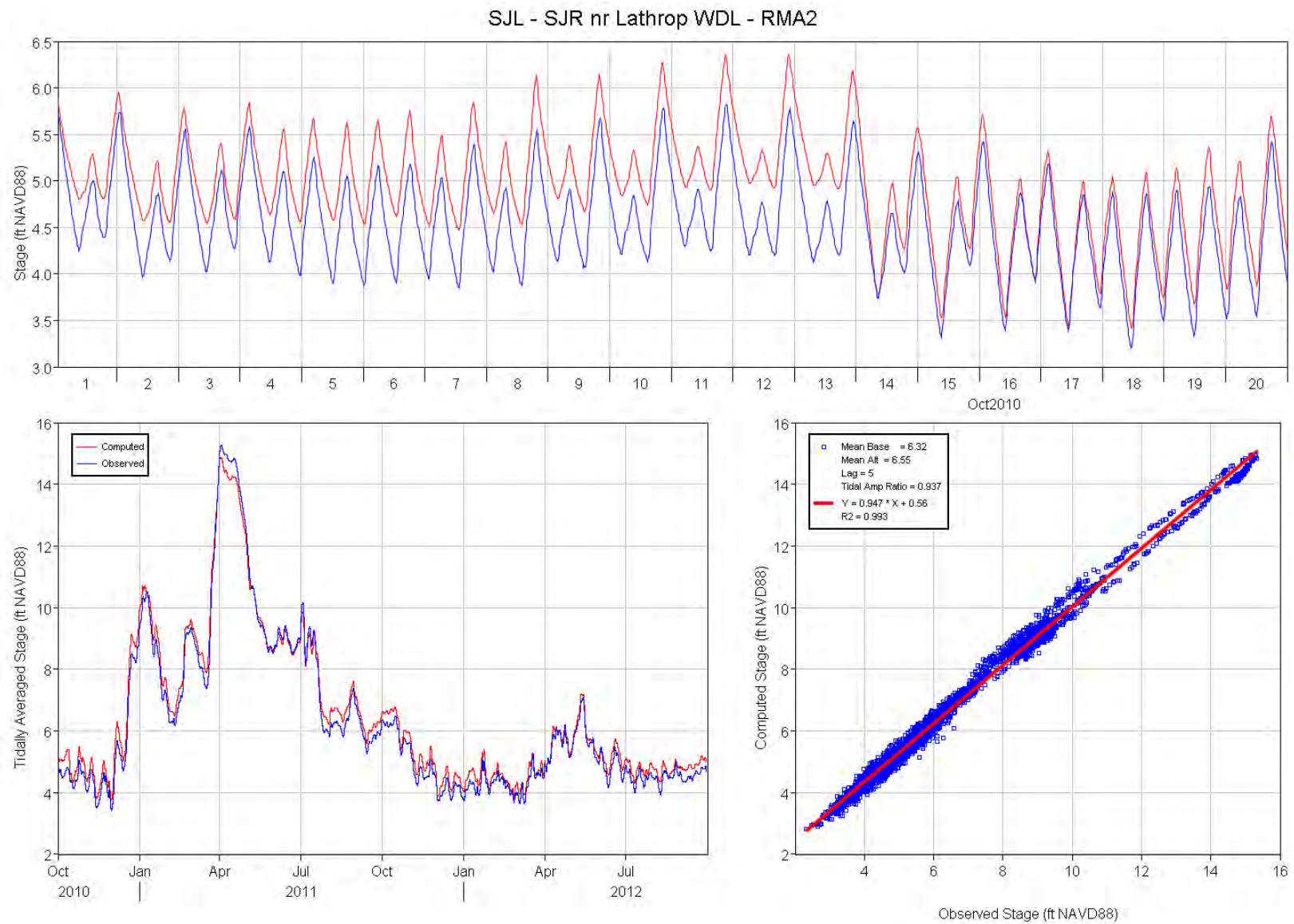


Figure 183 Computed (RMA2) and observed stage comparison plots for SJR near Lathrop.



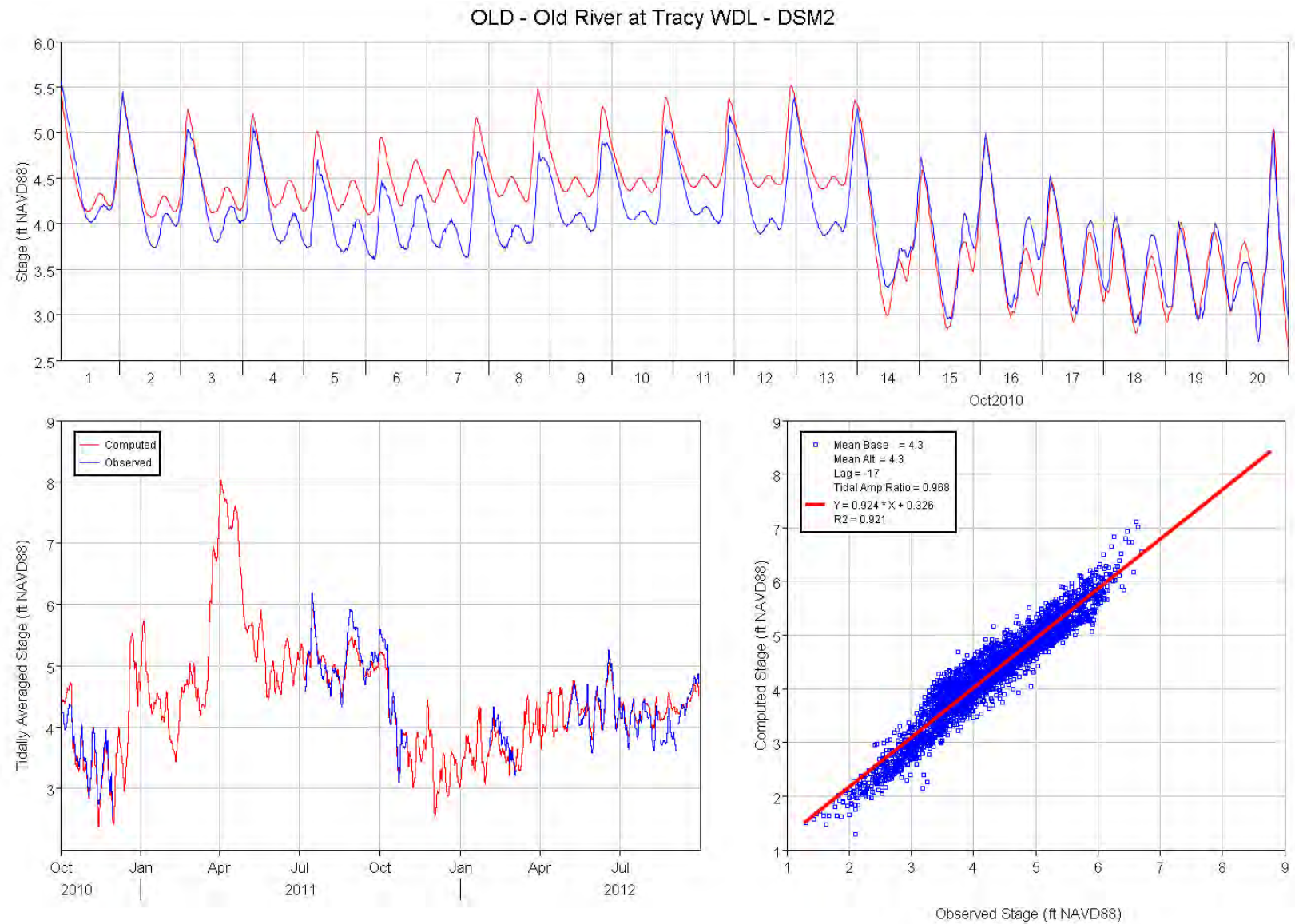


Figure 184 Computed (DSM2) and observed stage comparison plots for Old River at Tracy.

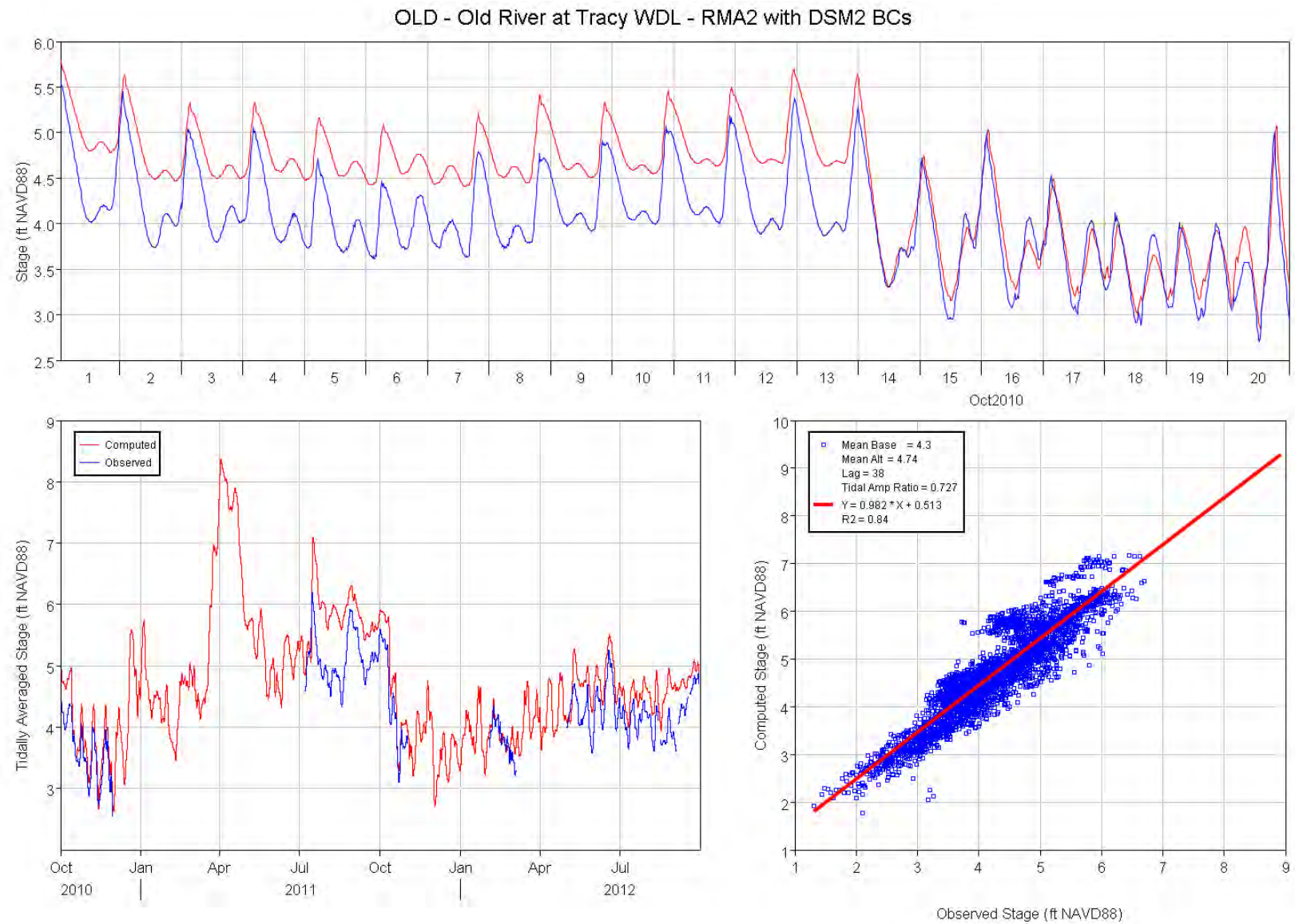


Figure 185 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Tracy.

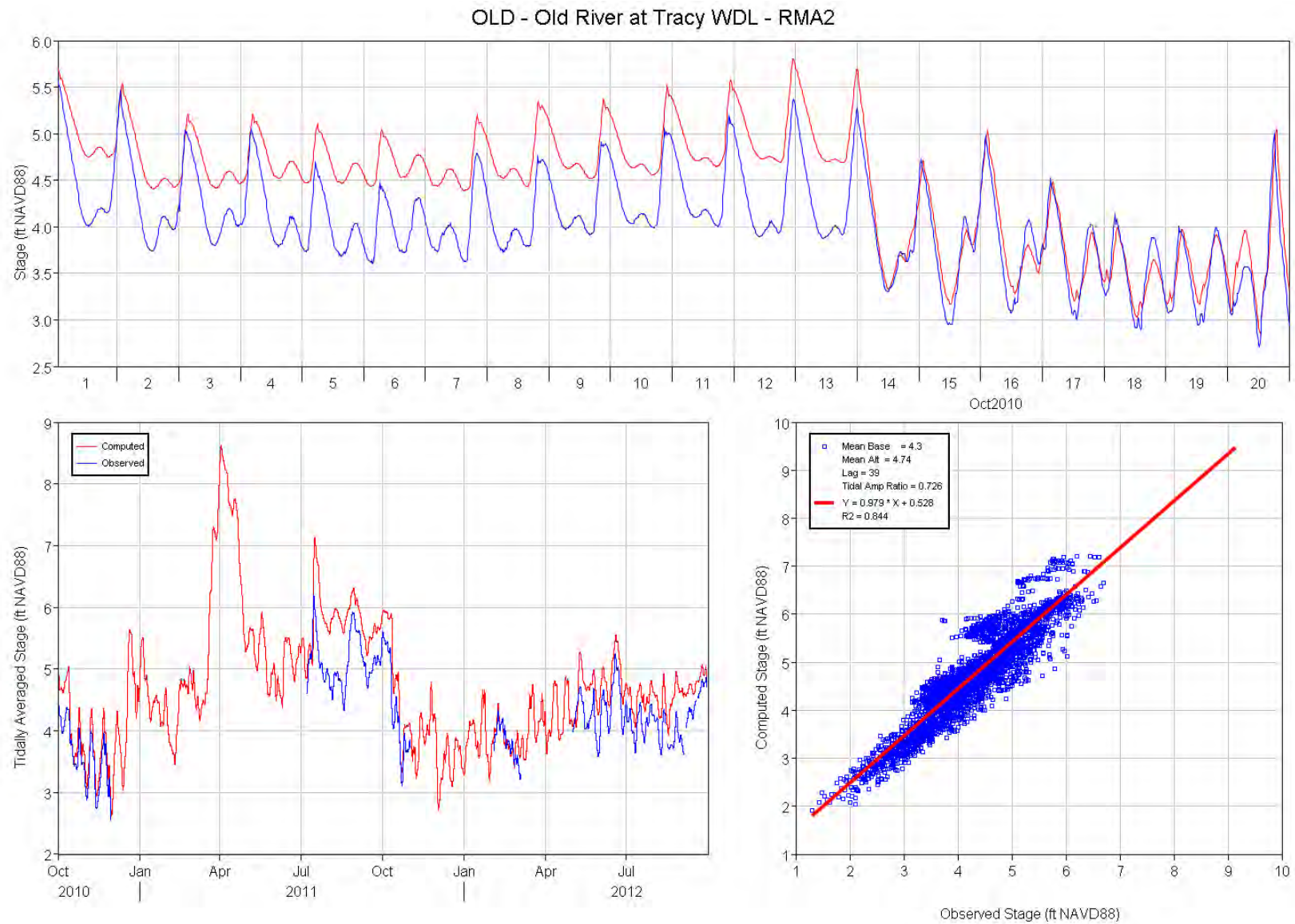


Figure 186 Computed (RMA2) and observed stage comparison plots for Old River at Tracy.



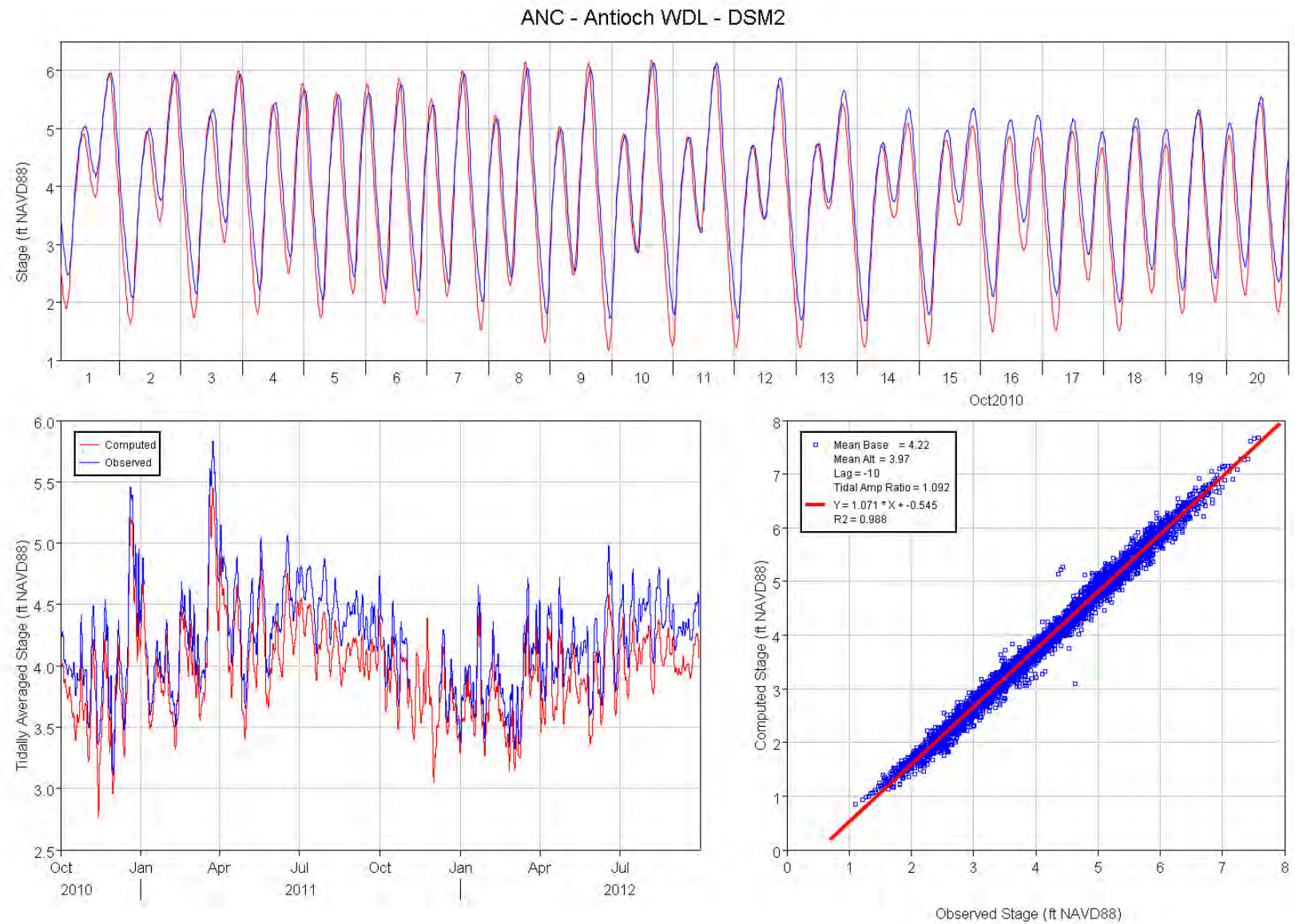


Figure 187 Computed (DSM2) and observed stage comparison plots for Antioch.

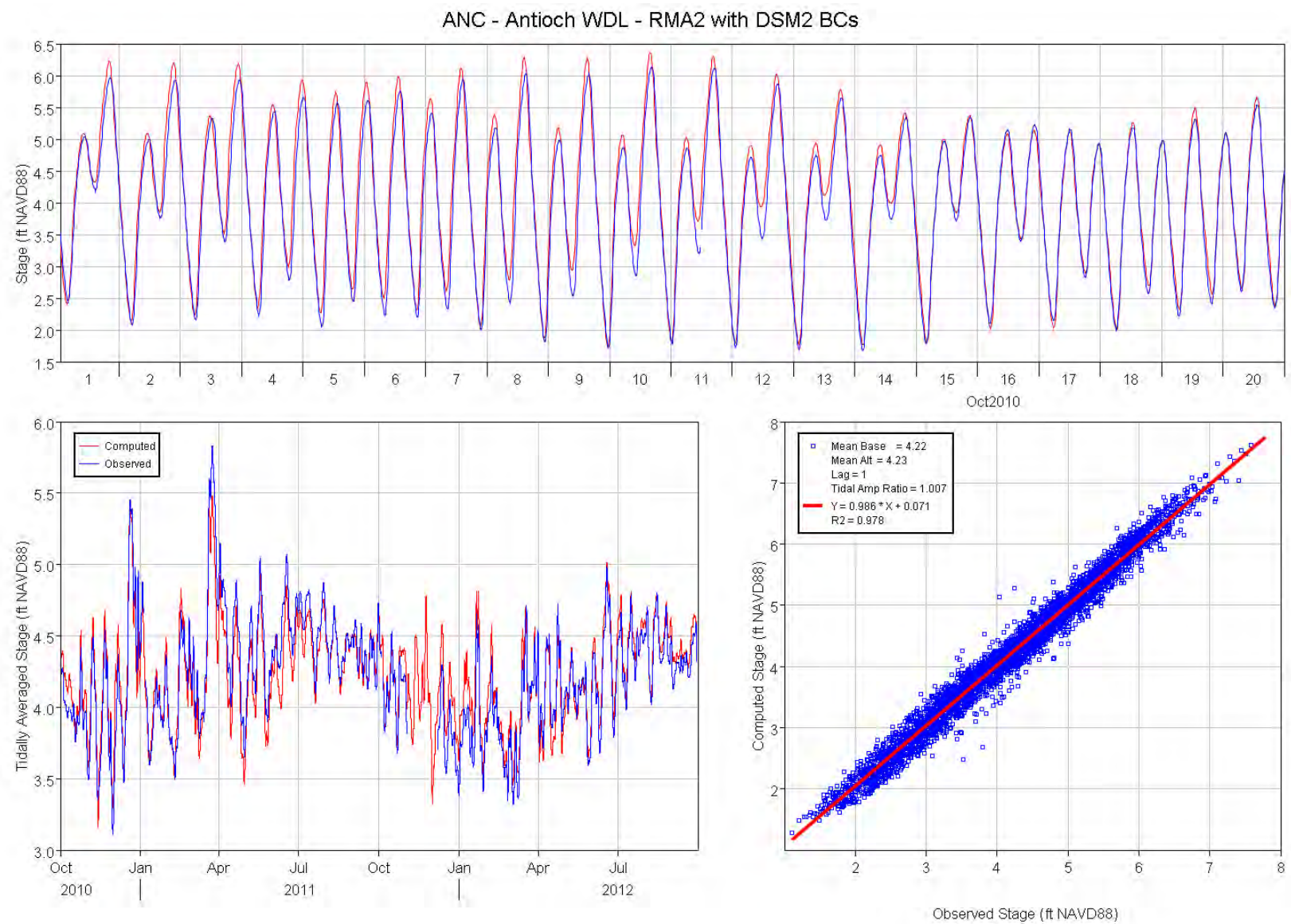


Figure 188 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Antioch.



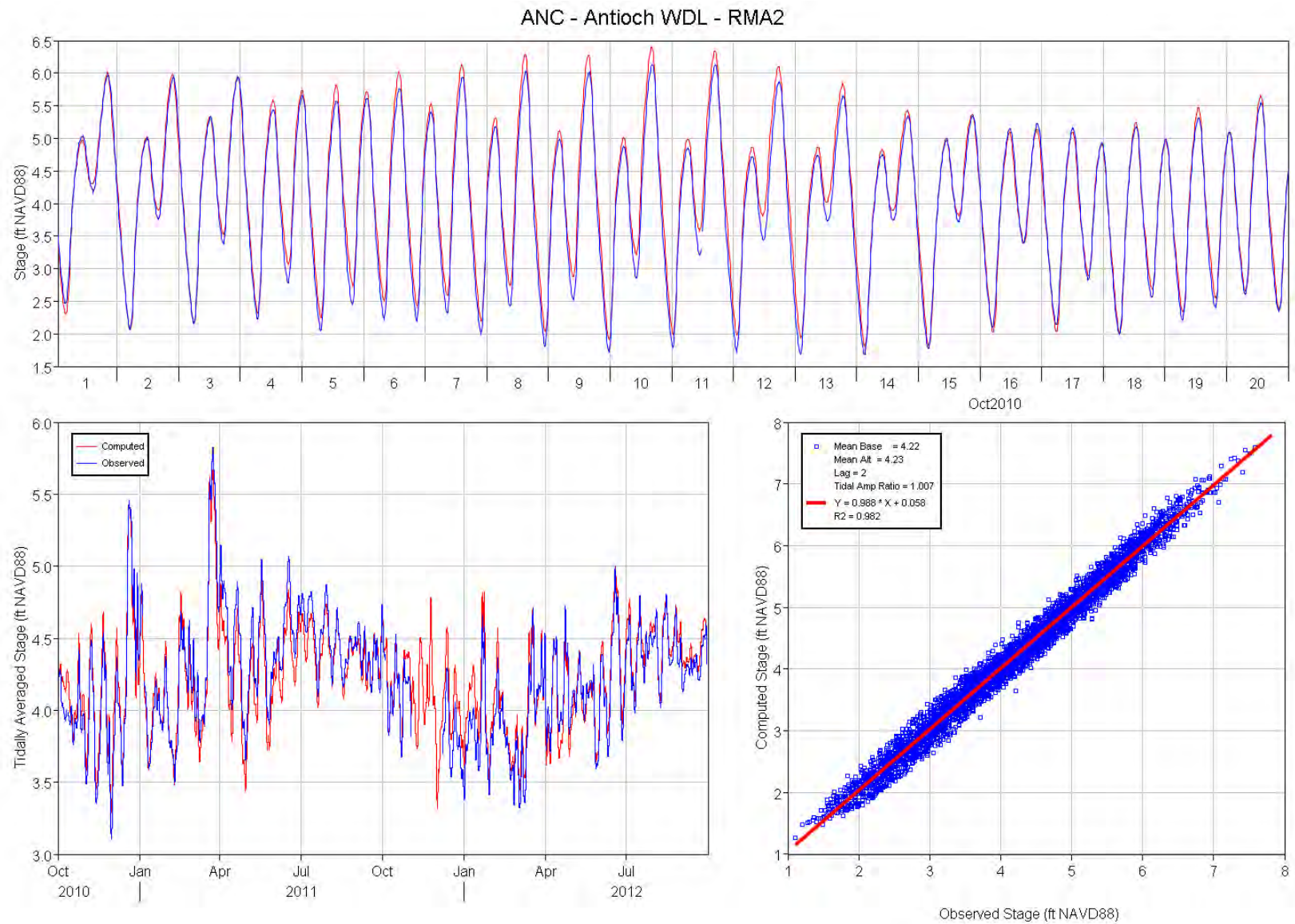


Figure 189 Computed (RMA2) and observed stage comparison plots for Antioch.



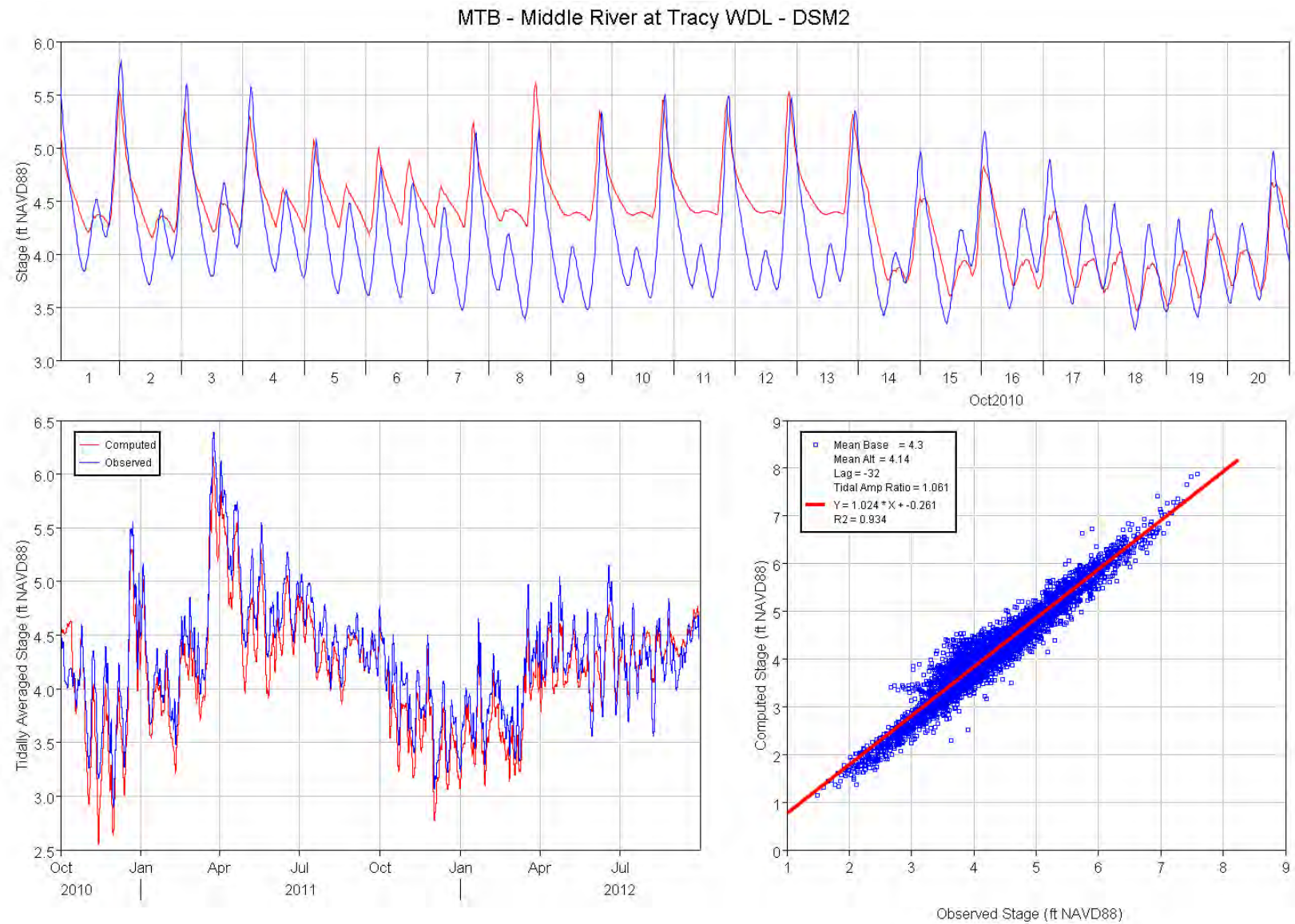


Figure 190 Computed (DSM2) and observed stage comparison plots for Middle River at Tracy.

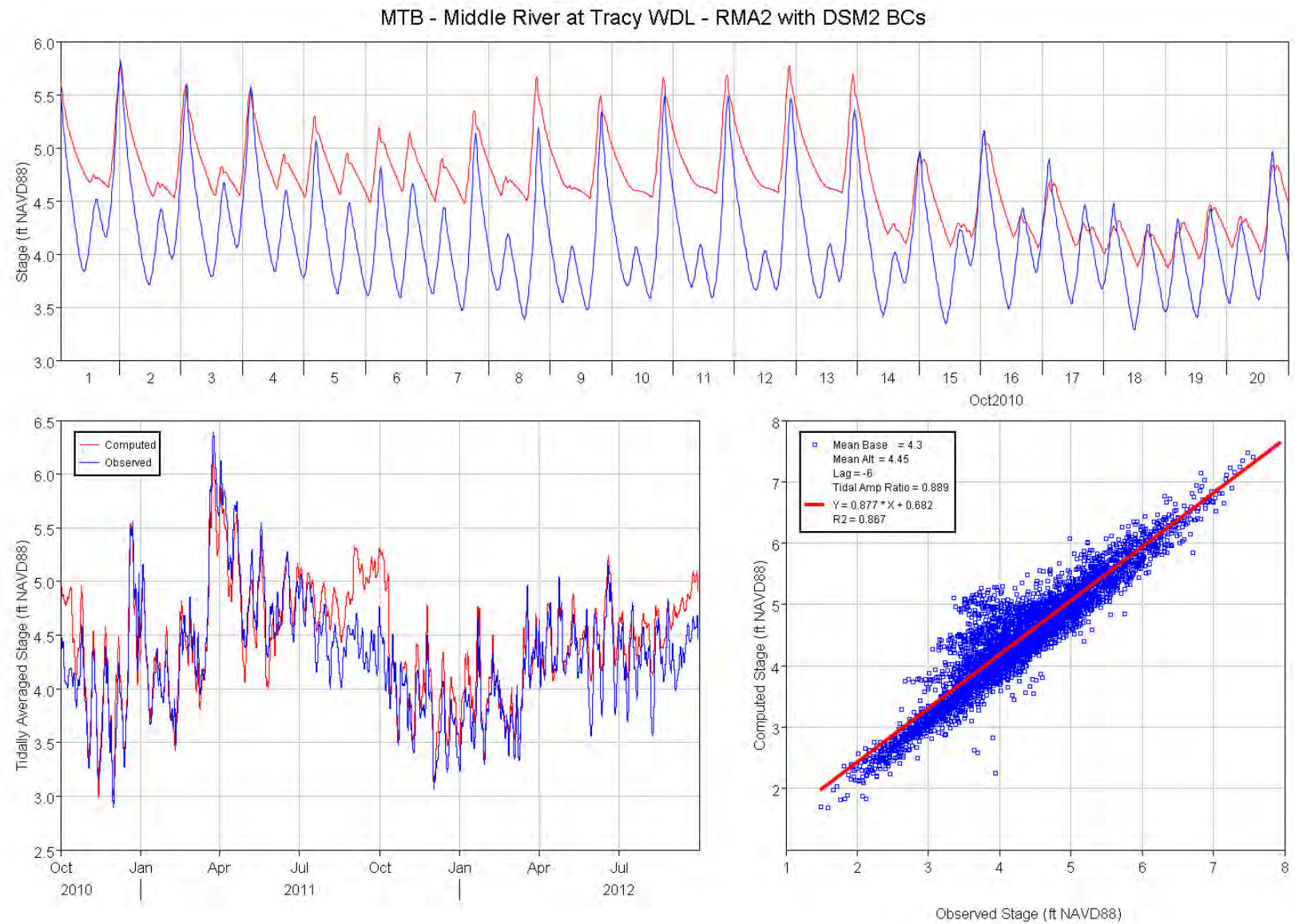


Figure 191 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Middle River at Tracy.

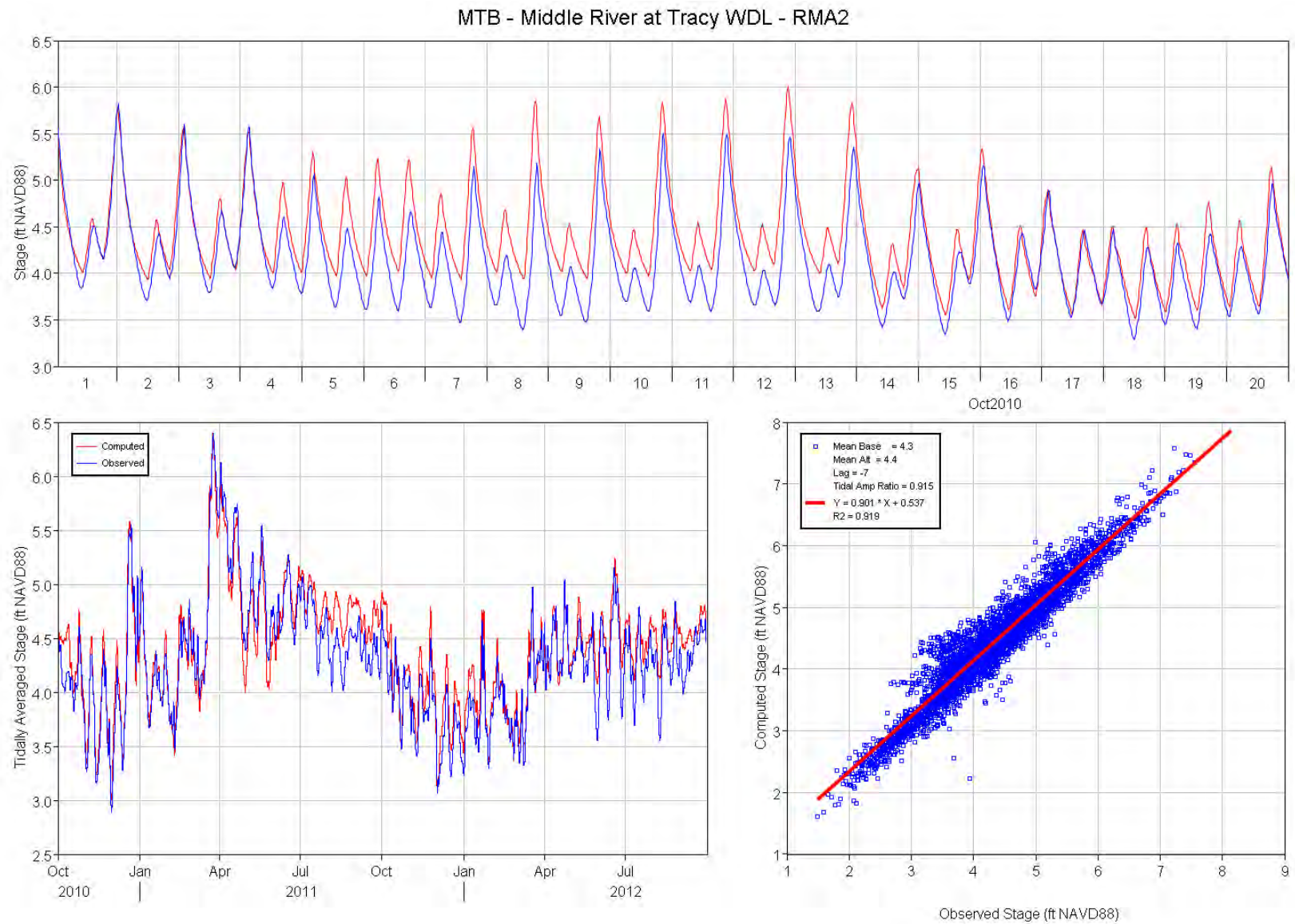


Figure 192 Computed (RMA2) and observed stage comparison plots for Middle River at Tracy.



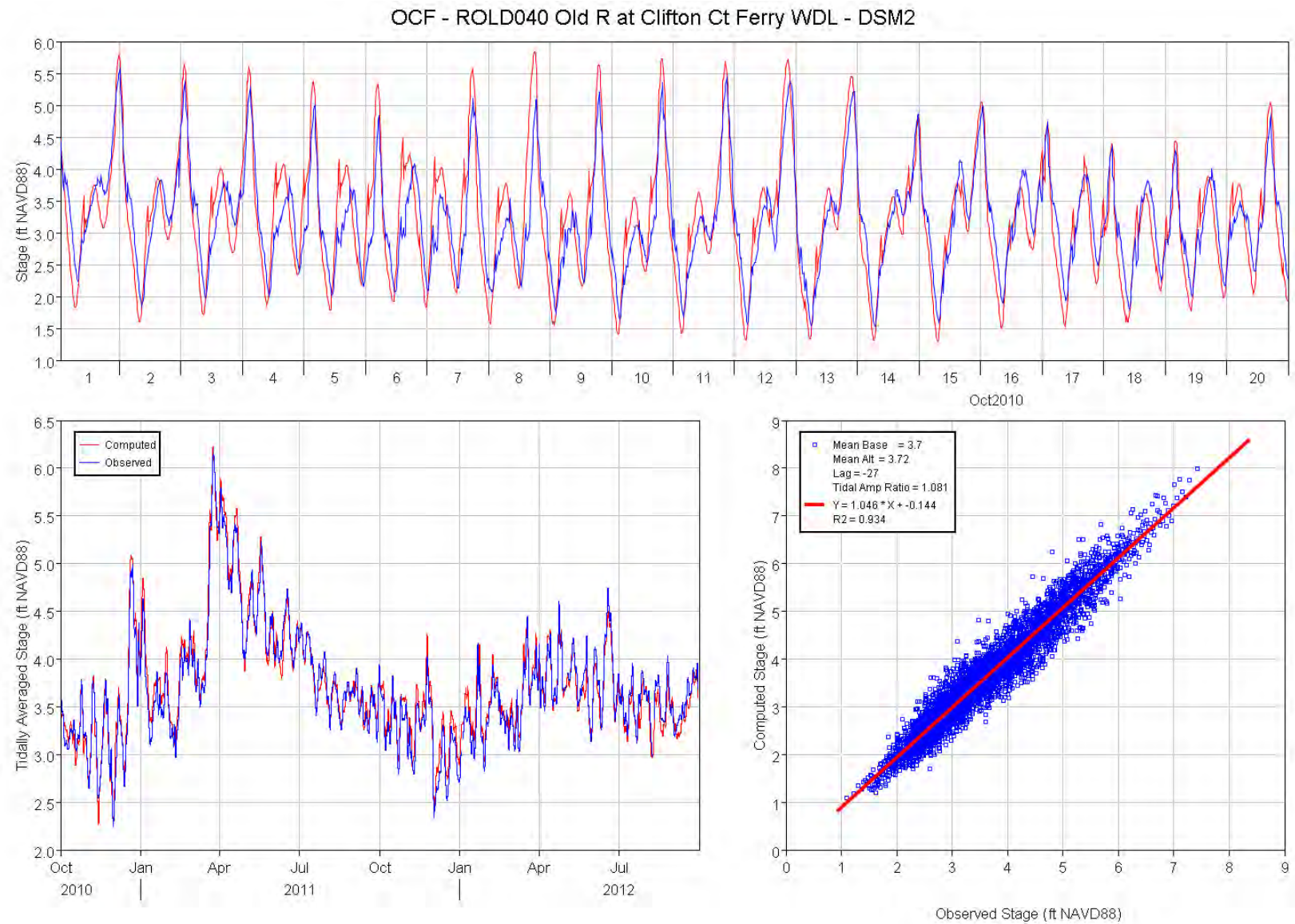


Figure 193 Computed (DSM2) and observed stage comparison plots for Old River at Clifton Court Ferry.

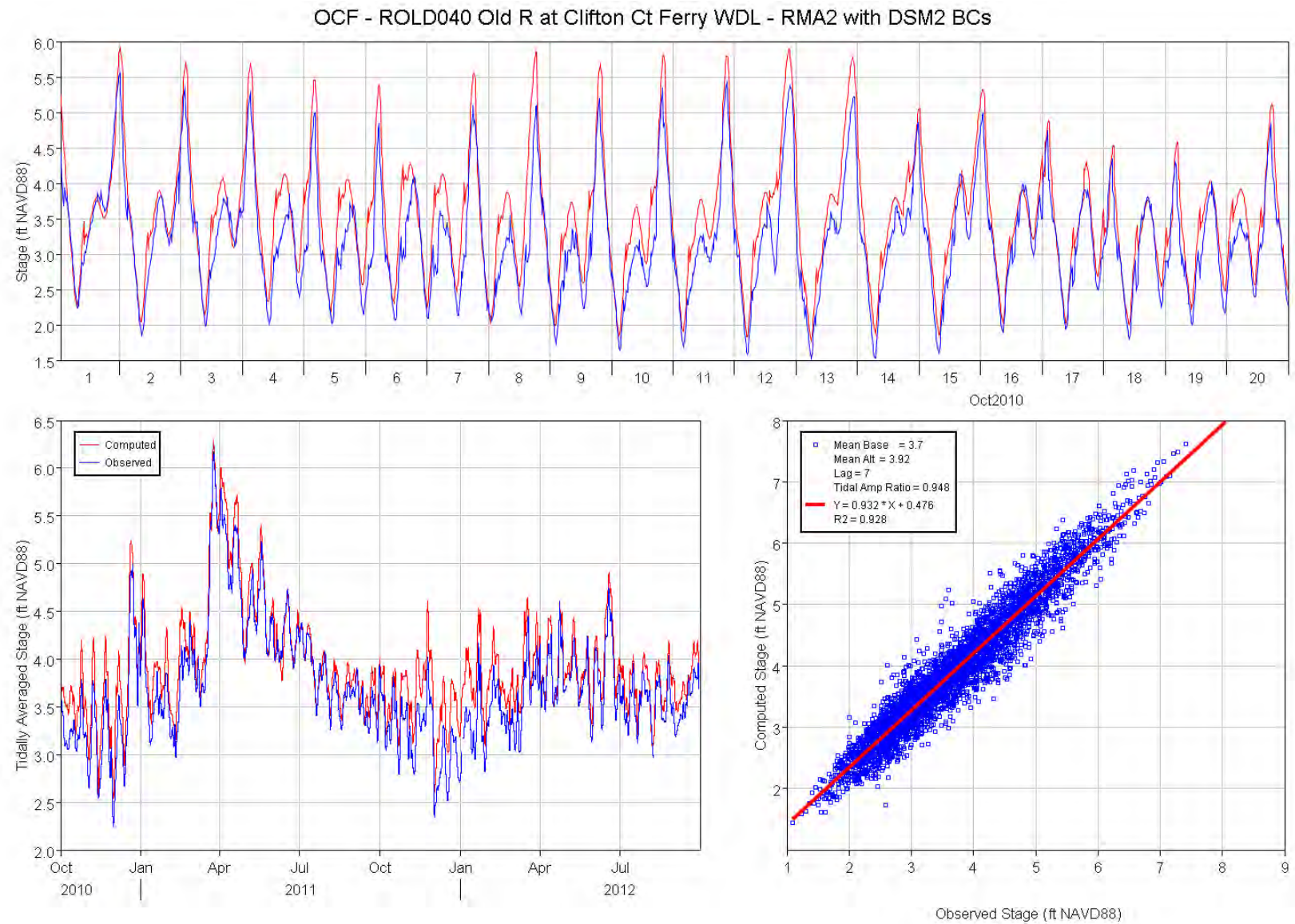


Figure 194 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at Clifton Court Ferry.



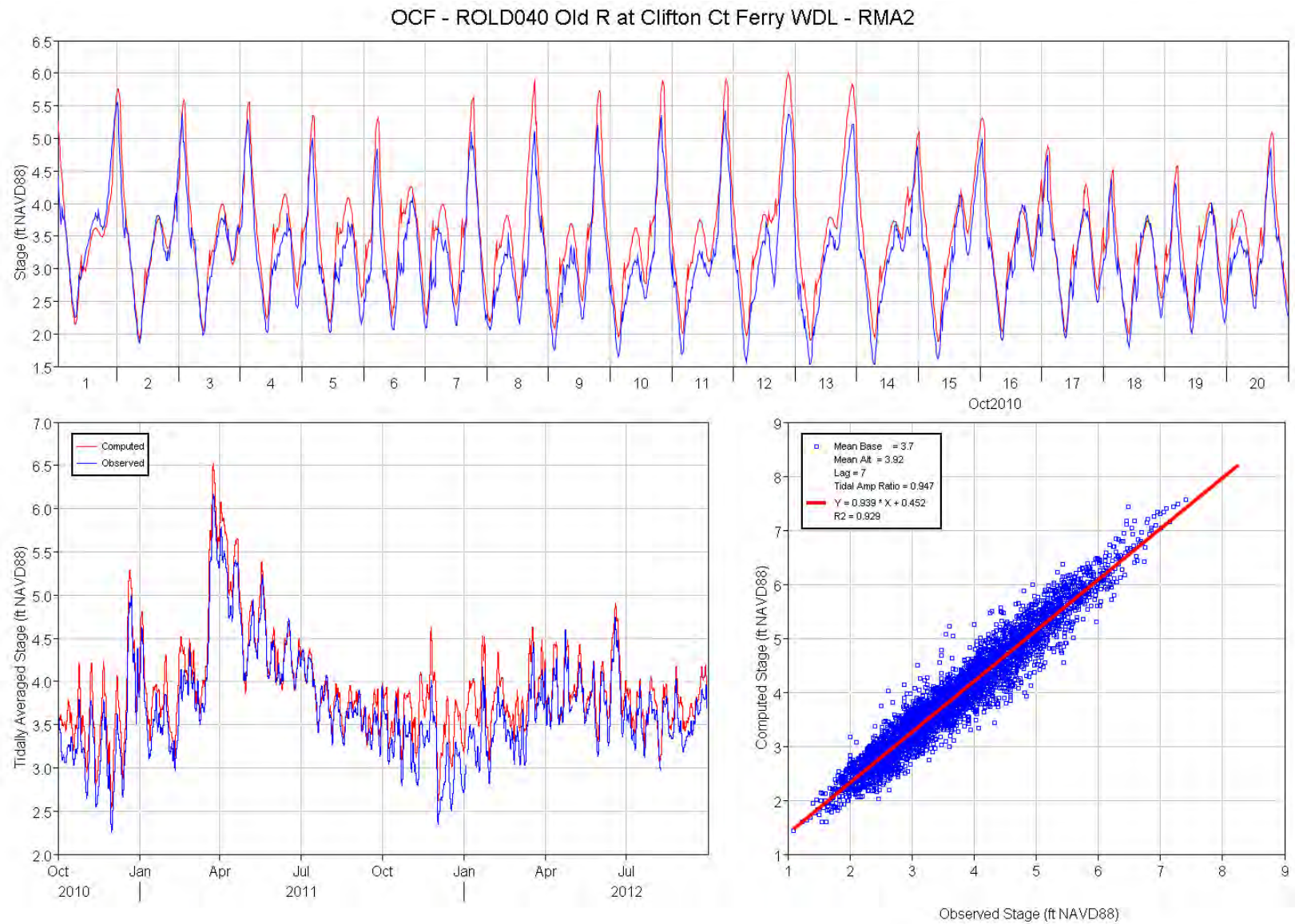


Figure 195 Computed (RMA2) and observed stage comparison plots for Old River at Clifton Court Ferry.



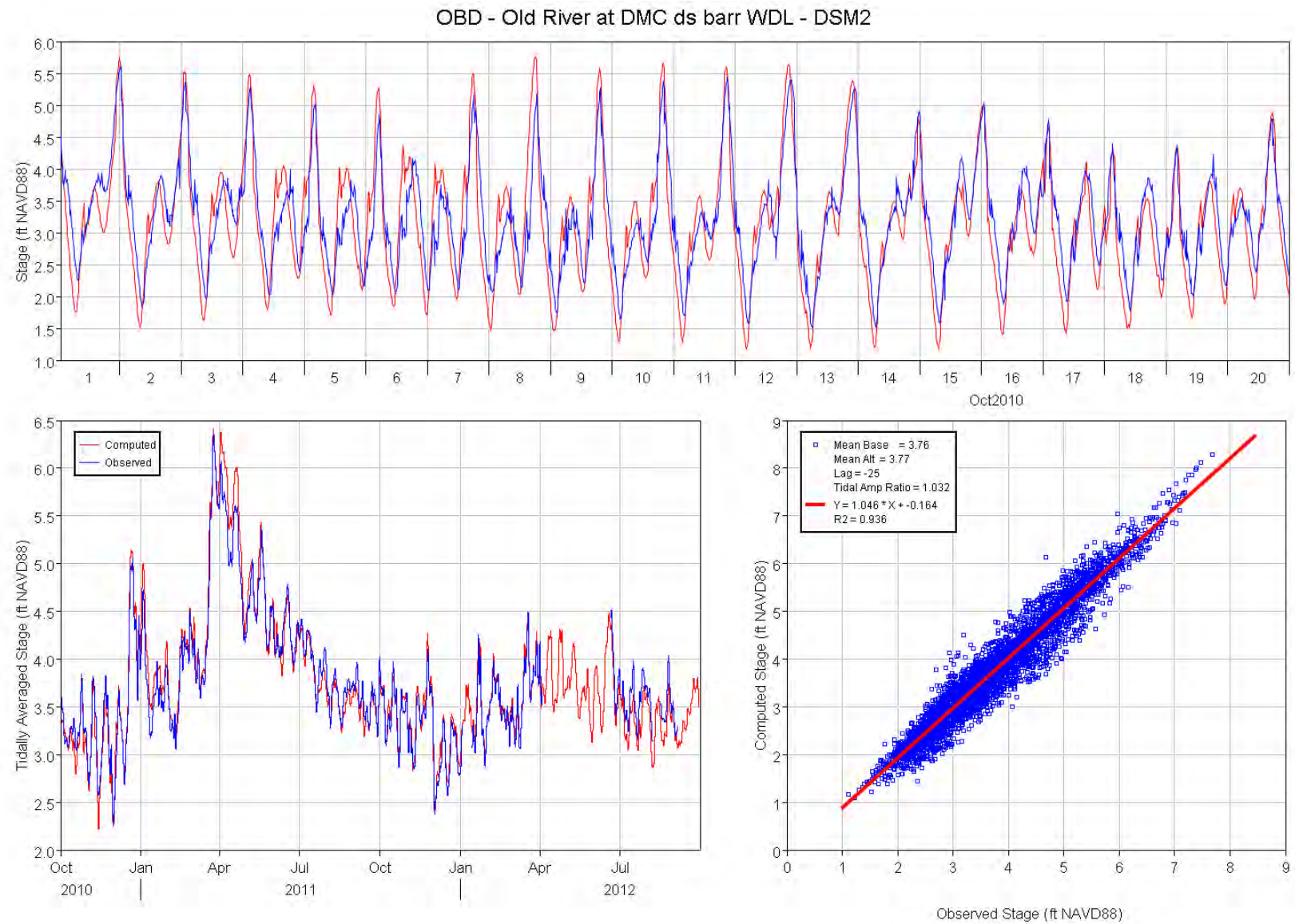


Figure 196 Computed (DSM2) and observed stage comparison plots for Old River at DMC downstream of Barrier.

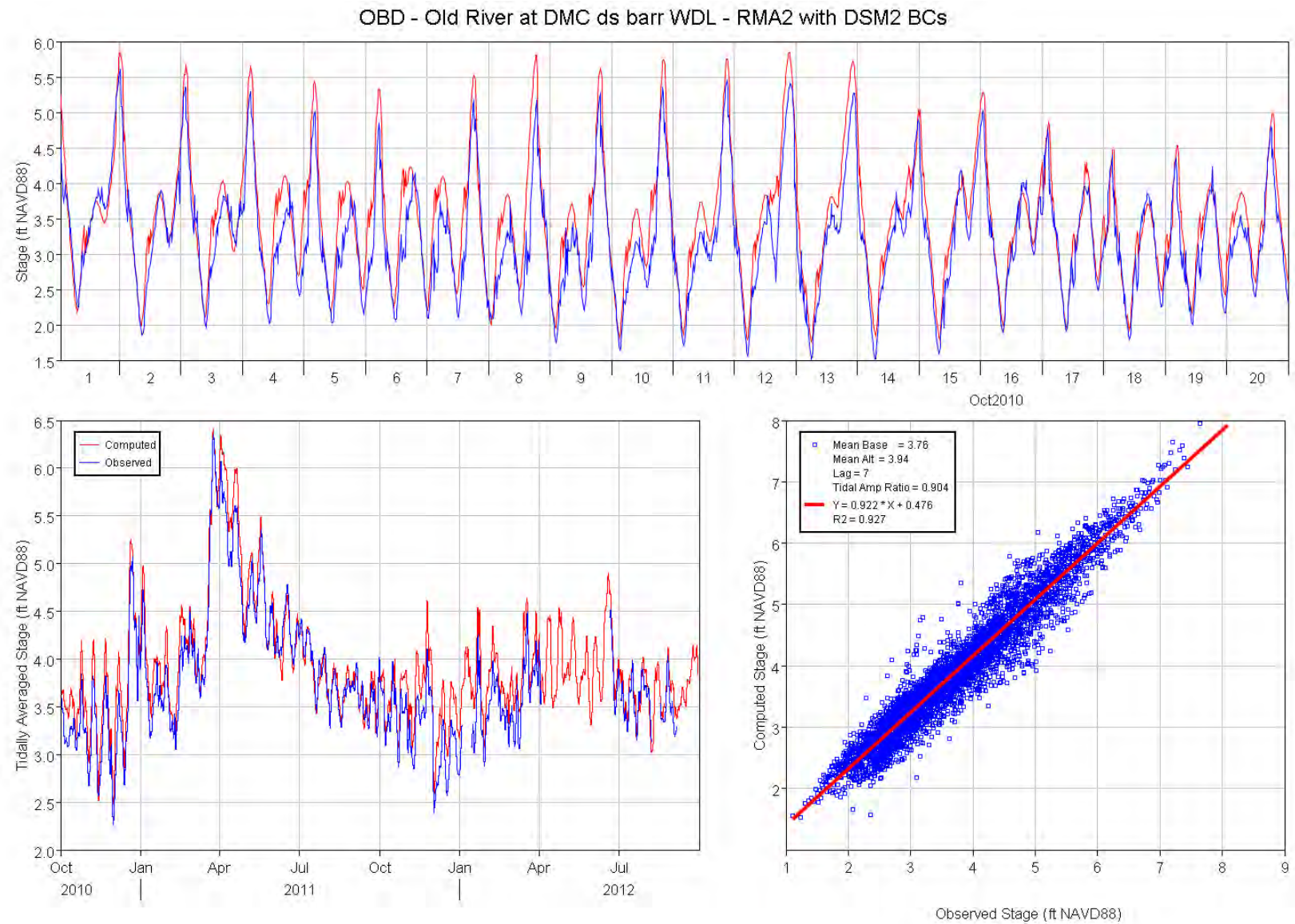


Figure 197 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for Old River at DMC downstream of Barrier.



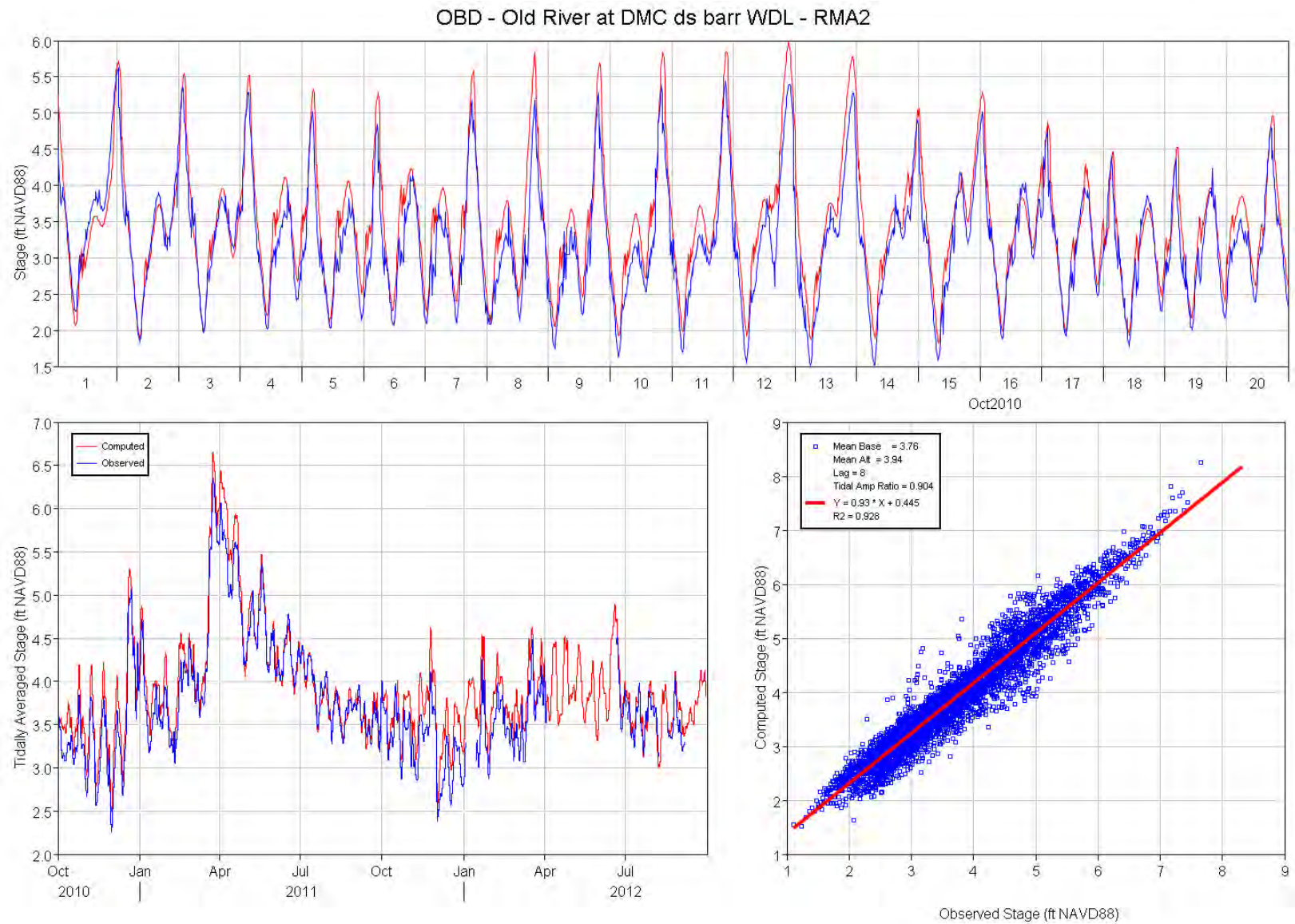


Figure 198 Computed (RMA2) and observed stage comparison plots for Old River at DMC downstream of Barrier.



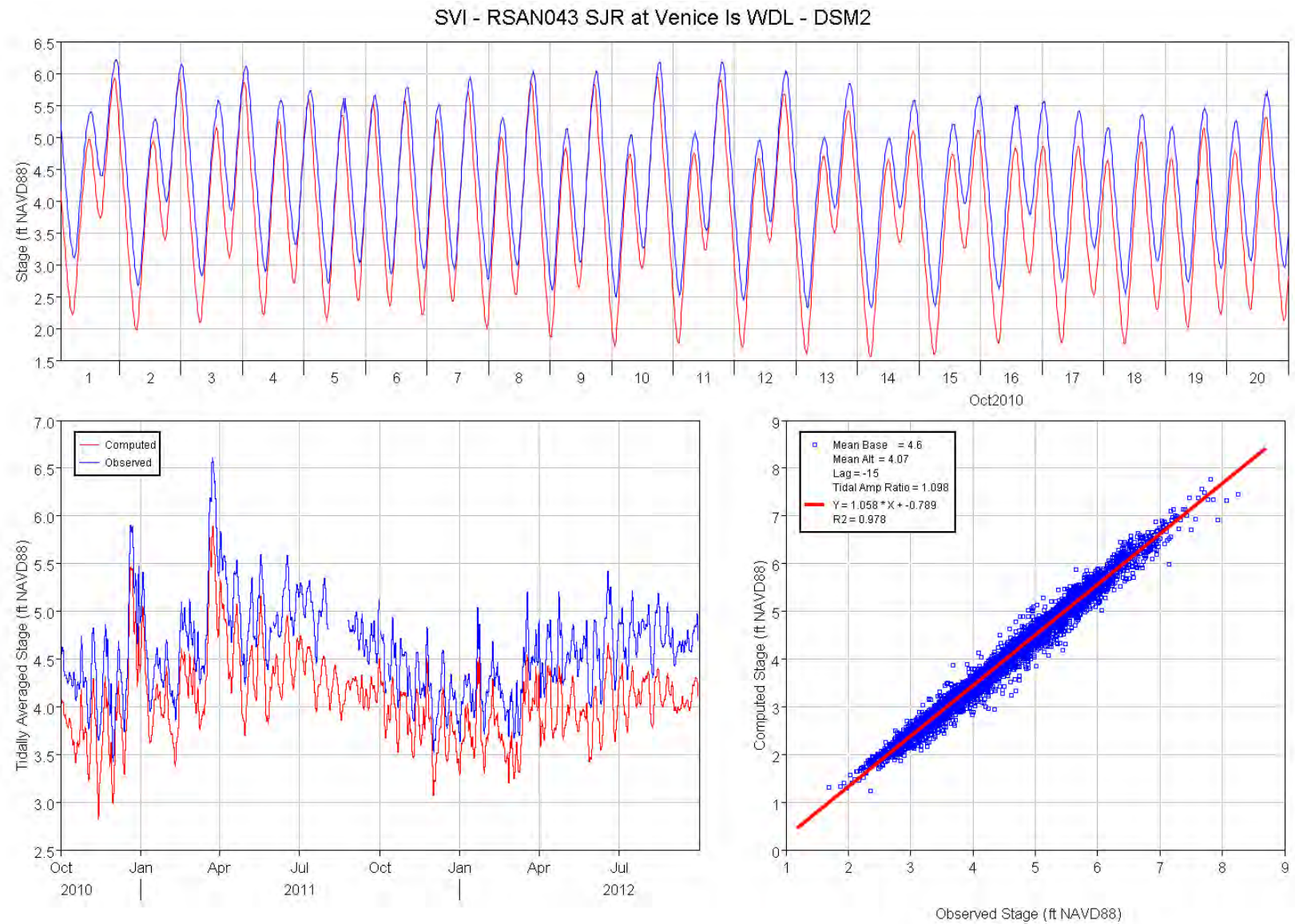


Figure 199 Computed (DSM2) and observed stage comparison plots for SJR at Venice Island.

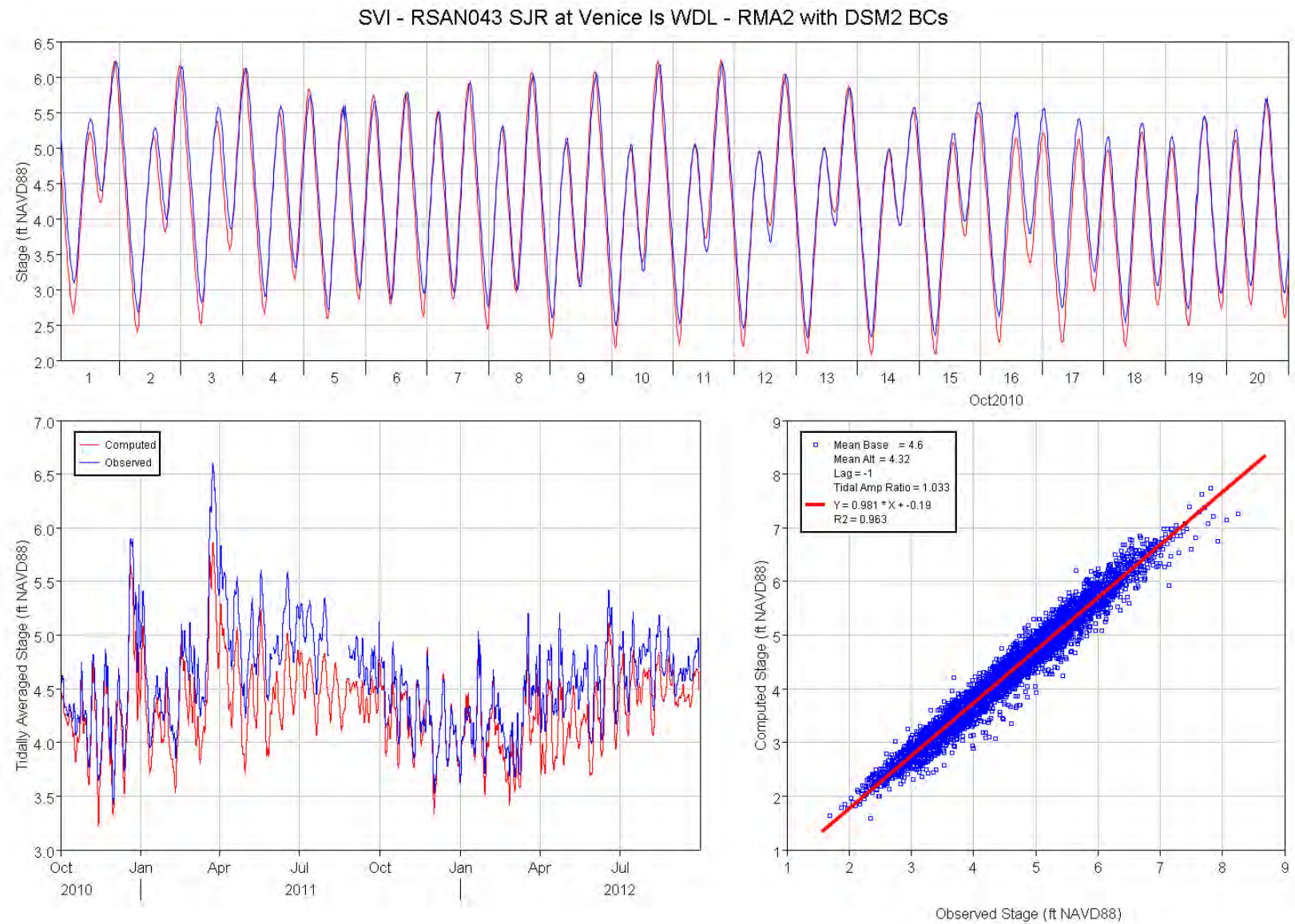


Figure 200 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR at Venice Island.



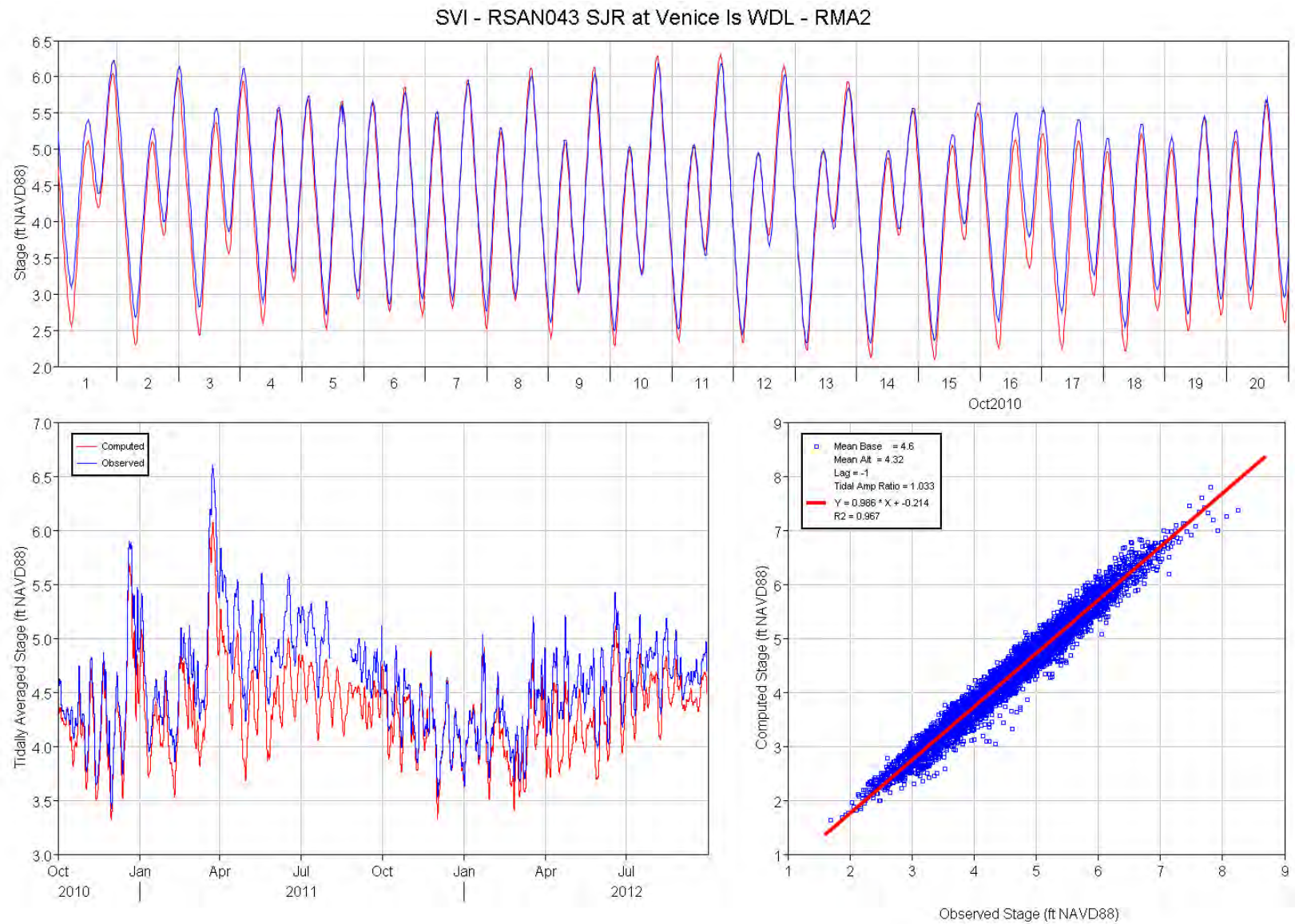


Figure 201 Computed (RMA2) and observed stage comparison plots for SJR at Venice Island.



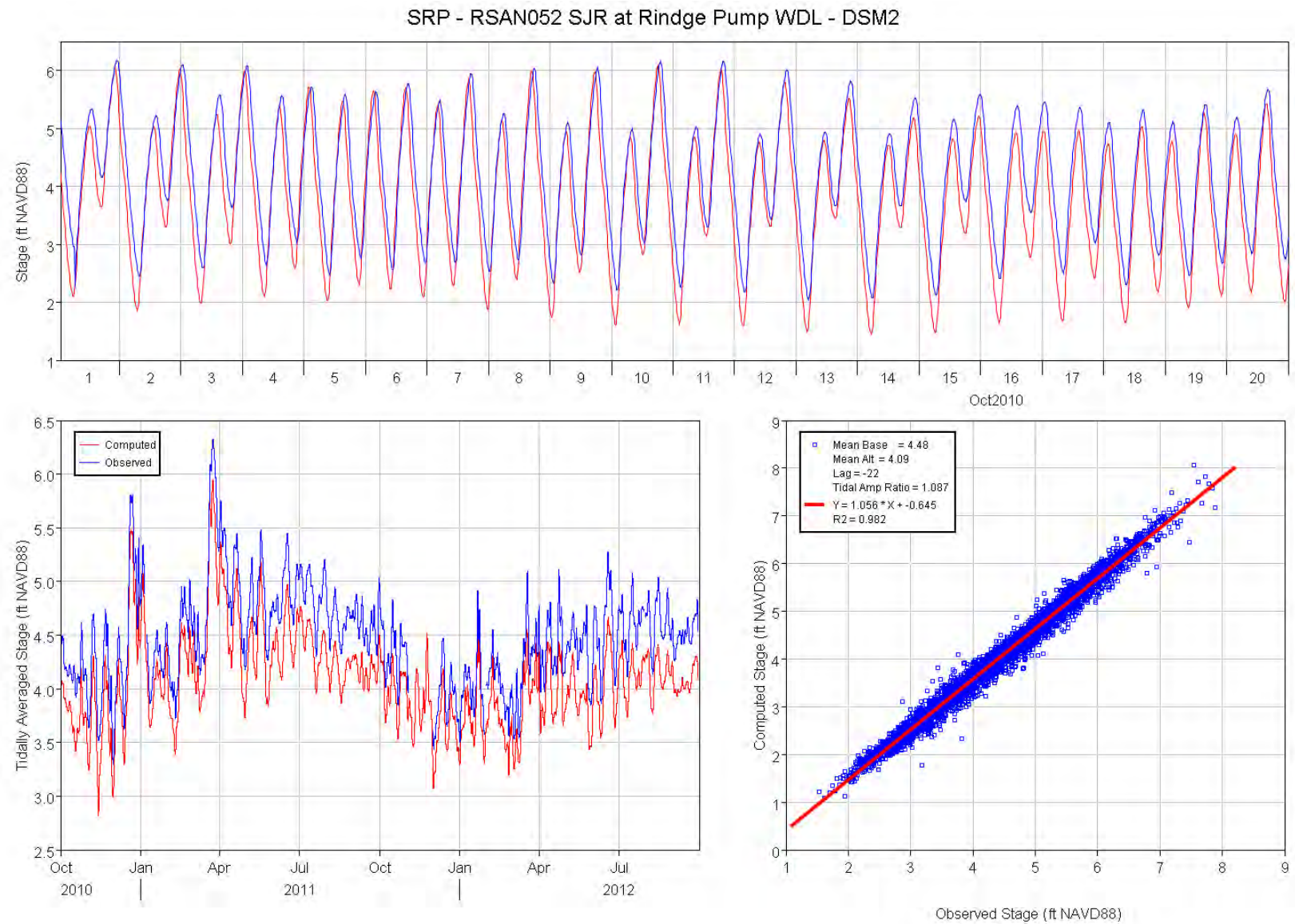


Figure 202 Computed (DSM2) and observed stage comparison plots for SJR at Rindge Pump.

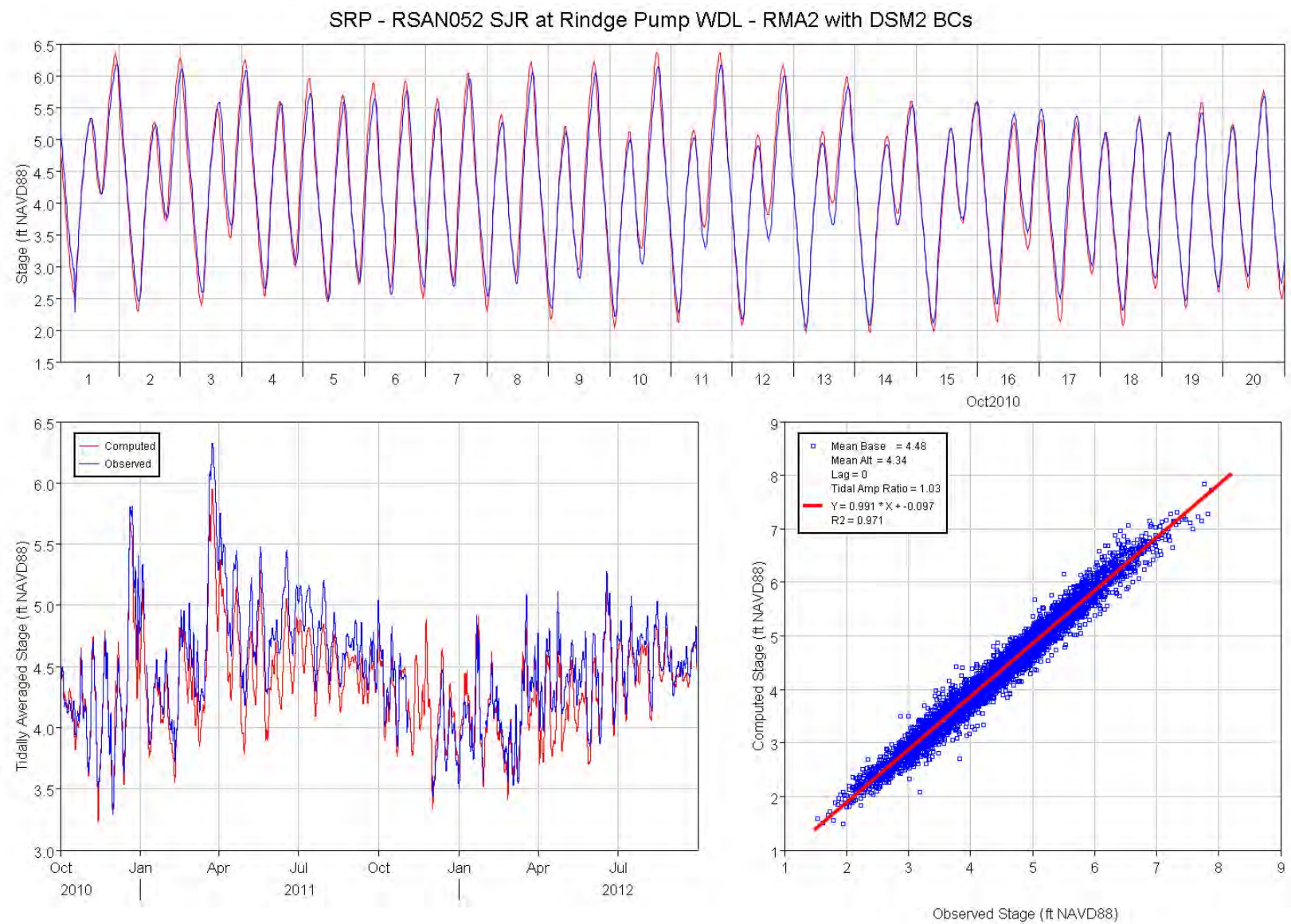


Figure 203 Computed (RMA2 with DSM2 BCs) and observed stage comparison plots for SJR at Rindge Pump.



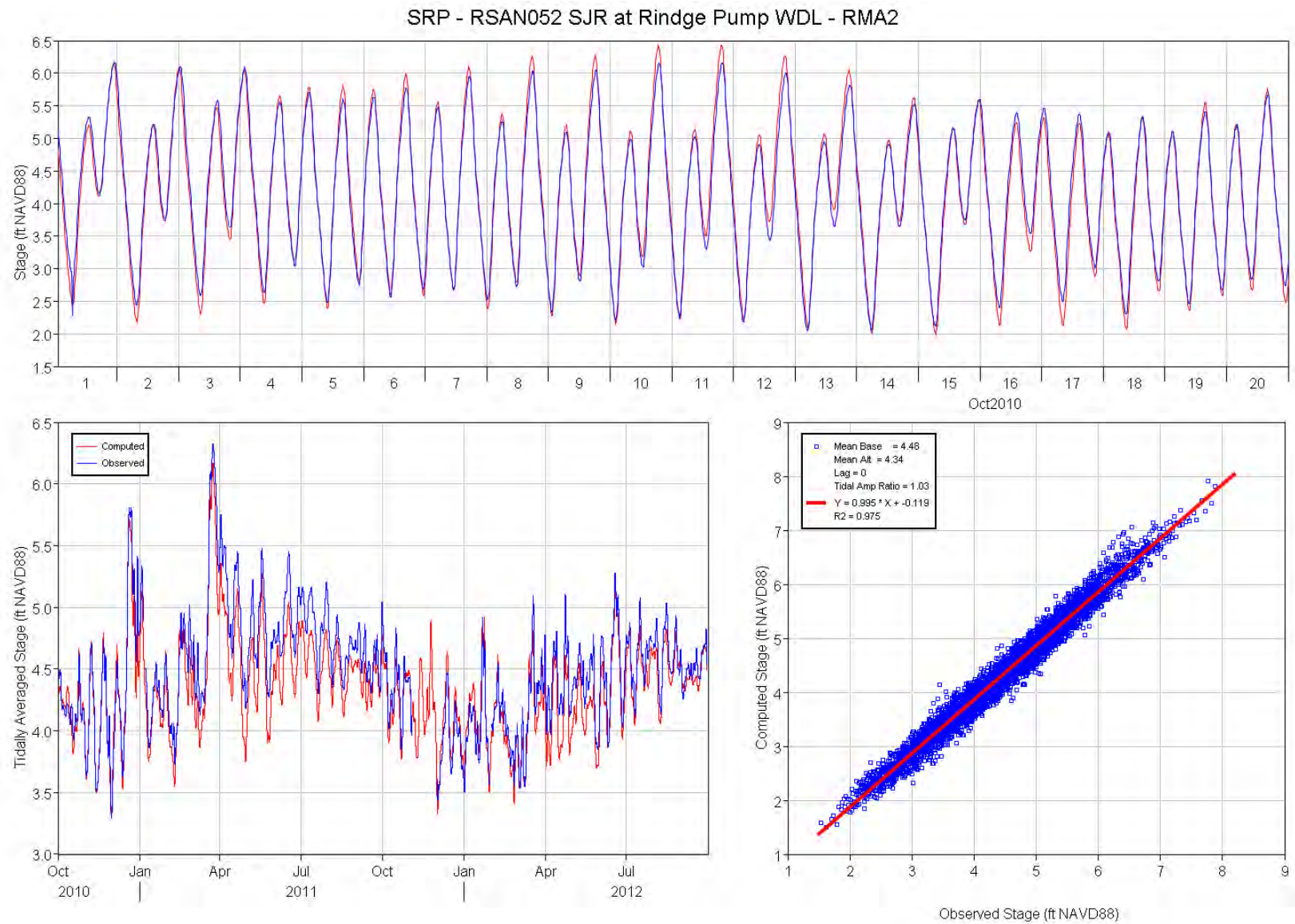


Figure 204 Computed (RMA2) and observed stage comparison plots for SJR at Rindge Pump.



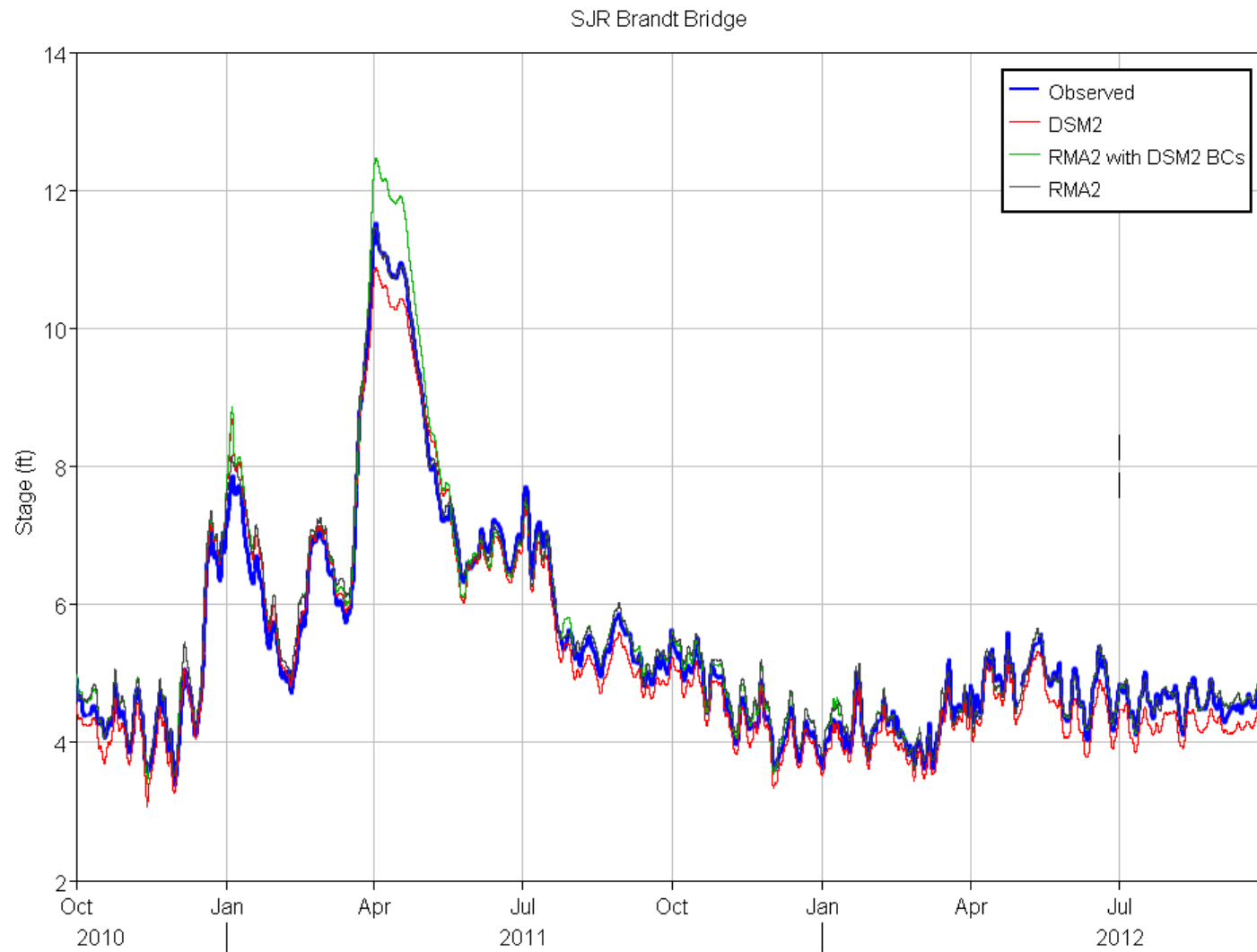


Figure 205 Computed (DSM2) and observed stage comparison plots for San Joaquin River at Brandt Bridge.

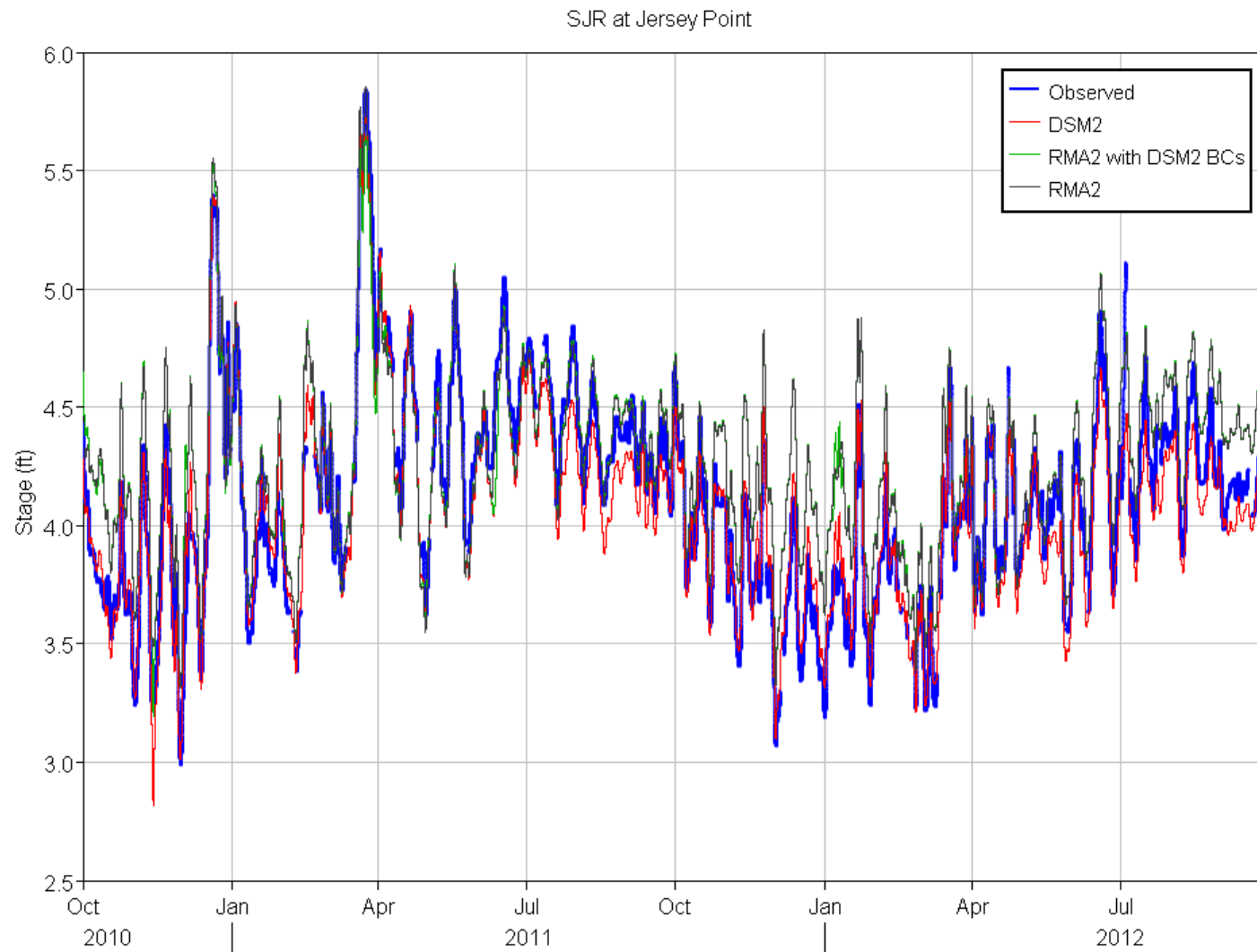


Figure 206 Computed (DSM2) and observed stage comparison plots for SJR at Jersey Point.

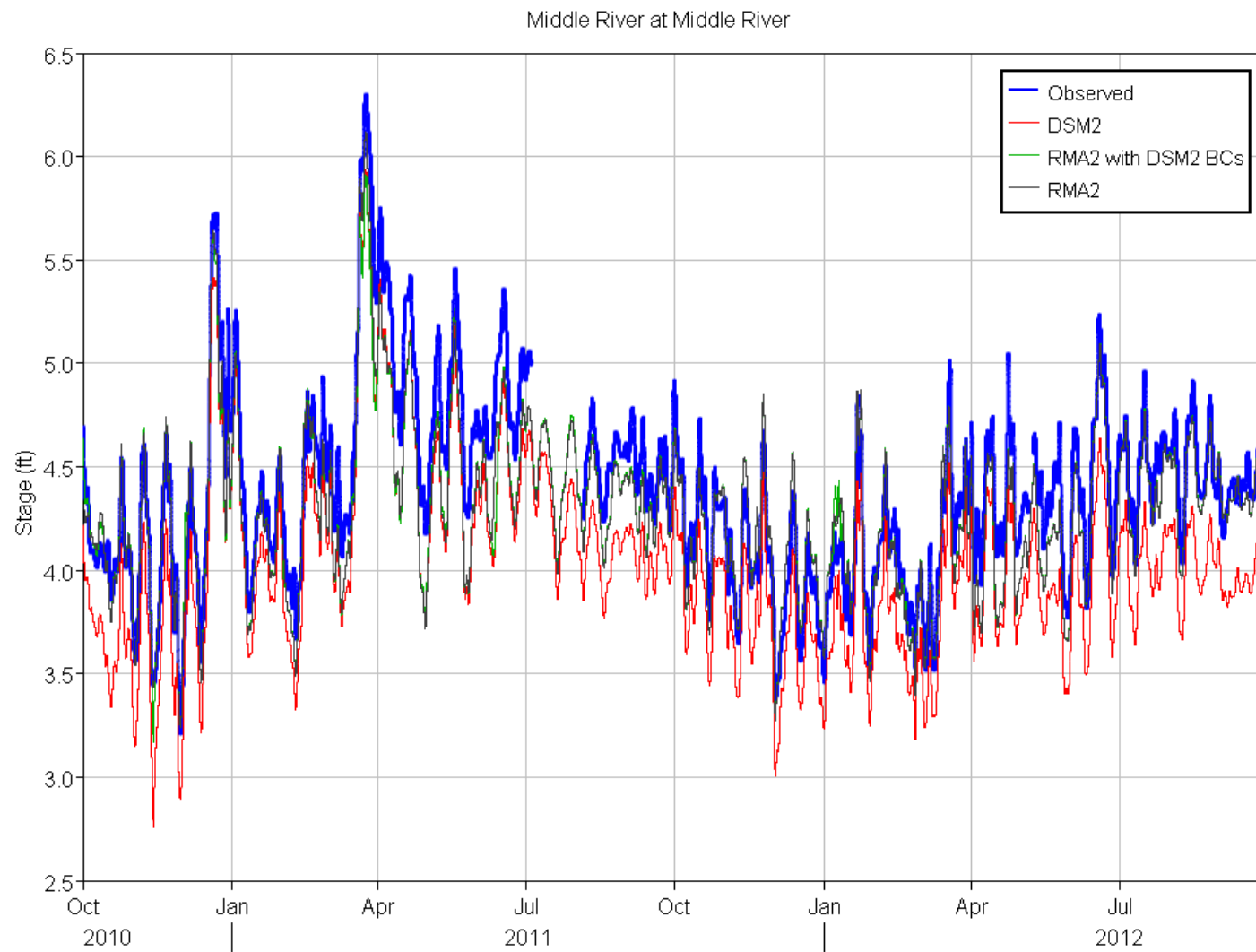


Figure 207 Computed (DSM2) and observed stage comparison plots for Middle River at Middle River.



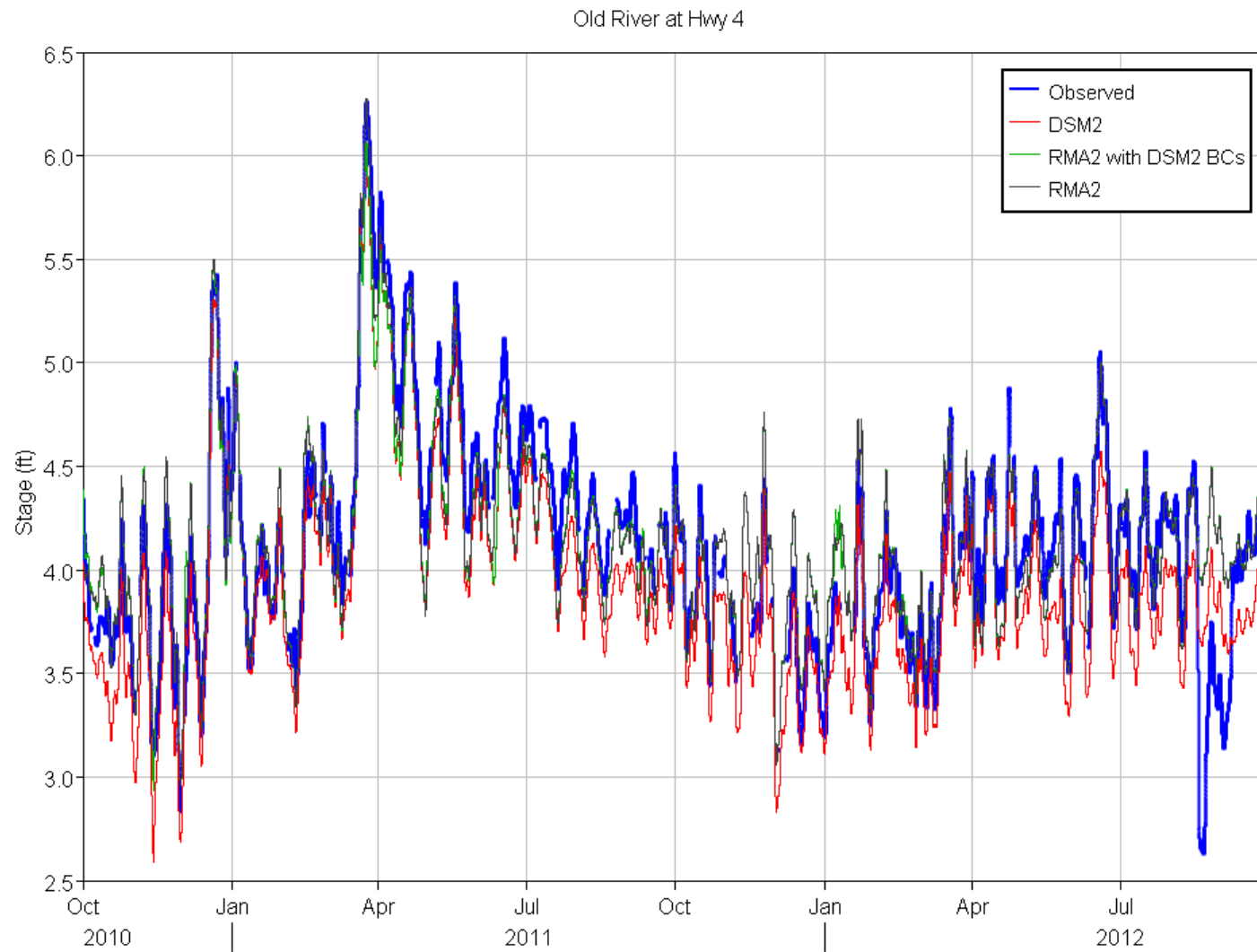


Figure 208 Computed (DSM2) and observed stage comparison plots for Old River at Hwy 4.

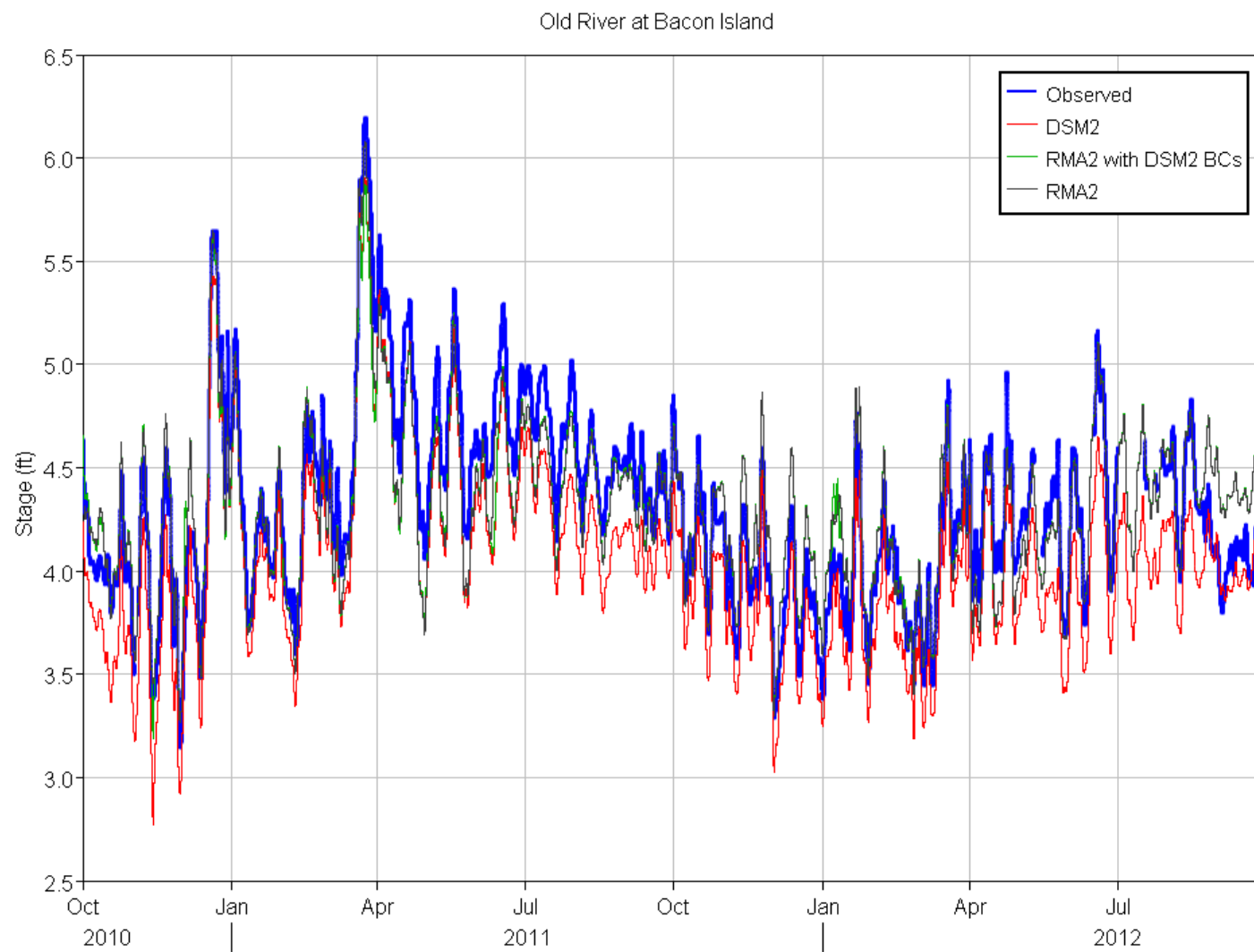


Figure 209 Computed (DSM2) and observed stage comparison plots for Old River at Bacon Island.

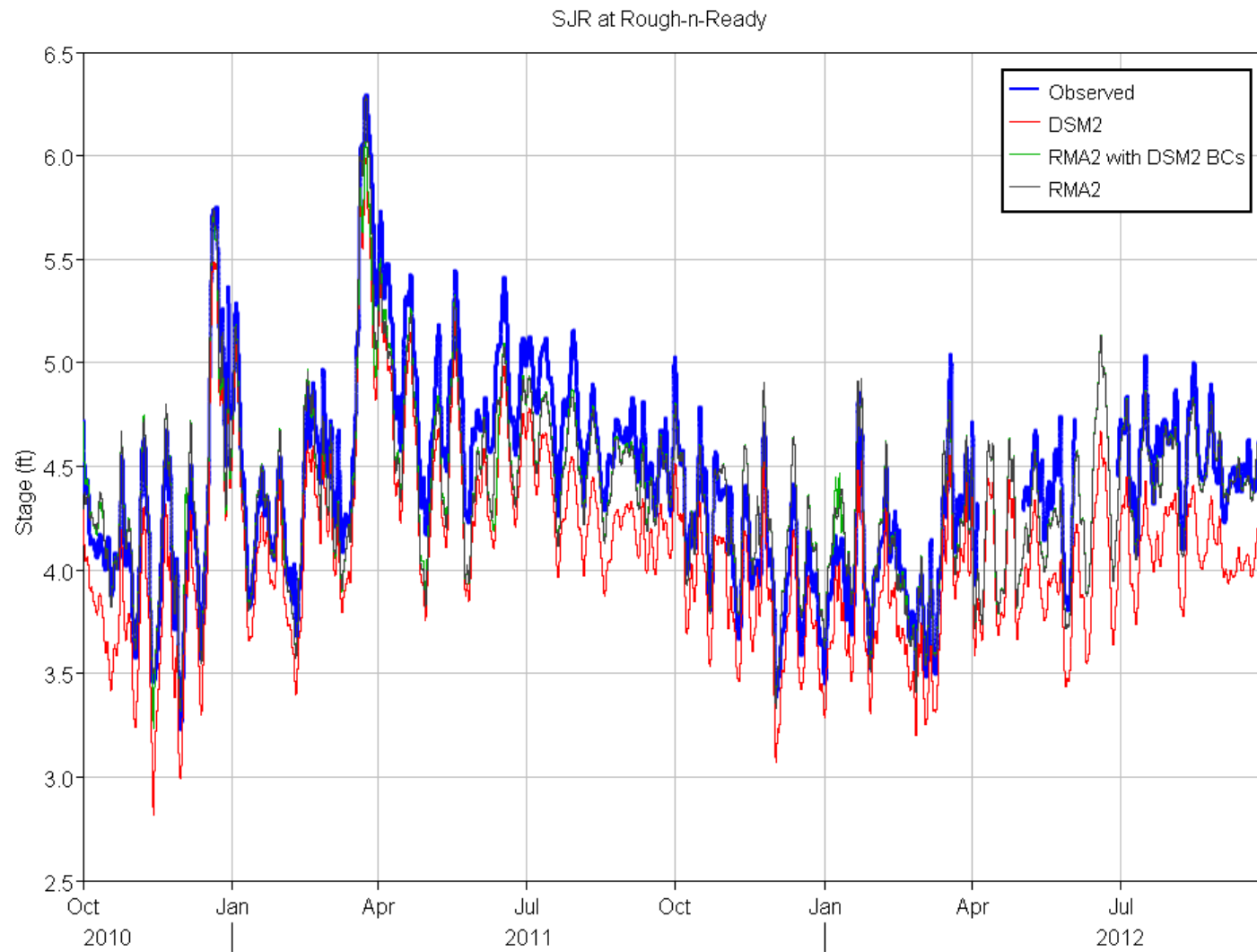


Figure 210 Computed (DSM2) and observed stage comparison plots for SJR at Rough-n-Ready.



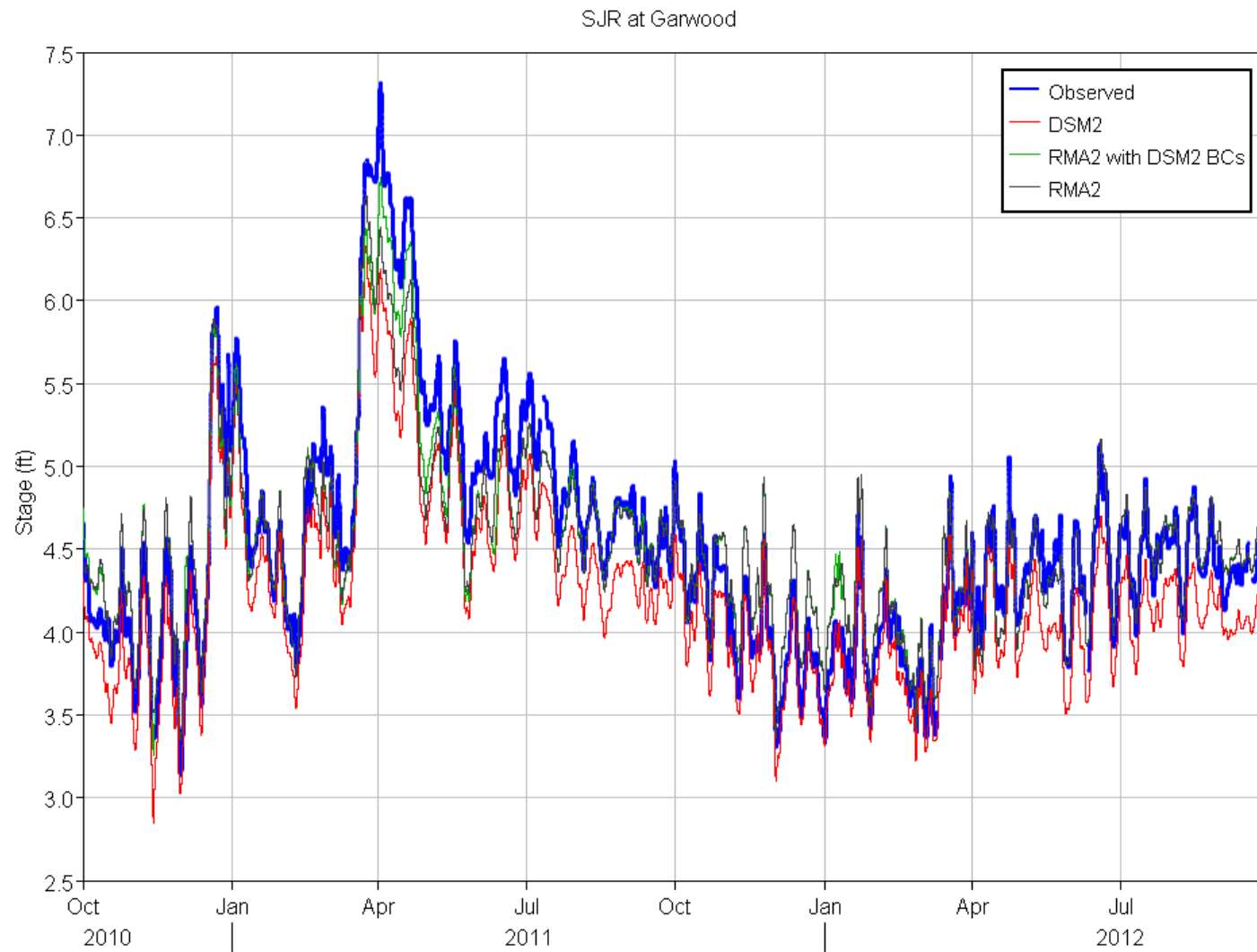


Figure 211 Computed (DSM2) and observed stage comparison plots for SJR at Garwood.

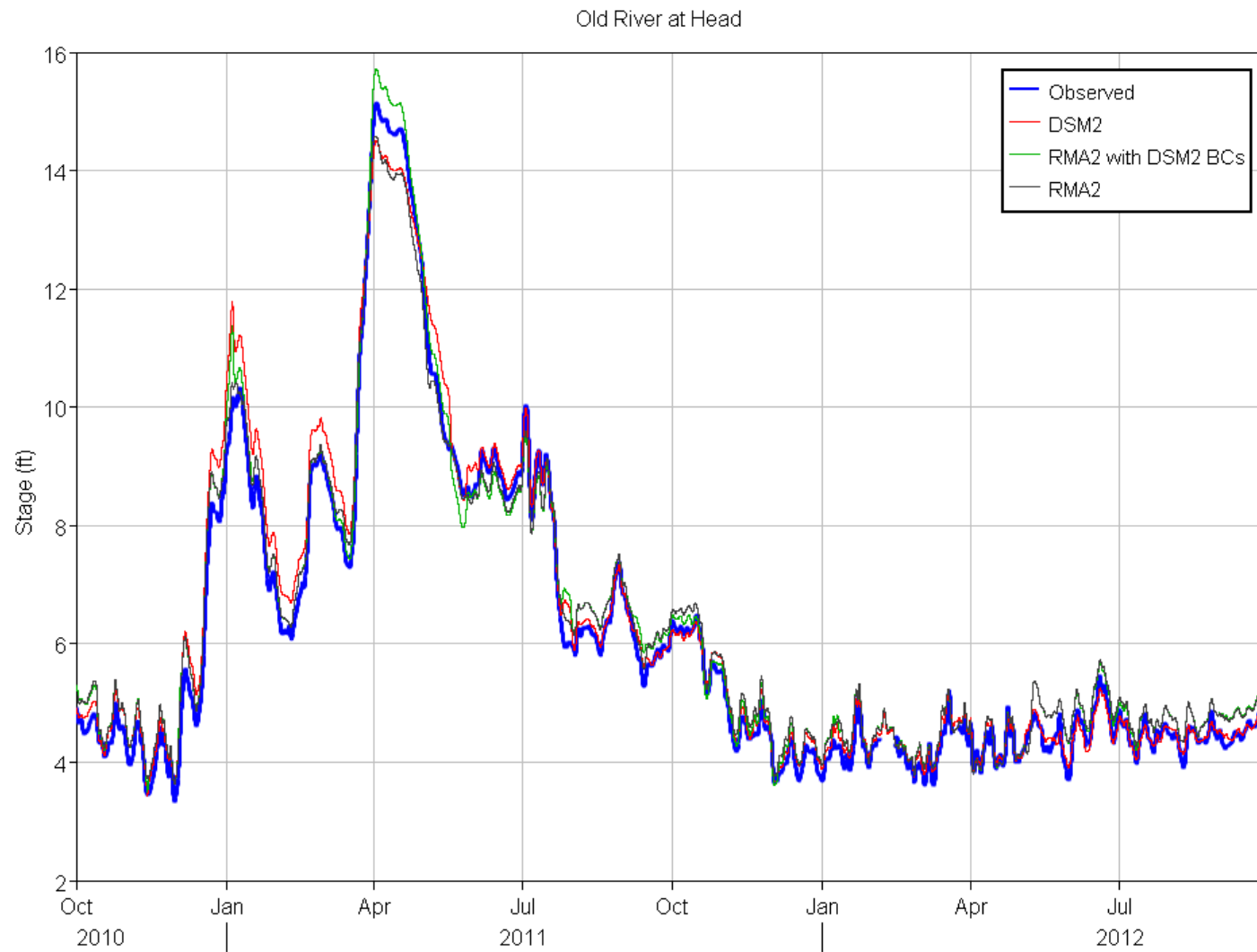


Figure 212 Computed (DSM2) and observed stage comparison plots for Old River at Head.

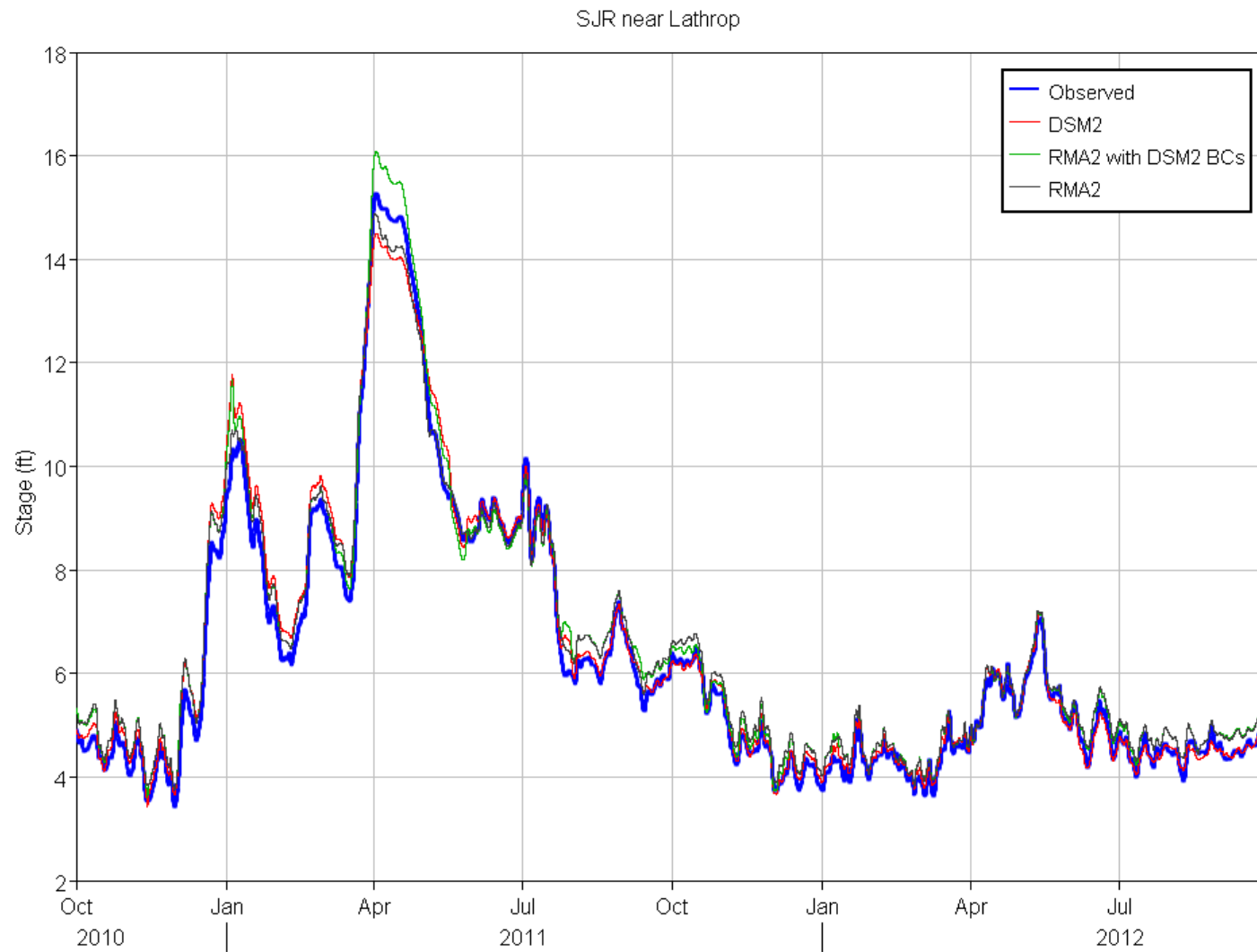
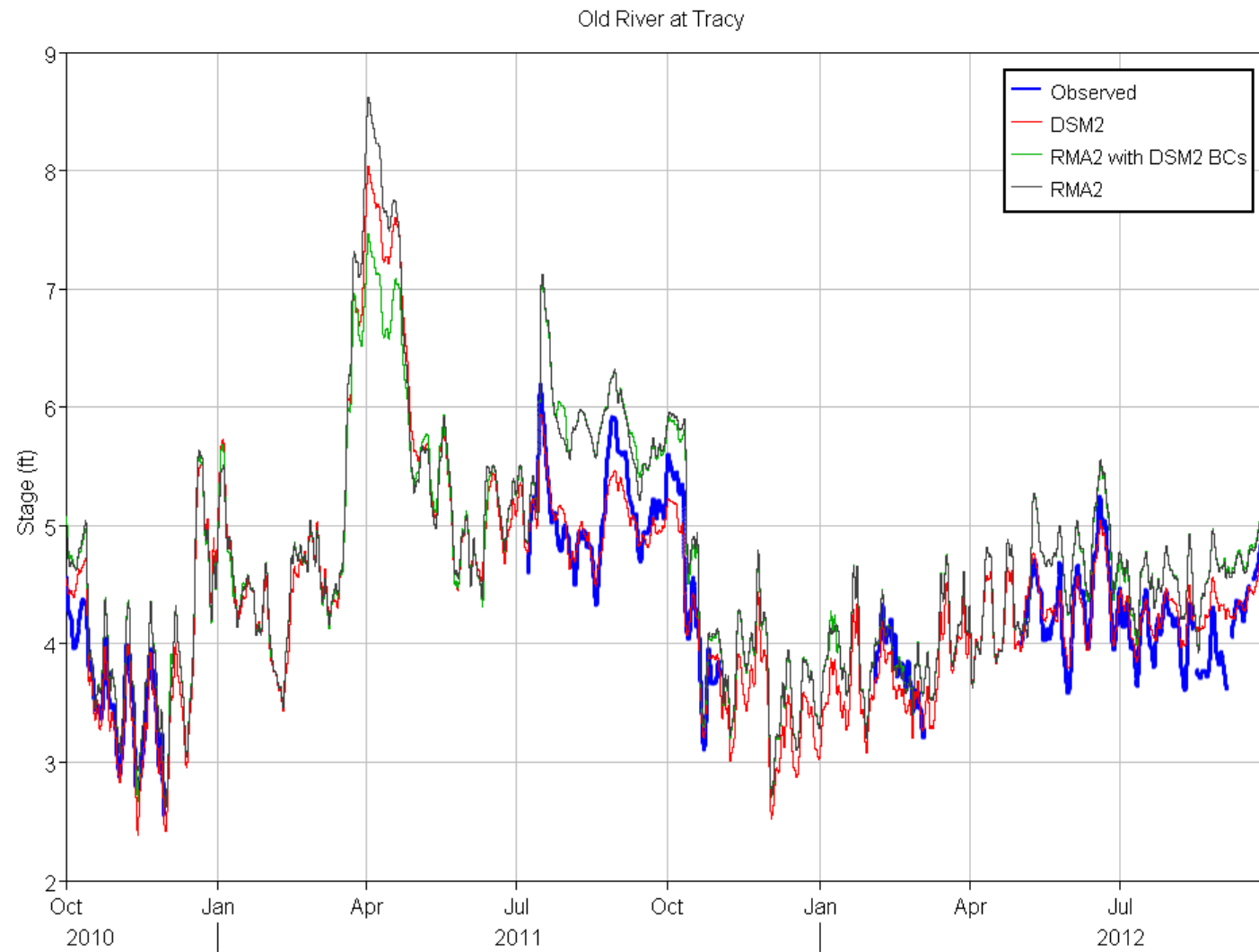


Figure 213 Computed (DSM2) and observed stage comparison plots for SJR near Lathrop.





**Figure 214 Computed (DSM2) and observed stage comparison plots for Old River at Tracy.**

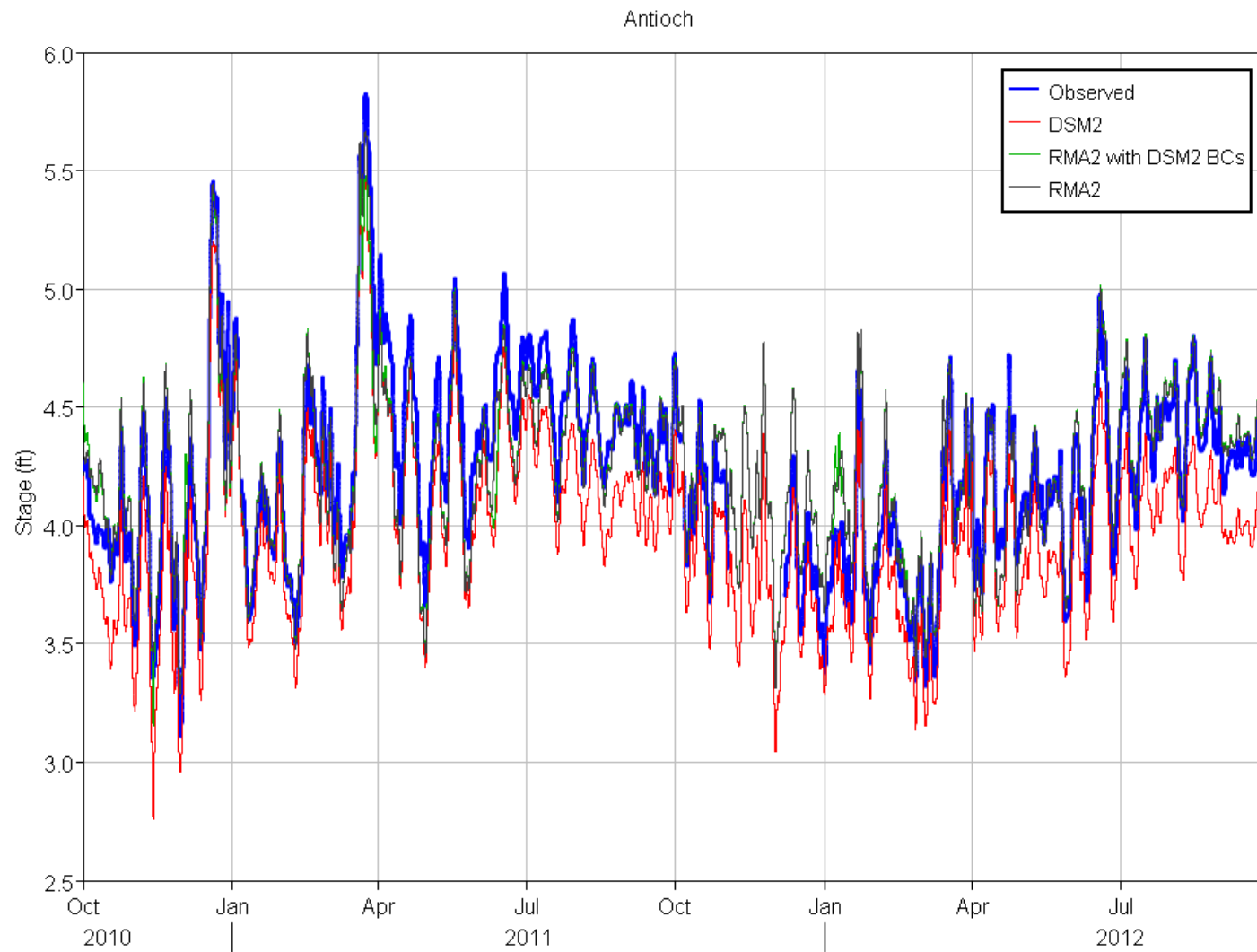


Figure 215 Computed (DSM2) and observed stage comparison plots for Antioch.

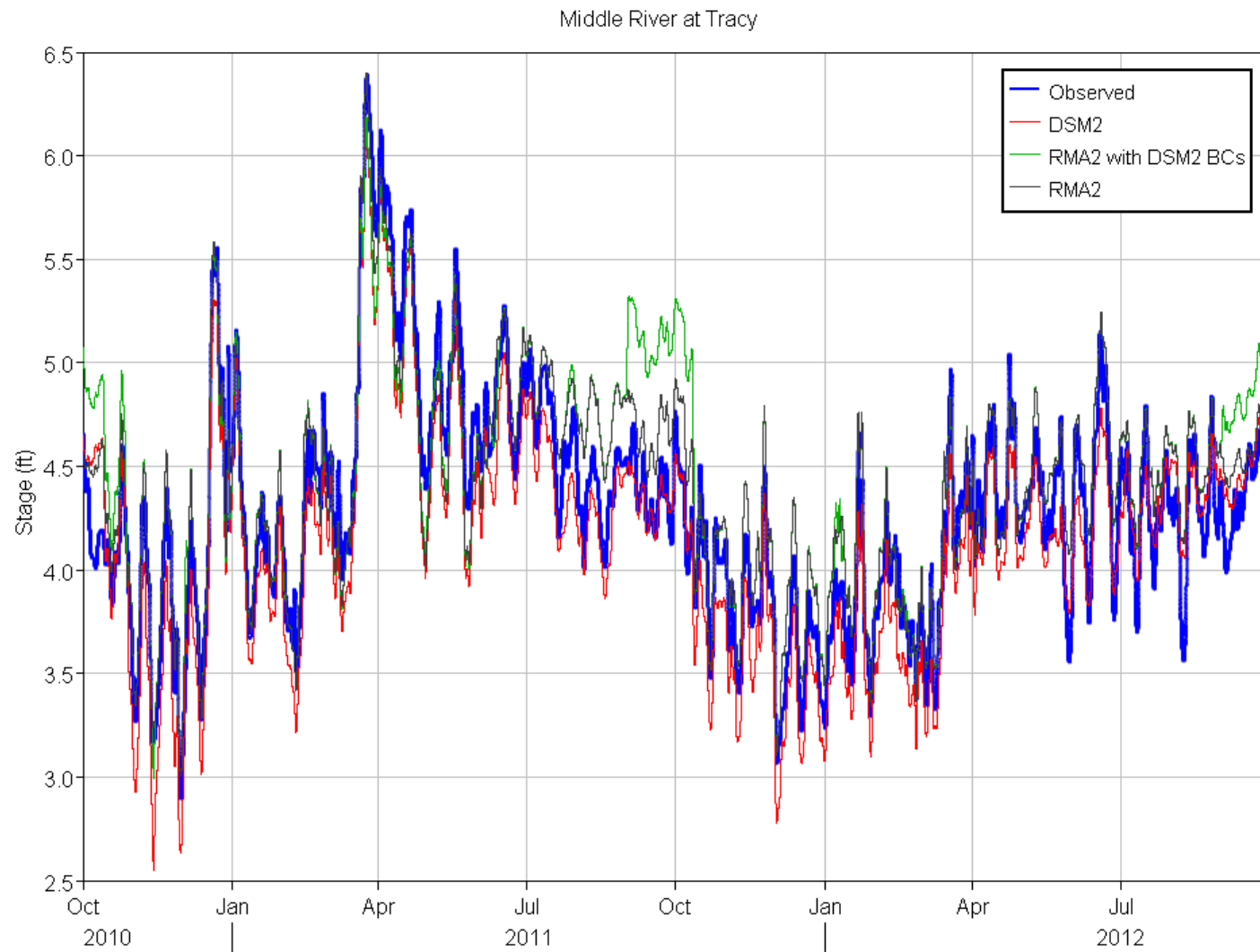


Figure 216 Computed (DSM2) and observed stage comparison plots for Middle River at Tracy.



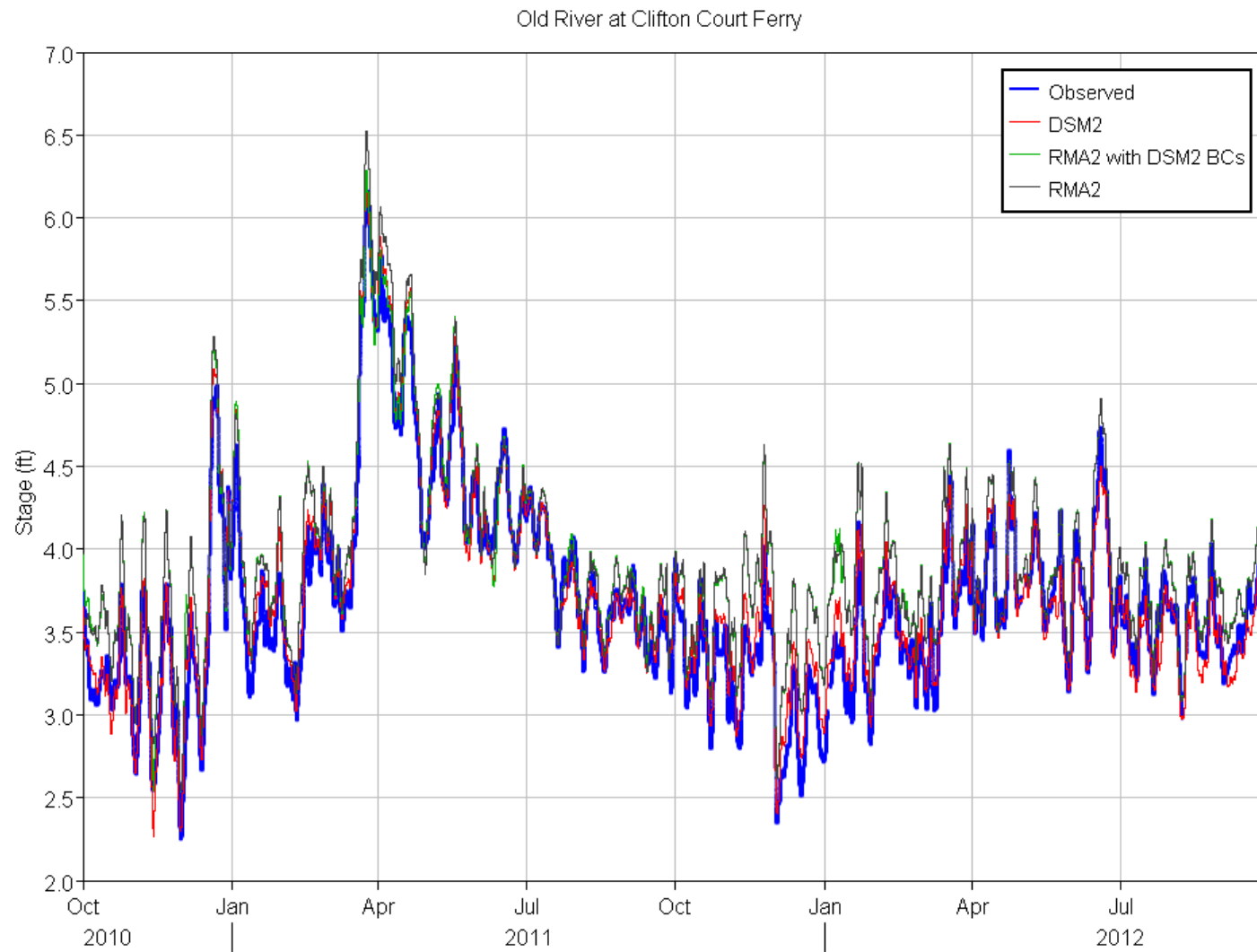


Figure 217 Computed (DSM2) and observed stage comparison plots for Old River at Clifton Court Ferry.

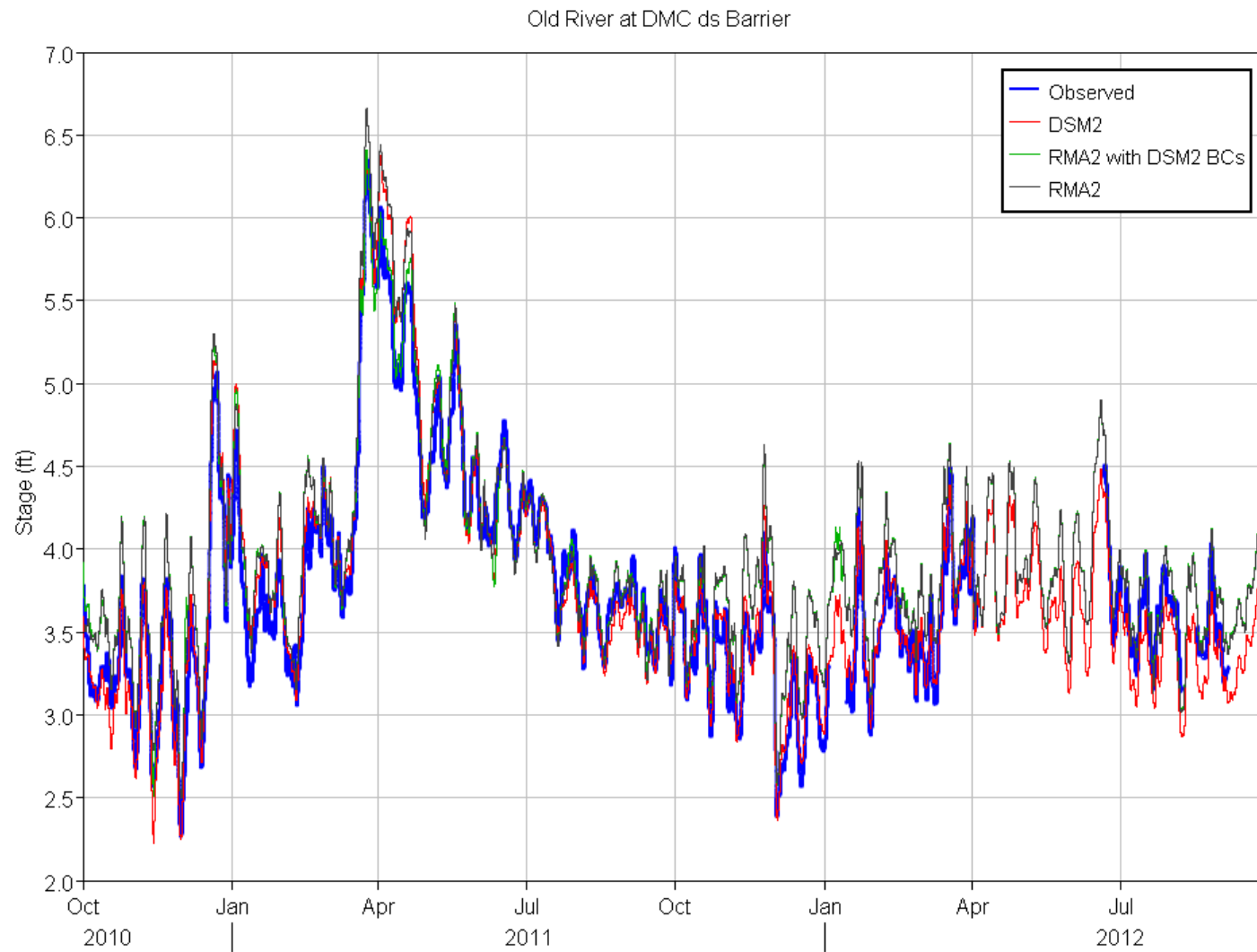


Figure 218 Computed (DSM2) and observed stage comparison plots for Old River at DMC ds Barrier.

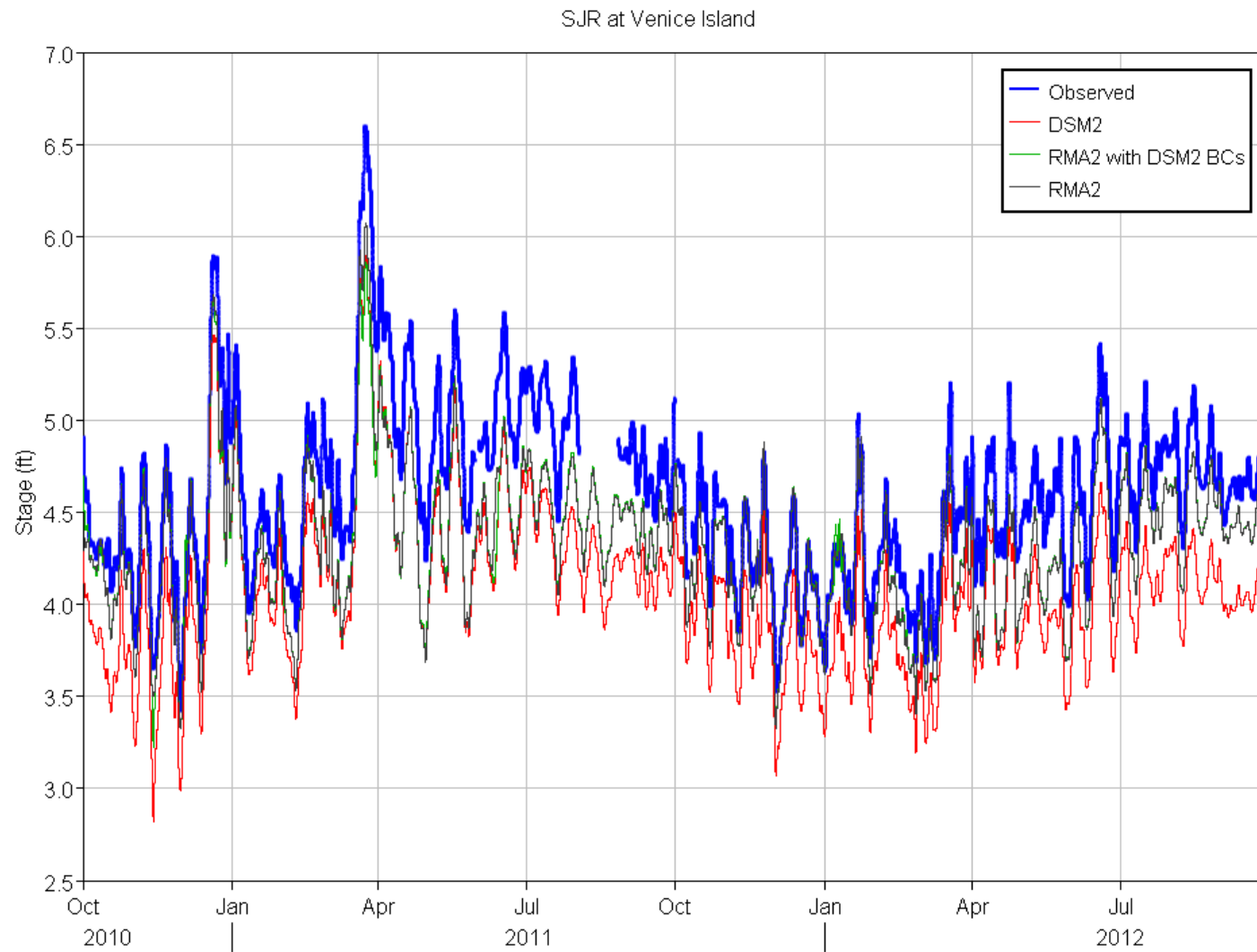


Figure 219 Computed (DSM2) and observed stage comparison plots for SJR at Venice Island.



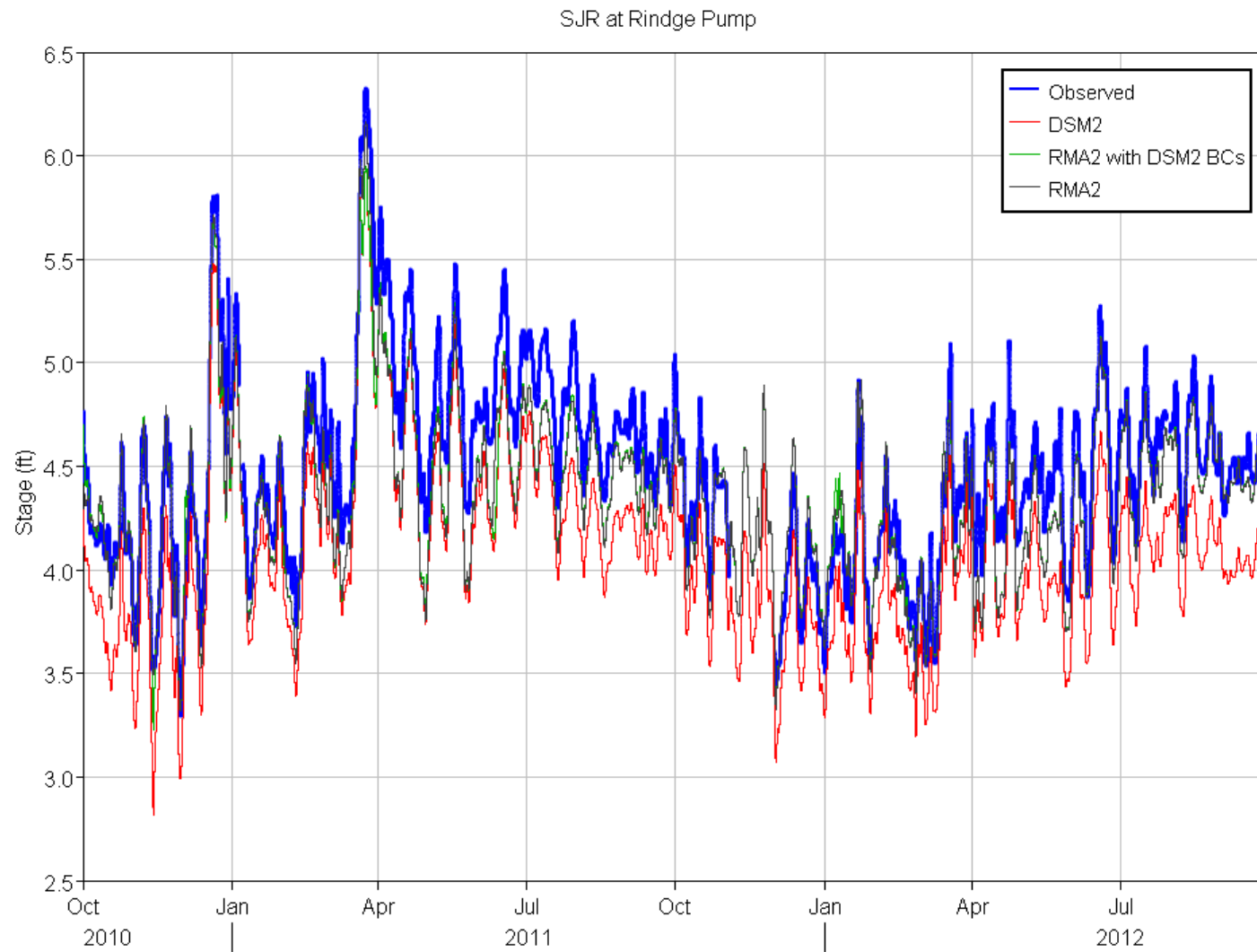


Figure 220 Computed (DSM2) and observed stage comparison plots for SJR at Rindge Pump.

## References

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