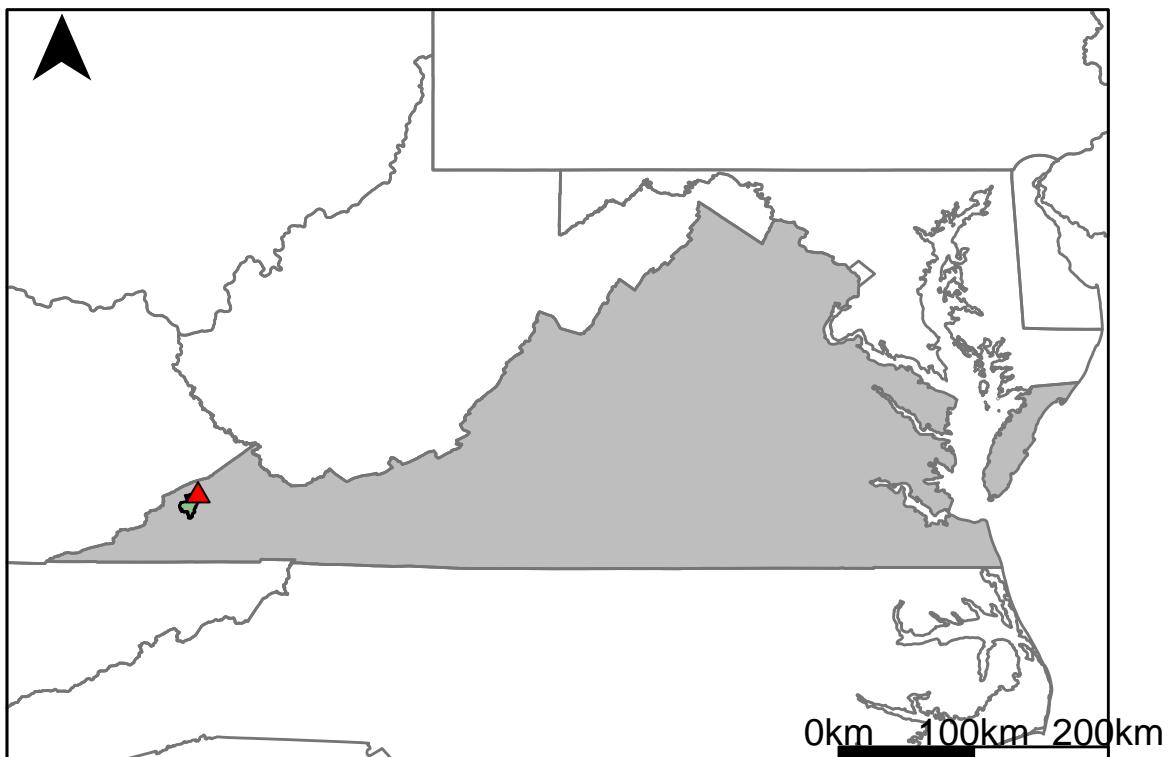


## Appendix A: Big Sandy River Gages

### Appendix A.1: USGS Gage 03208950 vs. BS1\_8730\_8540



This river segment follows part of the flow of the Cranes Nest River, a tributary of the Big Sandy River. The gage is located in Dickenson County, VA (Lat 37°07'26", Long 82°26'20") approximately 17 miles northeast of Norton, VA. Drainage area is 66.5 sq. miles. This gage started taking data in 1963 and is still taking data. This area is not regulated and should not have any man-made alterations that could affect flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was -7.35%, with 55.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	8.3	7.49	9.76
Feb. Low Flow	12	20.2	-68.3
Mar. Low Flow	16	24.8	-55
Apr. Low Flow	30	42.5	-41.7
May Low Flow	48	55.2	-15
Jun. Low Flow	54	50.6	6.3
Jul. Low Flow	54	36.7	32
Aug. Low Flow	32.6	23.3	28.5
Sep. Low Flow	19	13.8	27.4
Oct. Low Flow	14	11.4	18.6
Nov. Low Flow	11	13.8	-25.5
Dec. Low Flow	9.4	8.02	14.7

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	77.6	83.3	-7.35
Jan. Mean Flow	102	119	-16.7
Feb. Mean Flow	156	177	-13.5
Mar. Mean Flow	156	155	0.64
Apr. Mean Flow	134	112	16.4
May Mean Flow	90.1	81.2	9.88
Jun. Mean Flow	61.1	54.5	10.8
Jul. Mean Flow	39.5	36.6	7.34
Aug. Mean Flow	33.8	35.9	-6.21
Sep. Mean Flow	25.3	34.4	-36
Oct. Mean Flow	25	40.3	-61.2
Nov. Mean Flow	39.2	61	-55.6
Dec. Mean Flow	75	98.8	-31.7

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	36	70.3	-95.3
Feb. High Flow	163	200	-22.7
Mar. High Flow	231	239	-3.46
Apr. High Flow	380	309	18.7
May High Flow	596	561	5.87
Jun. High Flow	411	400	2.68
Jul. High Flow	255	266	-4.31
Aug. High Flow	243	332	-36.6
Sep. High Flow	97	77.3	20.3
Oct. High Flow	118	74.7	36.7
Nov. High Flow	79	72.4	8.35
Dec. High Flow	55	53.2	3.27

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	3	0	100
Med. 1 Day Min	7.4	4.75	35.8
Min. 3 Day Min	3.33	0.01	99.6
Med. 3 Day Min	7.53	5.23	30.5
Min. 7 Day Min	4.41	0.33	92.5
Med. 7 Day Min	7.84	6.25	20.3
Min. 30 Day Min	5.1	4.15	18.6
Med. 30 Day Min	11.2	12.4	-10.7
Min. 90 Day Min	8.91	8.69	2.47
Med. 90 Day Min	18.7	23.9	-27.8
7Q10	5.15	1.35	73.8
Year of 90-Day Min. Flow	1999	1988	100
Drought Year Mean	46.3	83.3	-79.9
Mean Baseflow	35.5	39.2	-10.4

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	3750	3090	17.6
Med. 1 Day Max	1020	1290	-26.5
Max. 3 Day Max	1710	1800	-5.26
Med. 3 Day Max	755	681	9.8
Max. 7 Day Max	873	1130	-29.4
Med. 7 Day Max	477	463	2.94
Max. 30 Day Max	451	528	-17.1
Med. 30 Day Max	247	254	-2.83
Max. 90 Day Max	320	391	-22.2
Med. 90 Day Max	162	171	-5.56

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	5.7	3.32	41.8
5% Non-Exceedance	8.3	7.88	5.06
50% Non-Exceedance	39.9	47.1	-18
95% Non-Exceedance	247	253	-2.43
99% Non-Exceedance	607	668	-10
Sept. 10% Non-Exceedance	5.95	5.65	5.04

**Fig. 1: Hydrograph**

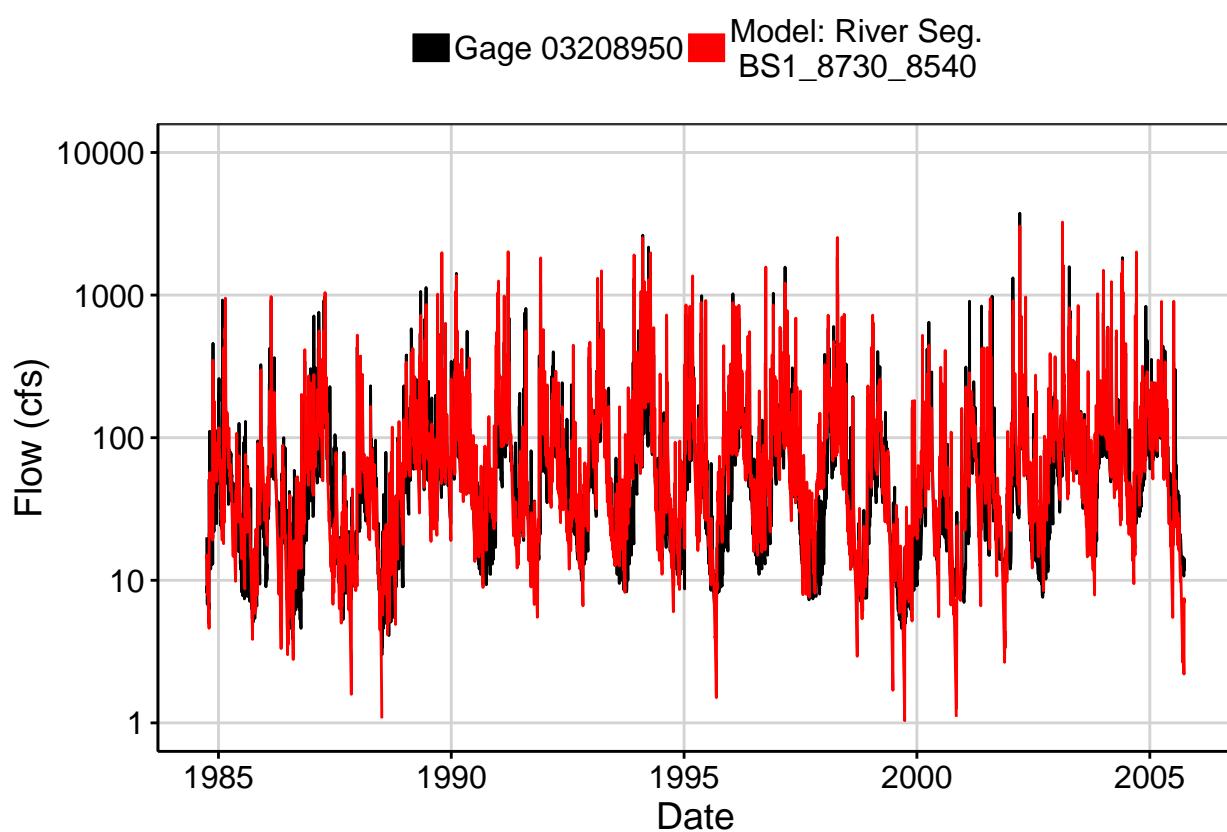


Fig. 2: Zoomed Hydrograph

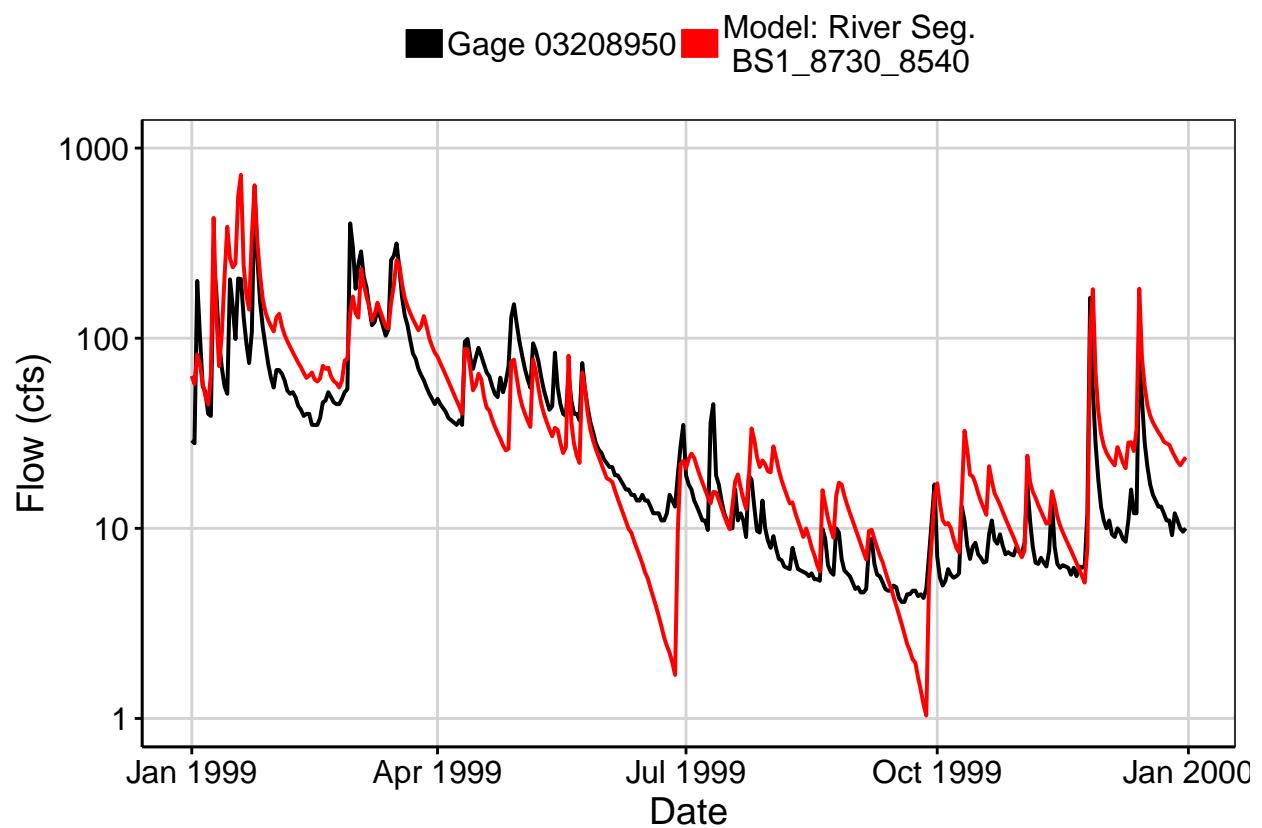


Fig. 3: Flow Exceedance

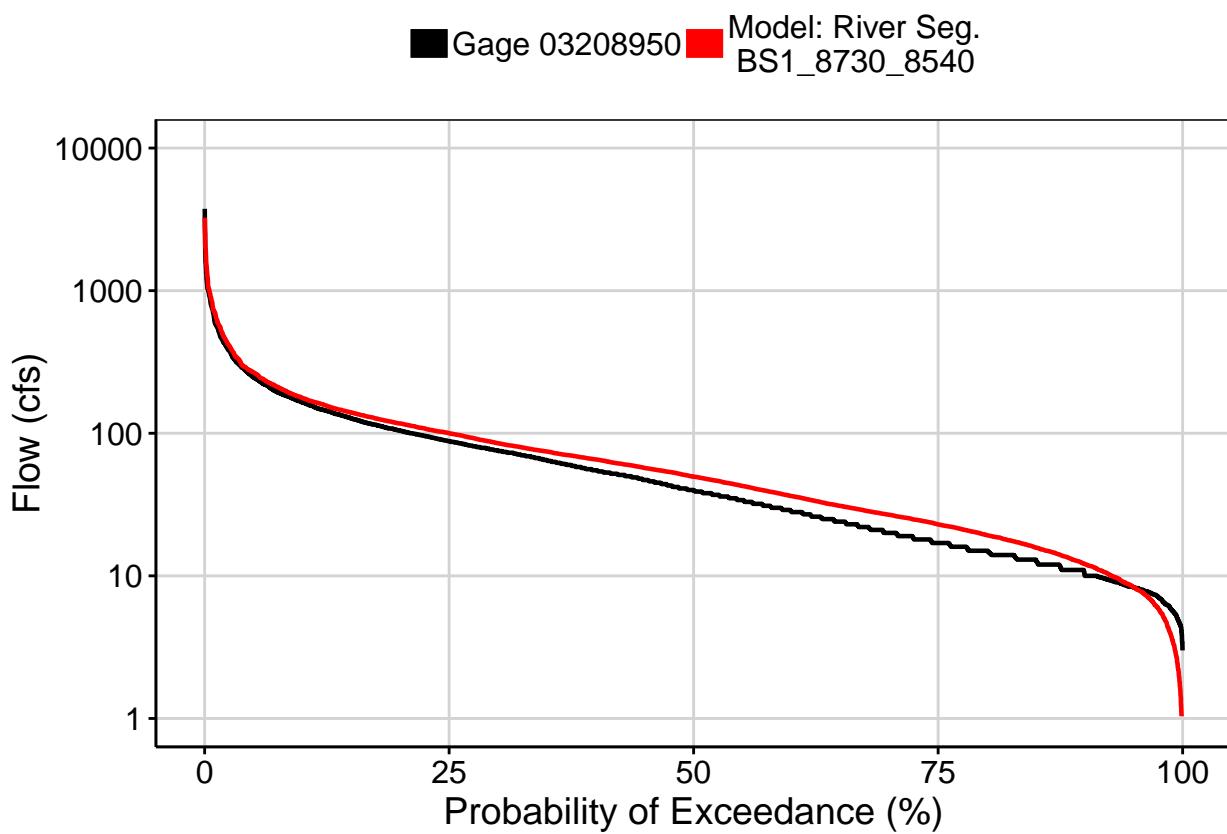


Fig. 4: Baseflow

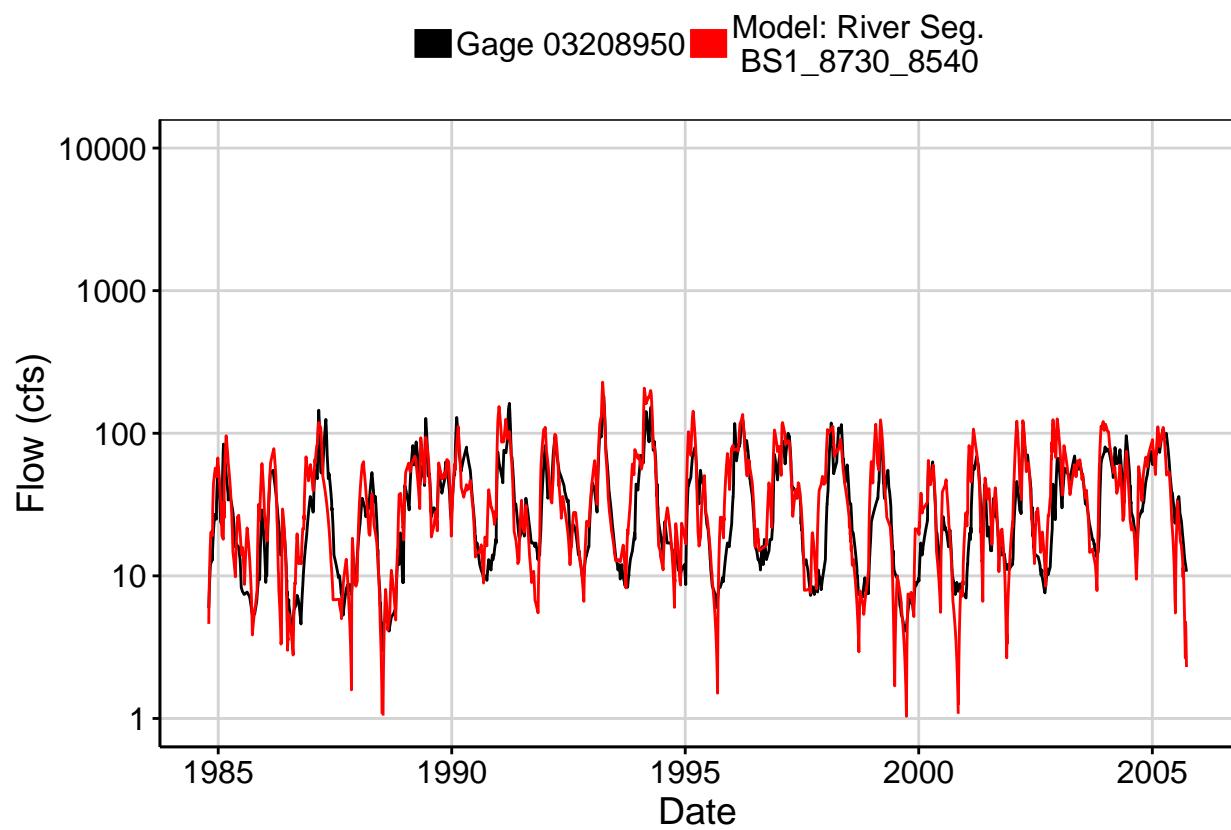


Fig. 5: Combined Baseflow

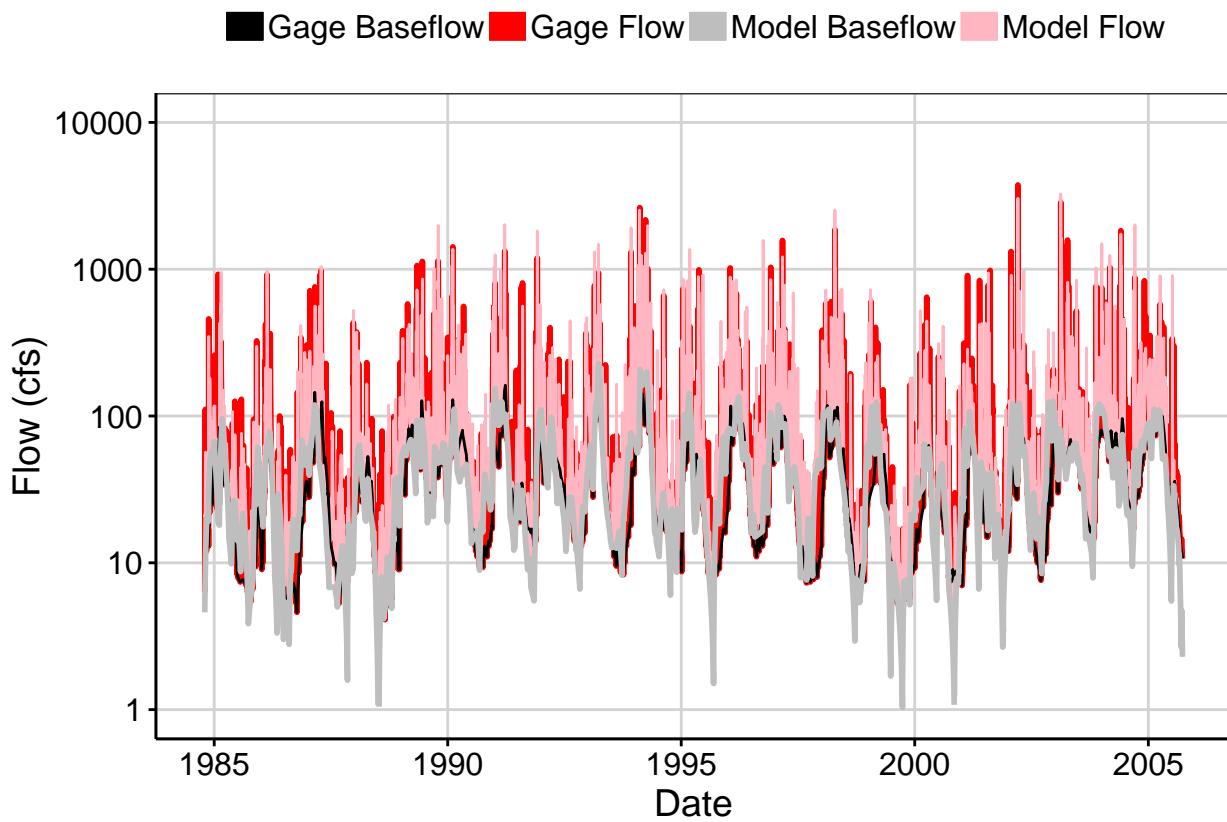


Fig. 6: Largest Error Segment

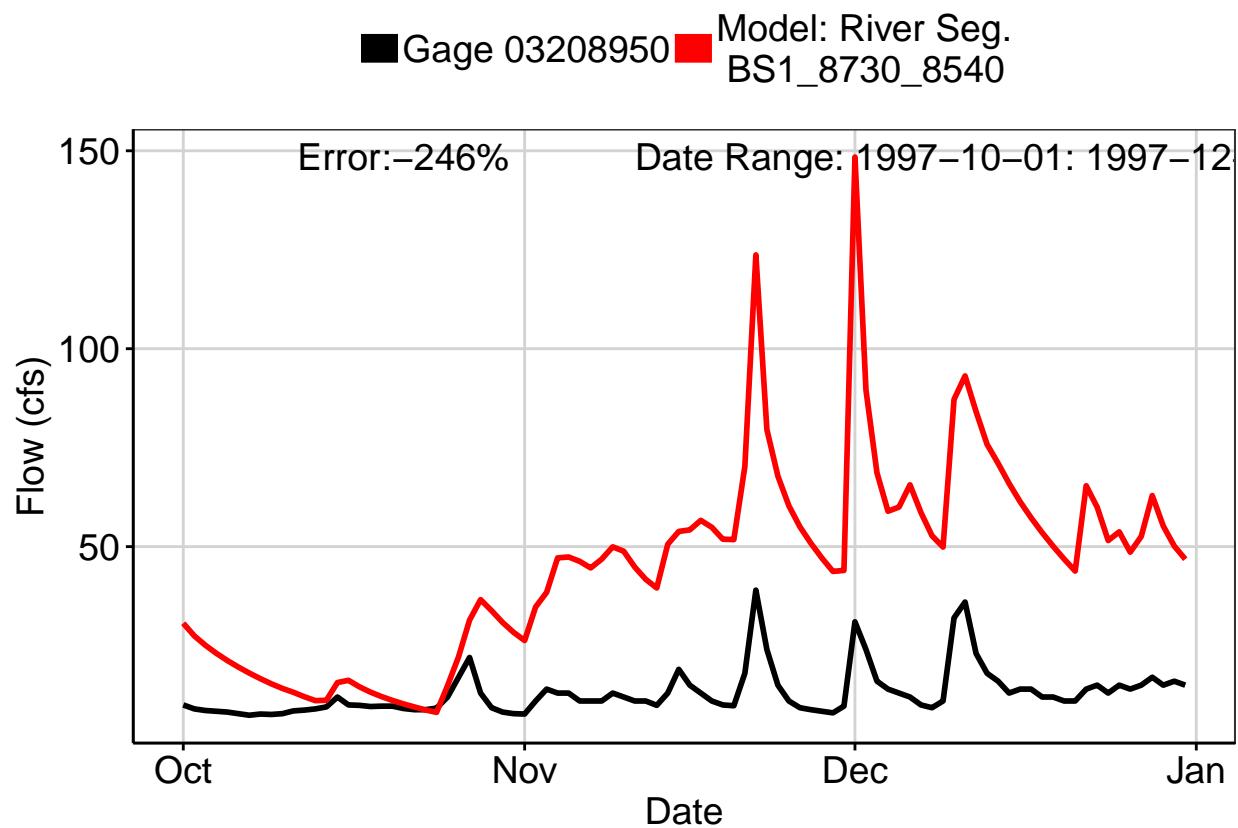


Fig. 7: Second Largest Error Segment

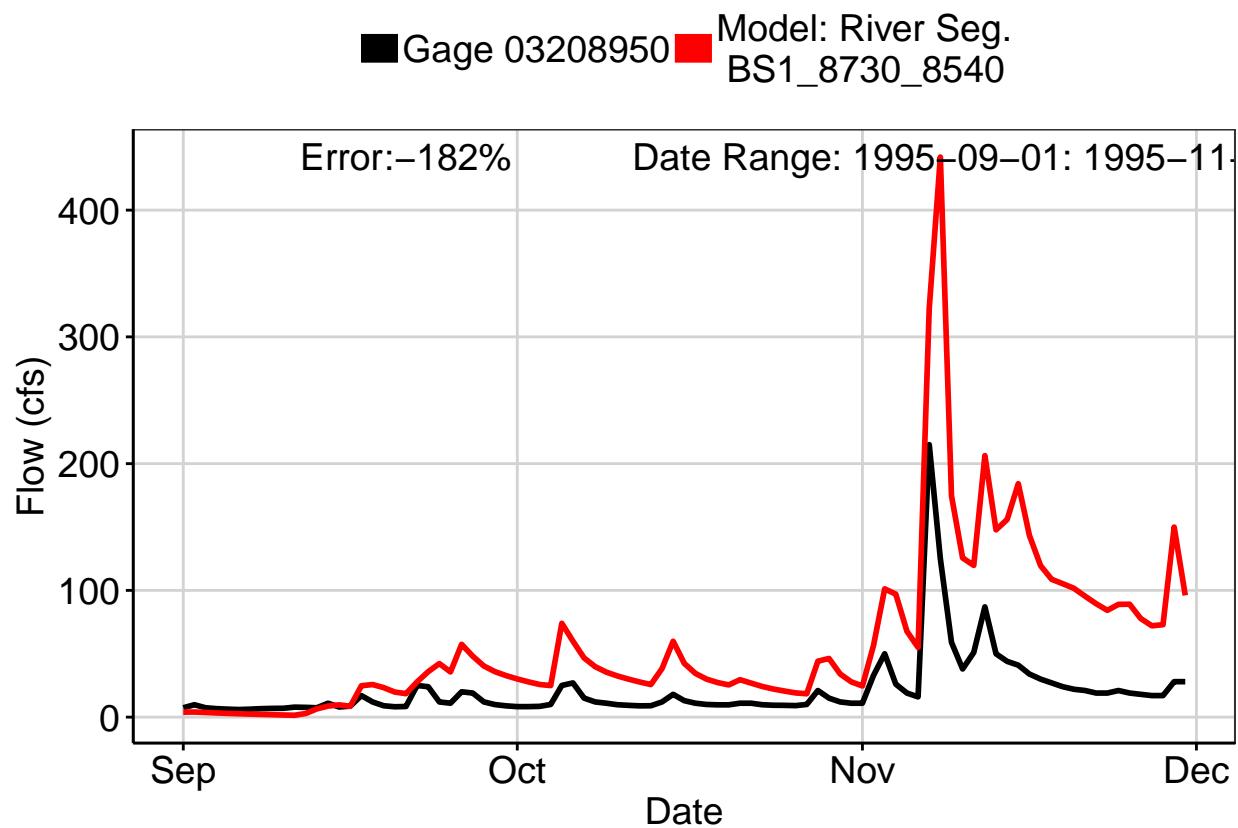


Fig. 8: Third Largest Error Segment

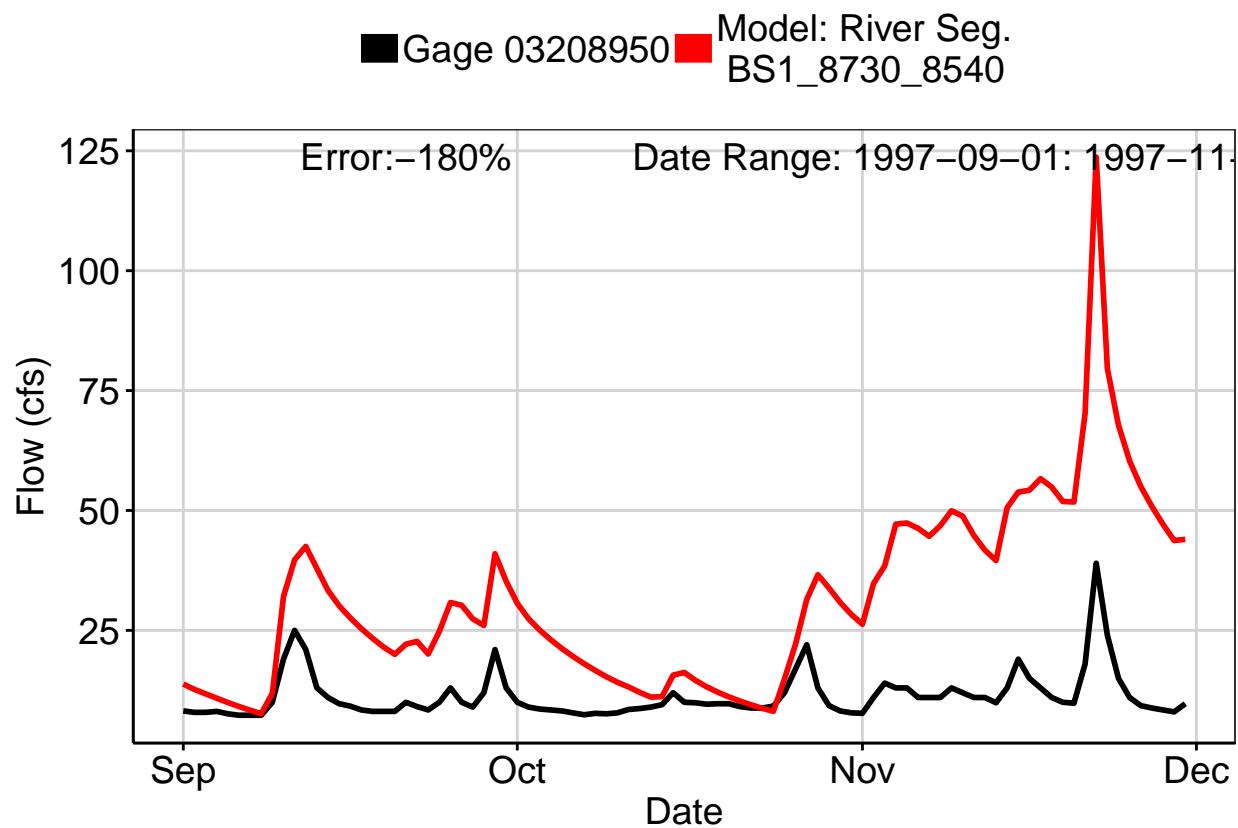
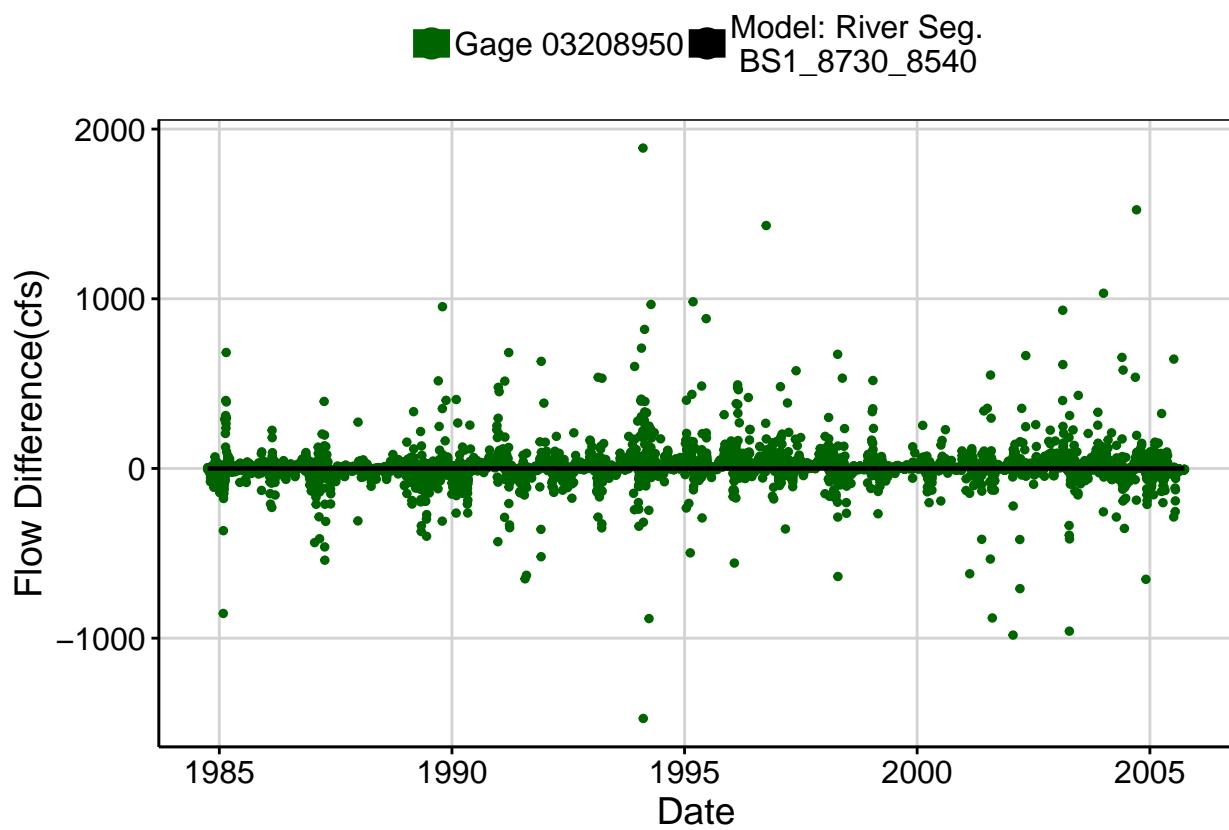
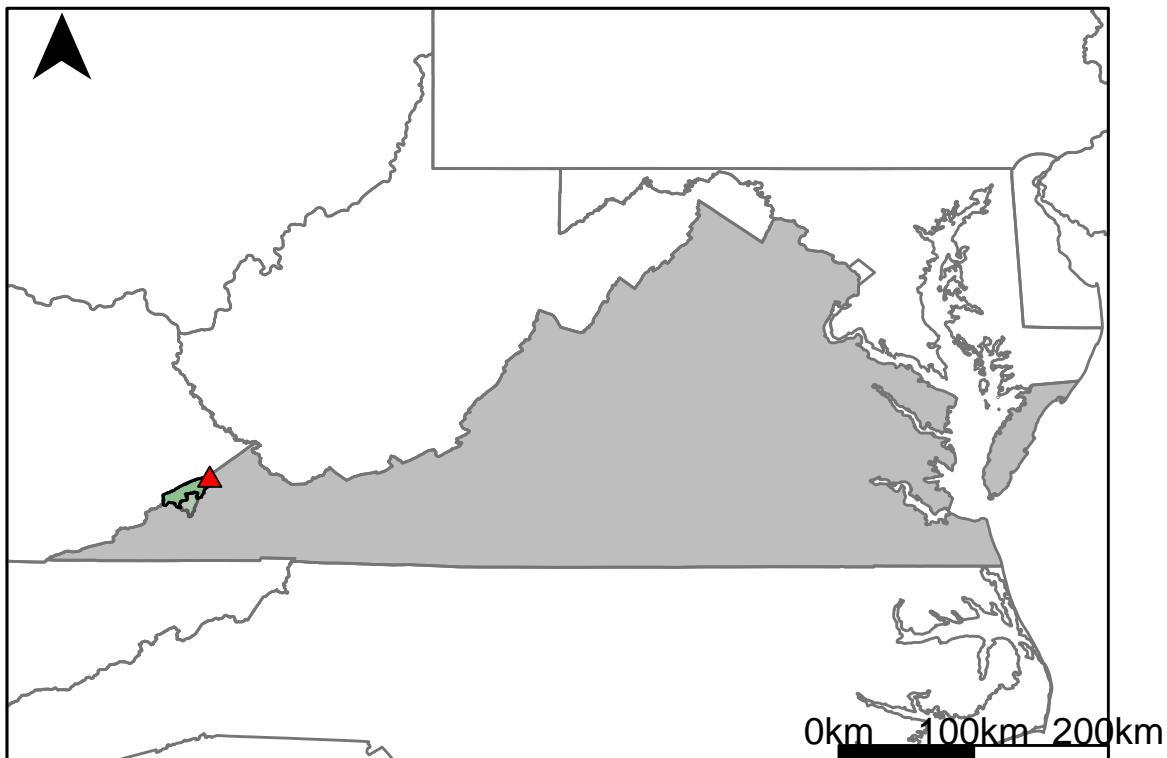


Fig. 9: Residuals Plot



## Appendix A.2: USGS Gage 03209000 vs. BS4\_8540\_8441



This river segment follows part of the flow of the Pound River, a tributary of the Big Sandy River. The gage is located in Dickenson County, VA (Lat 37°14'13", Long 82°20'36") approximately 26 miles northeast of Norton, VA. Drainage area is 221 sq. miles. This gage started taking data in 1926 and is still collecting data. Flow in this area is completely regulated by the Flannagan Dam, approximately 1,700 ft upstream. There is a possibility that some water will bypass the station if the reservoir fills completely and overflows across the spillway, this water will travel down the Cane Branch and return to the Pound River 4,600 ft below the gage. The average daily discharge error between the model and gage data for the 20 year timespan was -2.44%, with 50.4% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	51	55	-7.84
Feb. Low Flow	70	66.8	4.57
Mar. Low Flow	57	92.5	-62.3
Apr. Low Flow	46	150	-226
May Low Flow	92	186	-102
Jun. Low Flow	70	177	-153
Jul. Low Flow	51	55	-7.84
Aug. Low Flow	58	55	5.17
Sep. Low Flow	53	55	-3.77
Oct. Low Flow	46	55	-19.6
Nov. Low Flow	46	55	-19.6
Dec. Low Flow	46	55	-19.6

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	287	294	-2.44
Jan. Mean Flow	368	421	-14.4
Feb. Mean Flow	534	623	-16.7
Mar. Mean Flow	505	545	-7.92
Apr. Mean Flow	308	316	-2.6
May Mean Flow	325	165	49.2
Jun. Mean Flow	228	187	18
Jul. Mean Flow	138	114	17.4
Aug. Mean Flow	120	118	1.67
Sep. Mean Flow	94.5	120	-27
Oct. Mean Flow	226	371	-64.2
Nov. Mean Flow	292	220	24.7
Dec. Mean Flow	319	342	-7.21

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	383	752	-96.3
Feb. High Flow	669	721	-7.77
Mar. High Flow	949	788	17
Apr. High Flow	1160	1110	4.31
May High Flow	1740	2030	-16.7
Jun. High Flow	1360	1420	-4.41
Jul. High Flow	673	810	-20.4
Aug. High Flow	1260	401	68.2
Sep. High Flow	399	248	37.8
Oct. High Flow	365	203	44.4
Nov. High Flow	286	231	19.2
Dec. High Flow	119	153	-28.6

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	8.5	55	-547
Med. 1 Day Min	23	55	-139
Min. 3 Day Min	8.63	55	-537
Med. 3 Day Min	39	55	-41
Min. 7 Day Min	10.9	55	-405
Med. 7 Day Min	41	55	-34.1
Min. 30 Day Min	38.4	55	-43.2
Med. 30 Day Min	56	55	1.79
Min. 90 Day Min	48.1	55	-14.3
Med. 90 Day Min	78.9	70.4	10.8
7Q10	16.3	55.6	-241
Year of 90-Day Min. Flow	1995	1985	100
Drought Year Mean	239	294	-23
Mean Baseflow	101	136	-34.7

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	4010	3760	6.23
Med. 1 Day Max	2920	2590	11.3
Max. 3 Day Max	3700	3680	0.54
Med. 3 Day Max	2350	2350	0
Max. 7 Day Max	2650	3400	-28.3
Med. 7 Day Max	1760	1530	13.1
Max. 30 Day Max	1630	1800	-10.4
Med. 30 Day Max	845	838	0.83
Max. 90 Day Max	1080	1330	-23.1
Med. 90 Day Max	562	568	-1.07

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	16.7	55	-229
5% Non-Exceedance	44	55	-25
50% Non-Exceedance	145	159	-9.66
95% Non-Exceedance	1060	912	14
99% Non-Exceedance	2260	2420	-7.08
Sept. 10% Non-Exceedance	54	55	-1.85

**Fig. 1: Hydrograph**

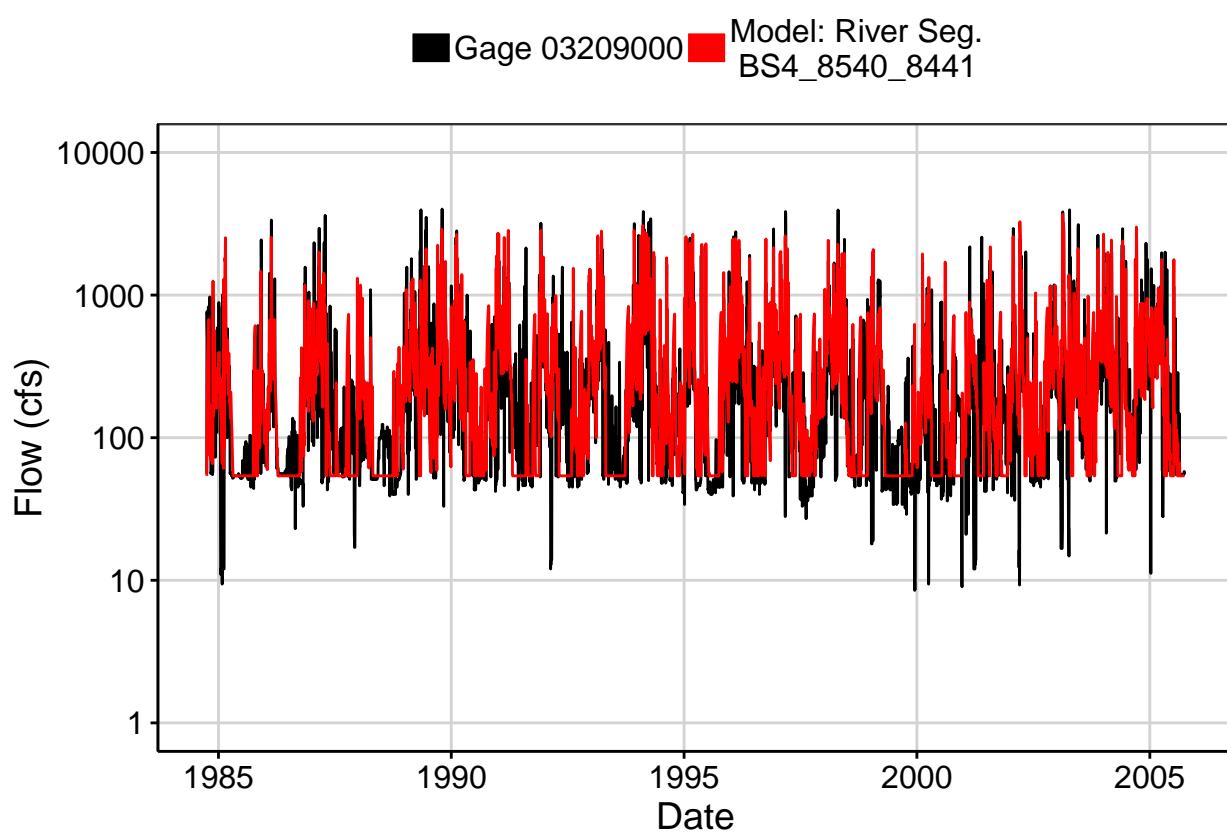


Fig. 2: Zoomed Hydrograph

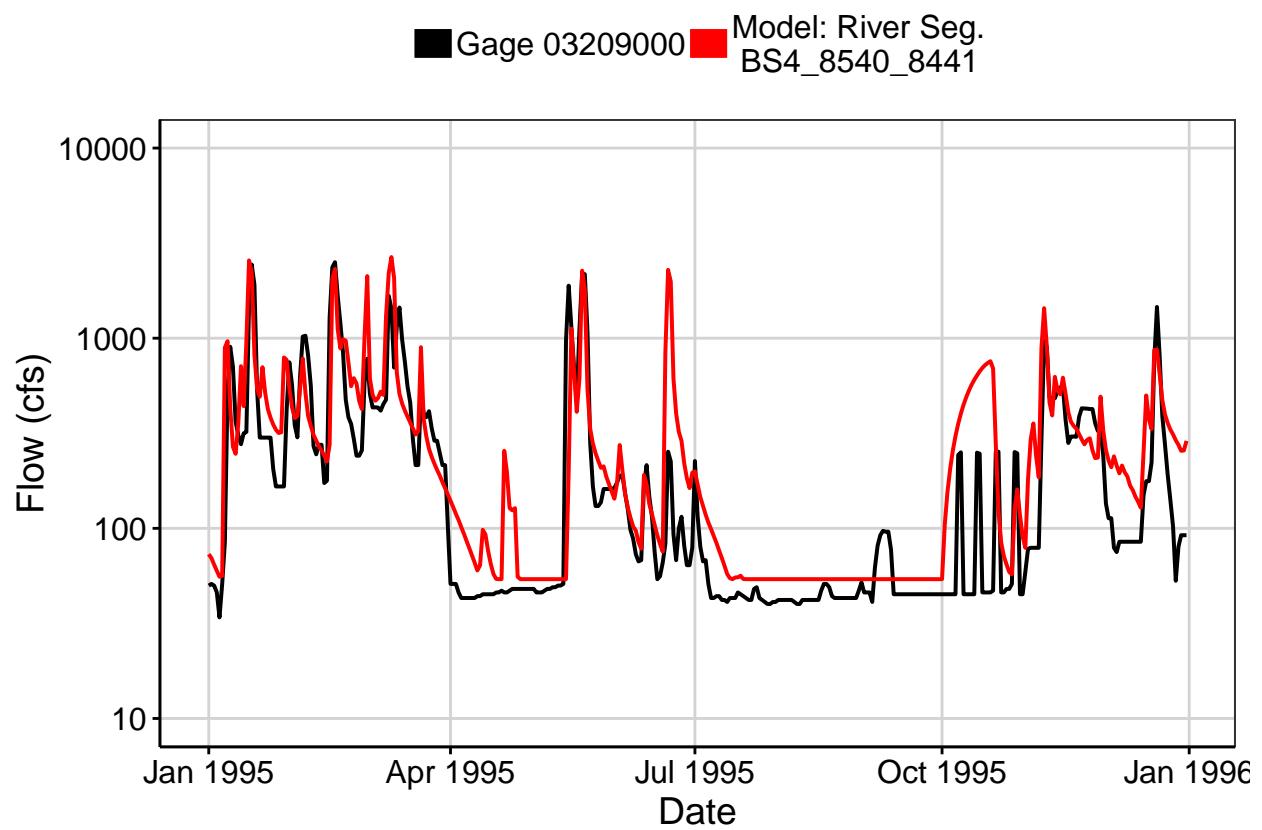


Fig. 3: Flow Exceedance

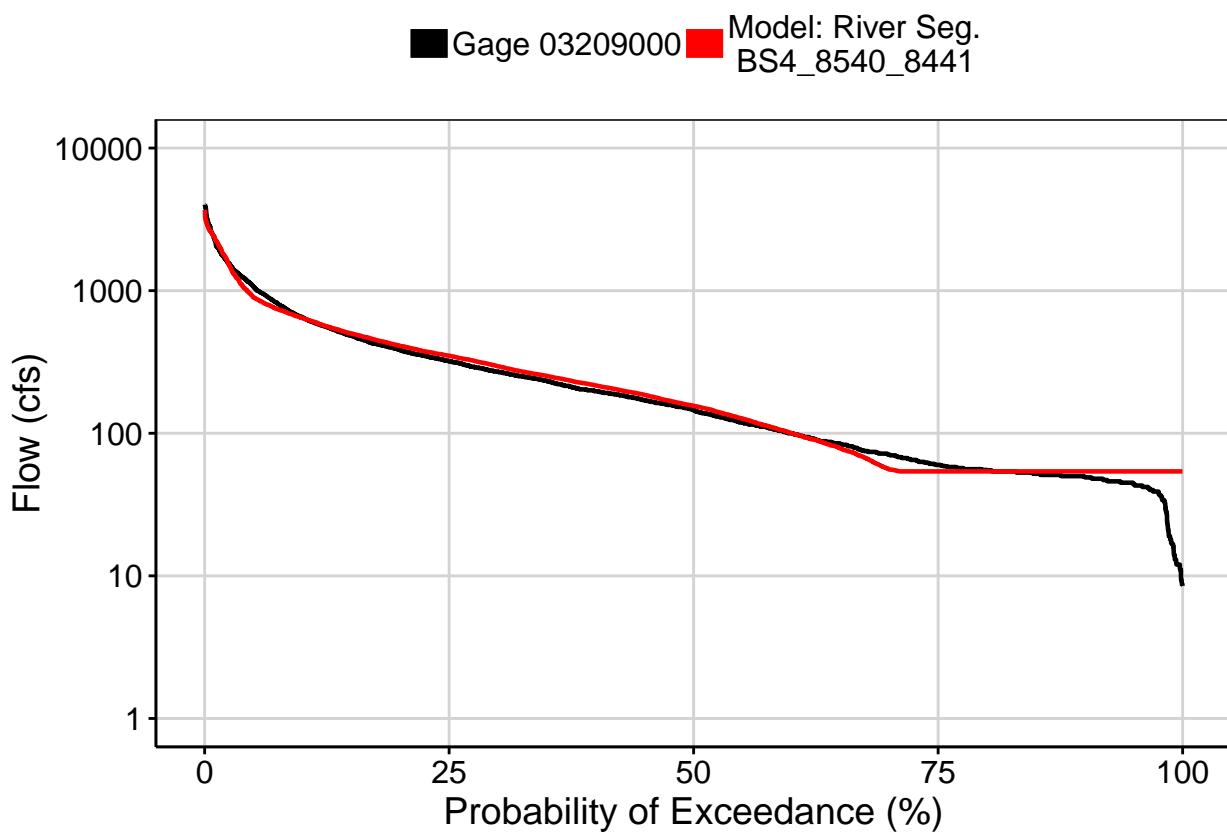


Fig. 4: Baseflow

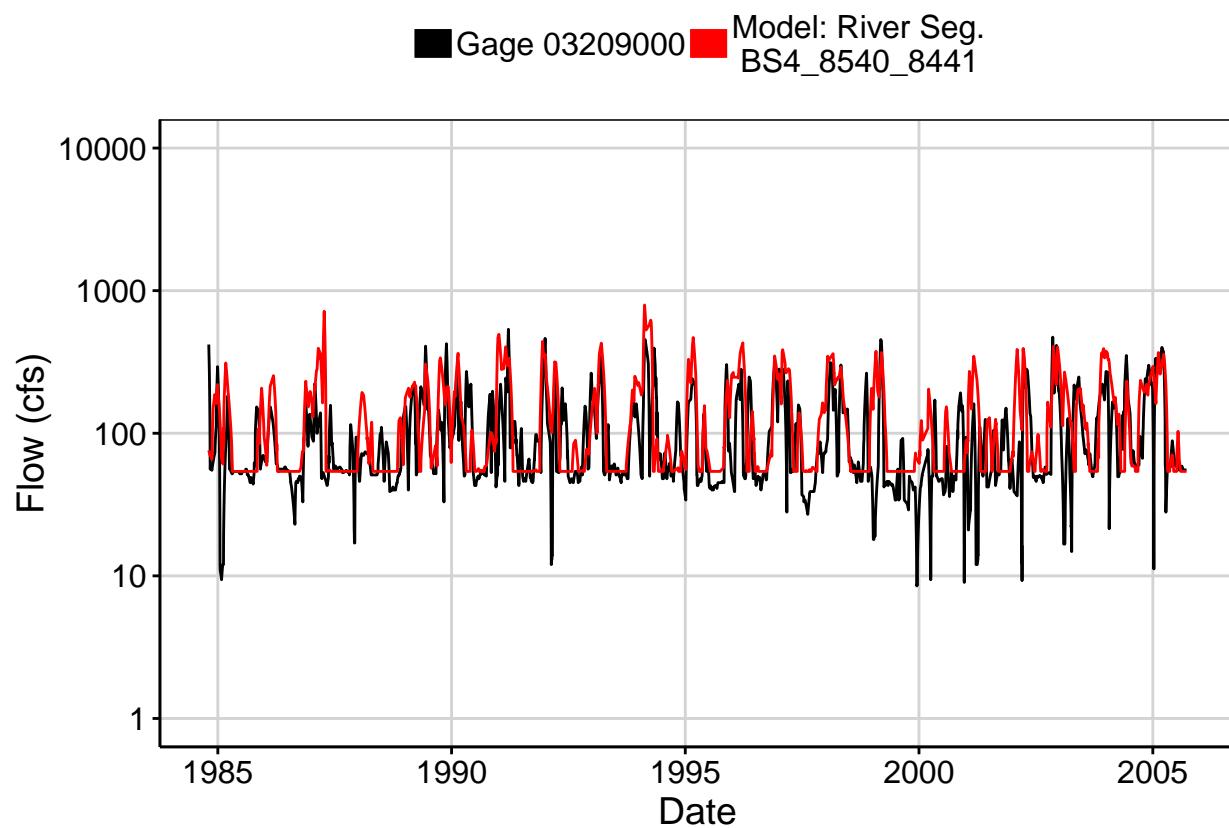


Fig. 5: Combined Baseflow

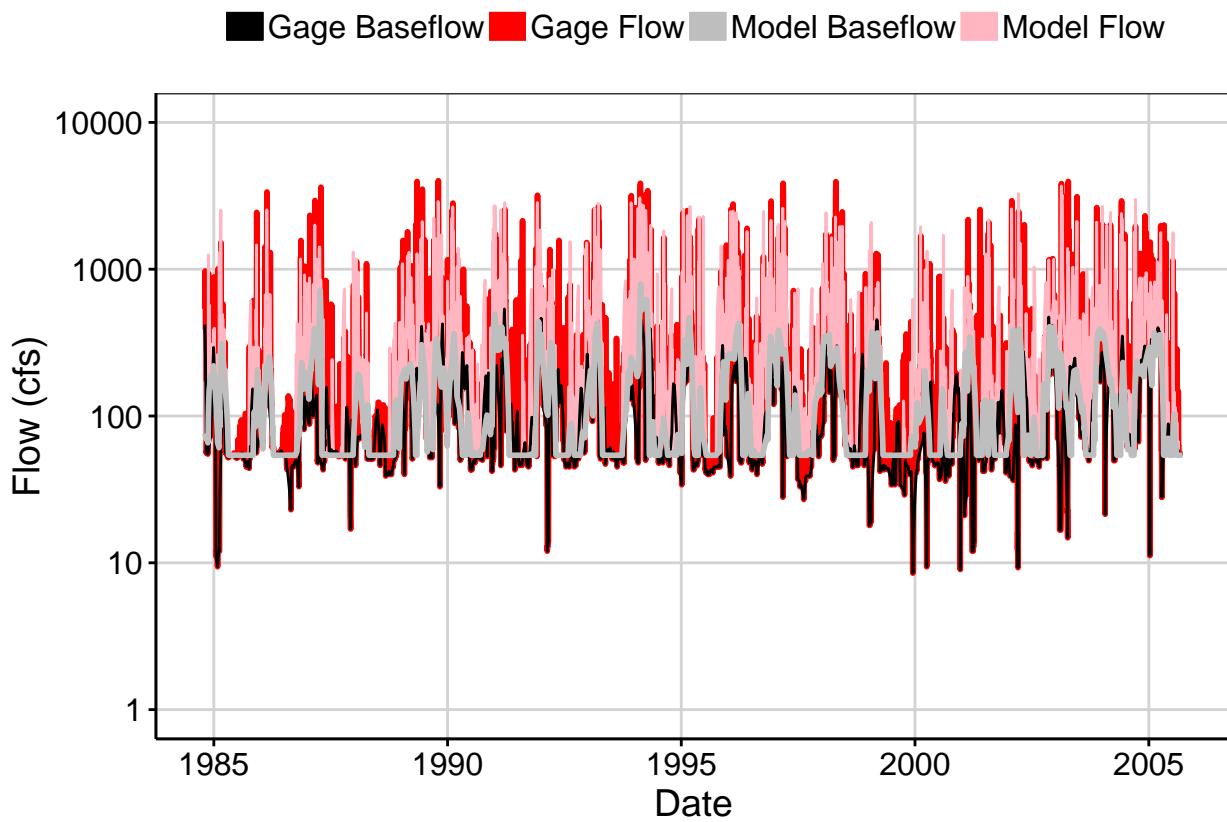


Fig. 6: Largest Error Segment

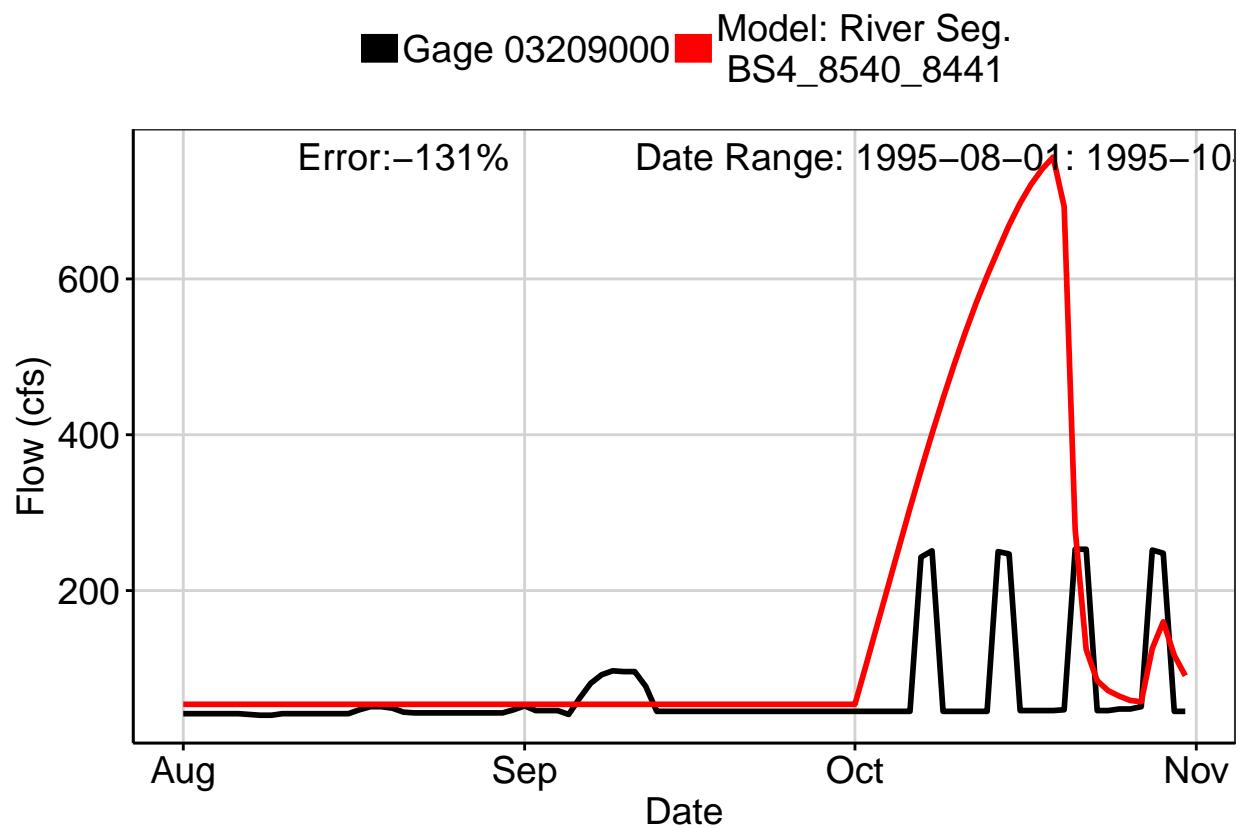


Fig. 7: Second Largest Error Segment

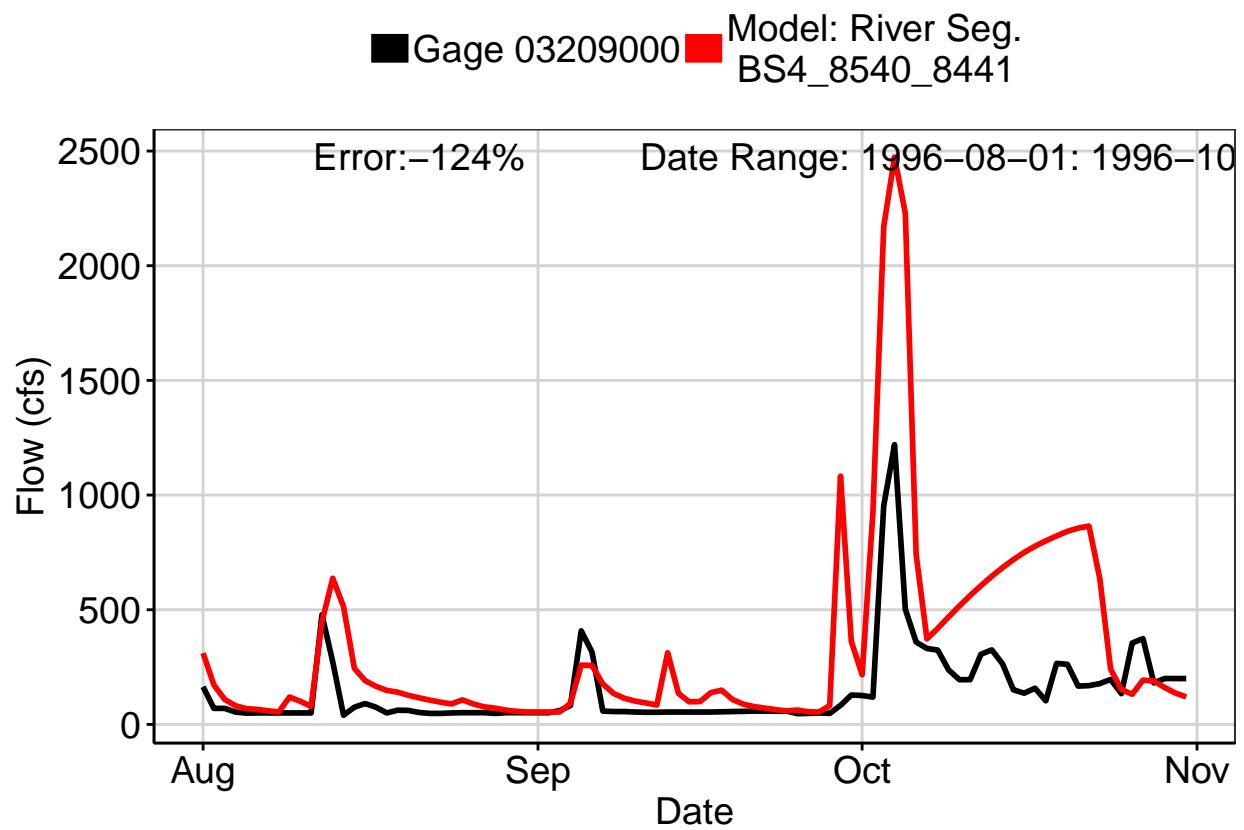


Fig. 8: Third Largest Error Segment

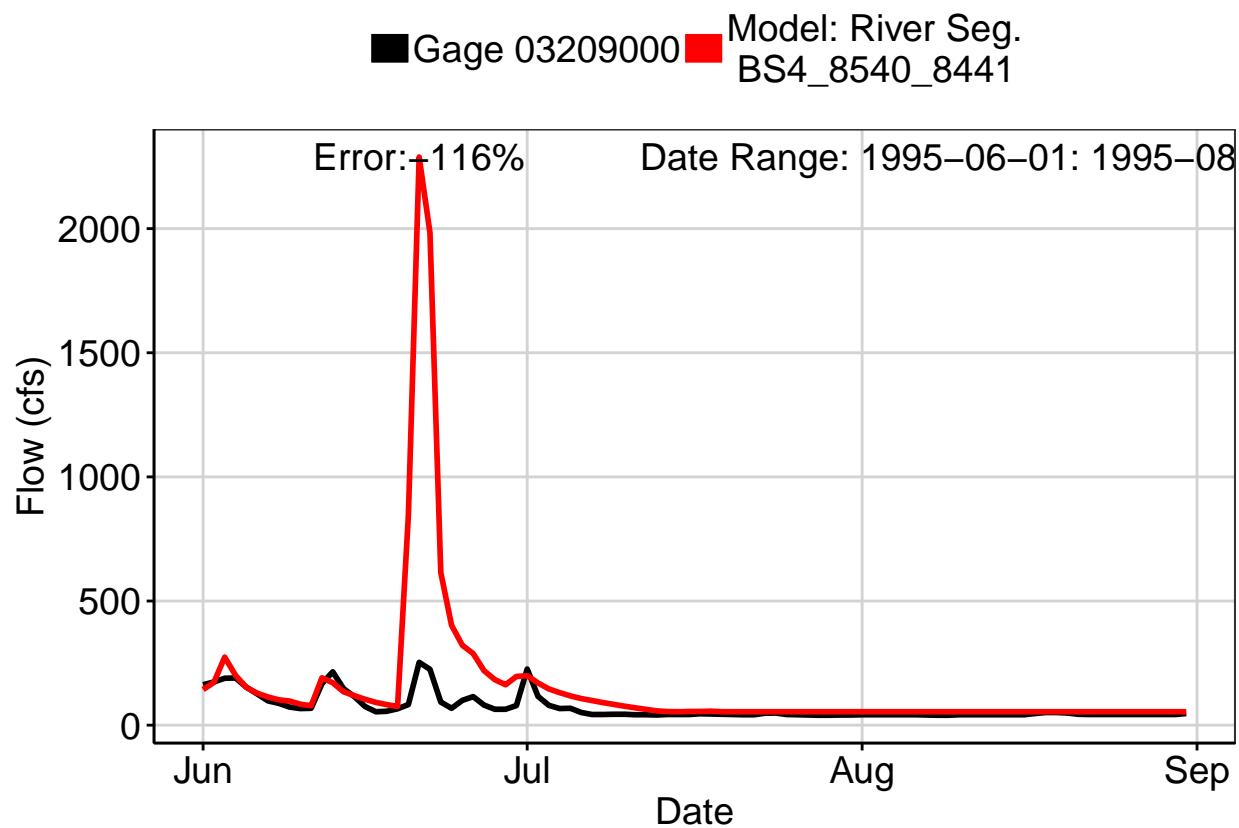
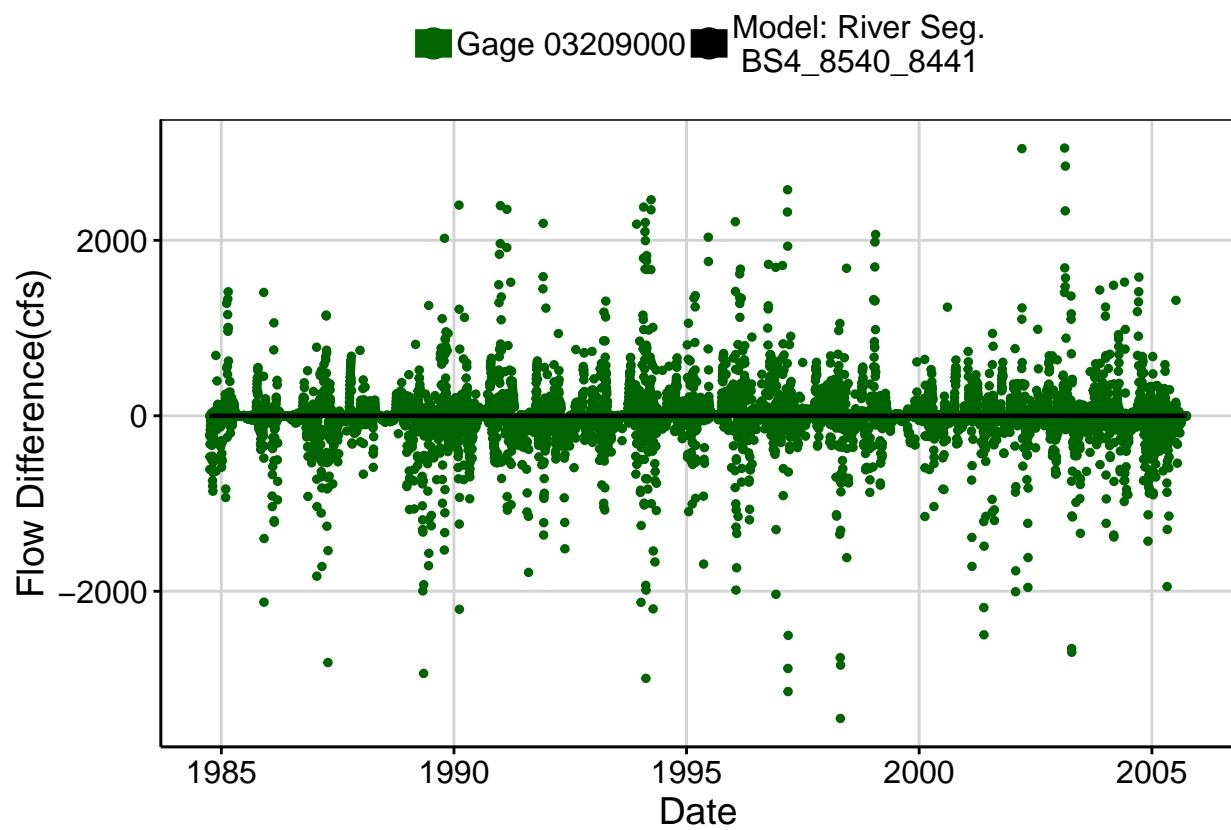
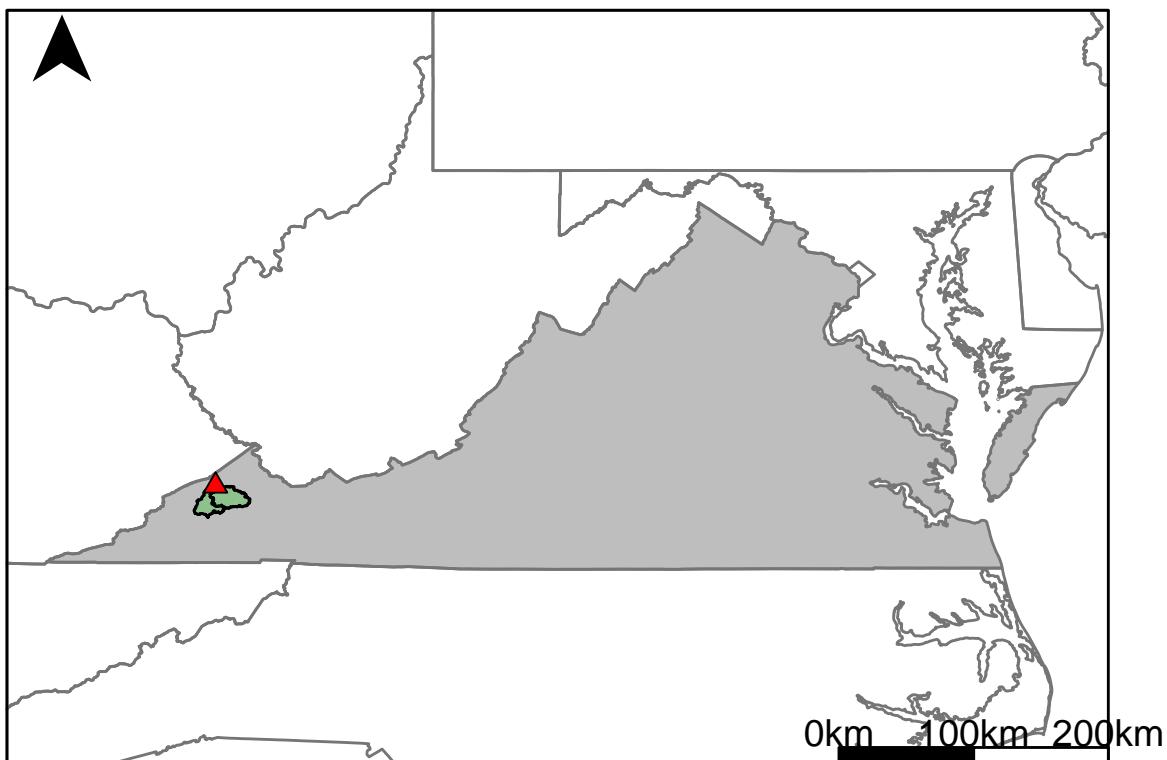


Fig. 9: Residuals Plot



## Appendix A.3: USGS Gage 03208500 vs. BS2\_8590\_8440+BS3\_8580\_8440



This river segment follows part of the flow of the Russell Fork, a tributary of the Big Sandy River. The gage is located in Dickenson County, VA (Lat 3712'25", Long 8217'45") approximately 26 miles northeast of Norton, VA. Drainage area is 286 sq. miles. This gage started taking data in 1926 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 44.3%, with 52.5% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	26	24.4	6.15
Feb. Low Flow	26.2	36.1	-37.8
Mar. Low Flow	60	86.9	-44.8
Apr. Low Flow	111	115	-3.6
May Low Flow	191	142	25.7
Jun. Low Flow	218	149	31.7
Jul. Low Flow	258	101	60.9
Aug. Low Flow	120	69.1	42.4
Sep. Low Flow	64	44.6	30.3
Oct. Low Flow	56	20.9	62.7
Nov. Low Flow	39	16.1	58.7
Dec. Low Flow	27	16.1	40.4

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	366	204	44.3
Jan. Mean Flow	488	285	41.6
Feb. Mean Flow	733	406	44.6
Mar. Mean Flow	751	362	51.8
Apr. Mean Flow	674	280	58.5
May Mean Flow	433	225	48
Jun. Mean Flow	281	145	48.4
Jul. Mean Flow	194	95.4	50.8
Aug. Mean Flow	122	89.5	26.6
Sep. Mean Flow	94.3	78.1	17.2
Oct. Mean Flow	108	105	2.78
Nov. Mean Flow	177	152	14.1
Dec. Mean Flow	357	238	33.3

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	126	154	-22.2
Feb. High Flow	955	619	35.2
Mar. High Flow	1250	566	54.7
Apr. High Flow	1820	676	62.9
May High Flow	3640	1360	62.6
Jun. High Flow	2040	830	59.3
Jul. High Flow	1300	646	50.3
Aug. High Flow	1320	633	52
Sep. High Flow	508	285	43.9
Oct. High Flow	437	206	52.9
Nov. High Flow	363	250	31.1
Dec. High Flow	246	130	47.2

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	8.2	0.66	92
Med. 1 Day Min	17	6.53	61.6
Min. 3 Day Min	8.73	0.89	89.8
Med. 3 Day Min	17.6	7.07	59.8
Min. 7 Day Min	9.17	1.43	84.4
Med. 7 Day Min	20.3	8.61	57.6
Min. 30 Day Min	12.7	5.77	54.6
Med. 30 Day Min	28.8	20.9	27.4
Min. 90 Day Min	28.5	11	61.4
Med. 90 Day Min	75.1	52.5	30.1
7Q10	12.3	2.9	76.4
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	132	204	-54.5
Mean Baseflow	143	96.9	32.2

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	15000	7010	53.3
Med. 1 Day Max	5940	3250	45.3
Max. 3 Day Max	7440	4390	41
Med. 3 Day Max	3590	1650	54
Max. 7 Day Max	4400	2940	33.2
Med. 7 Day Max	2570	1170	54.5
Max. 30 Day Max	2030	1230	39.4
Med. 30 Day Max	1150	583	49.3
Max. 90 Day Max	1470	871	40.7
Med. 90 Day Max	766	396	48.3

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	15	5.77	61.5
5% Non-Exceedance	24	13.7	42.9
50% Non-Exceedance	159	119	25.2
95% Non-Exceedance	1260	619	50.9
99% Non-Exceedance	3380	1640	51.5
Sept. 10% Non-Exceedance	18.5	8.53	53.9

**Fig. 1: Hydrograph**

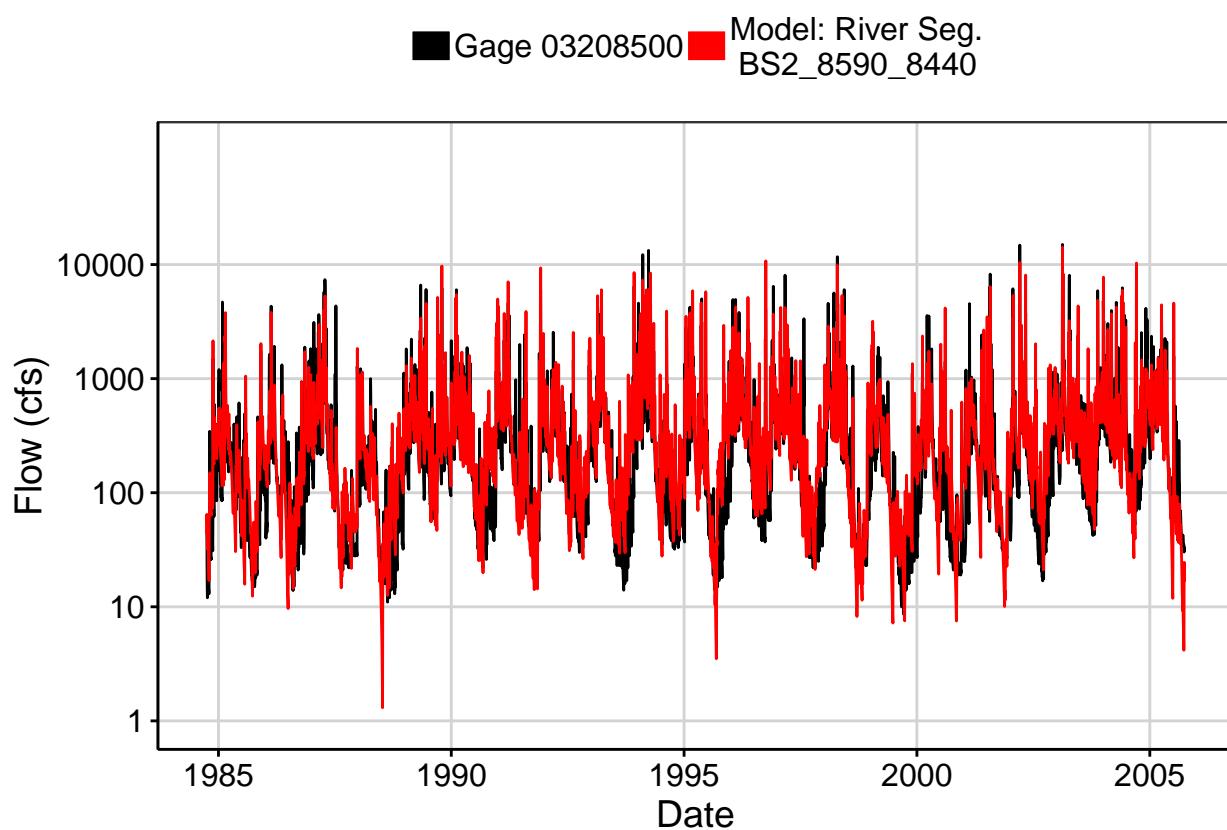


Fig. 2: Zoomed Hydrograph

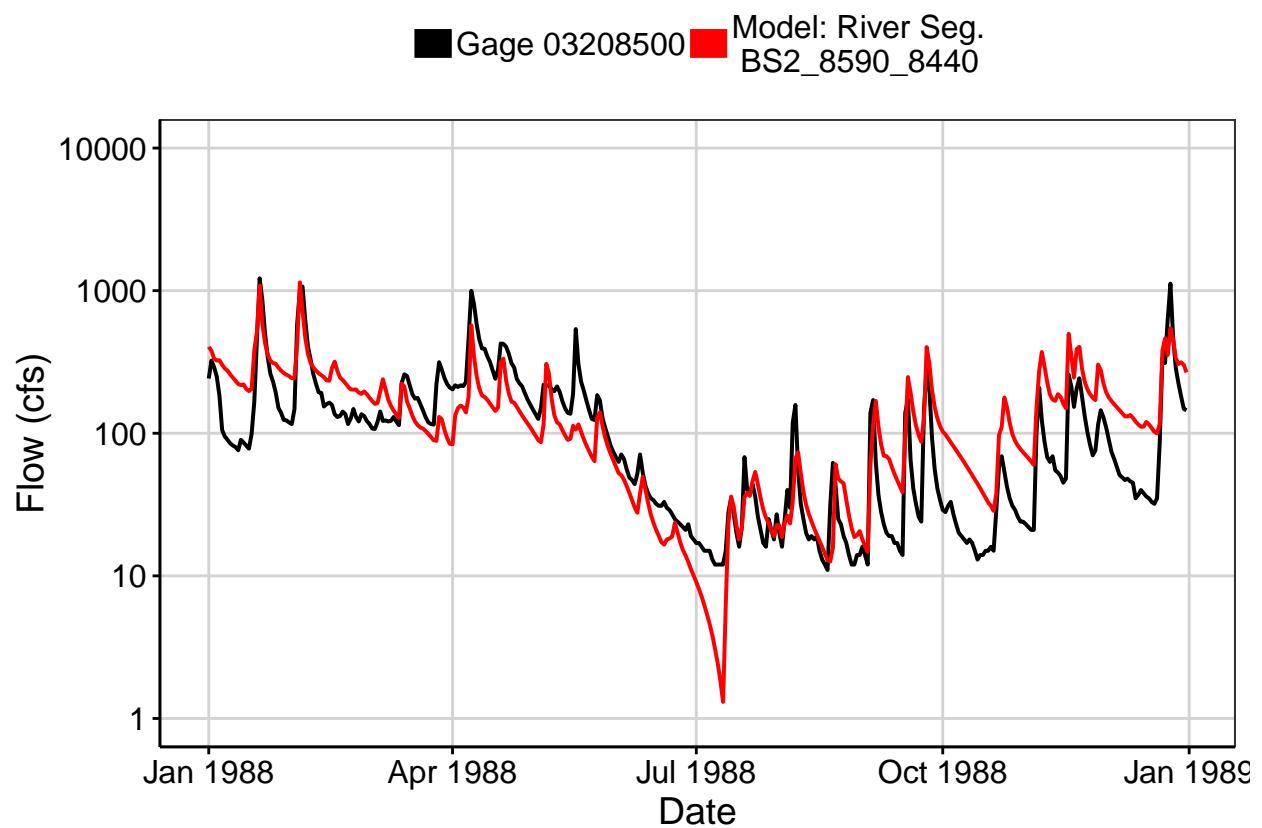


Fig. 3: Flow Exceedance

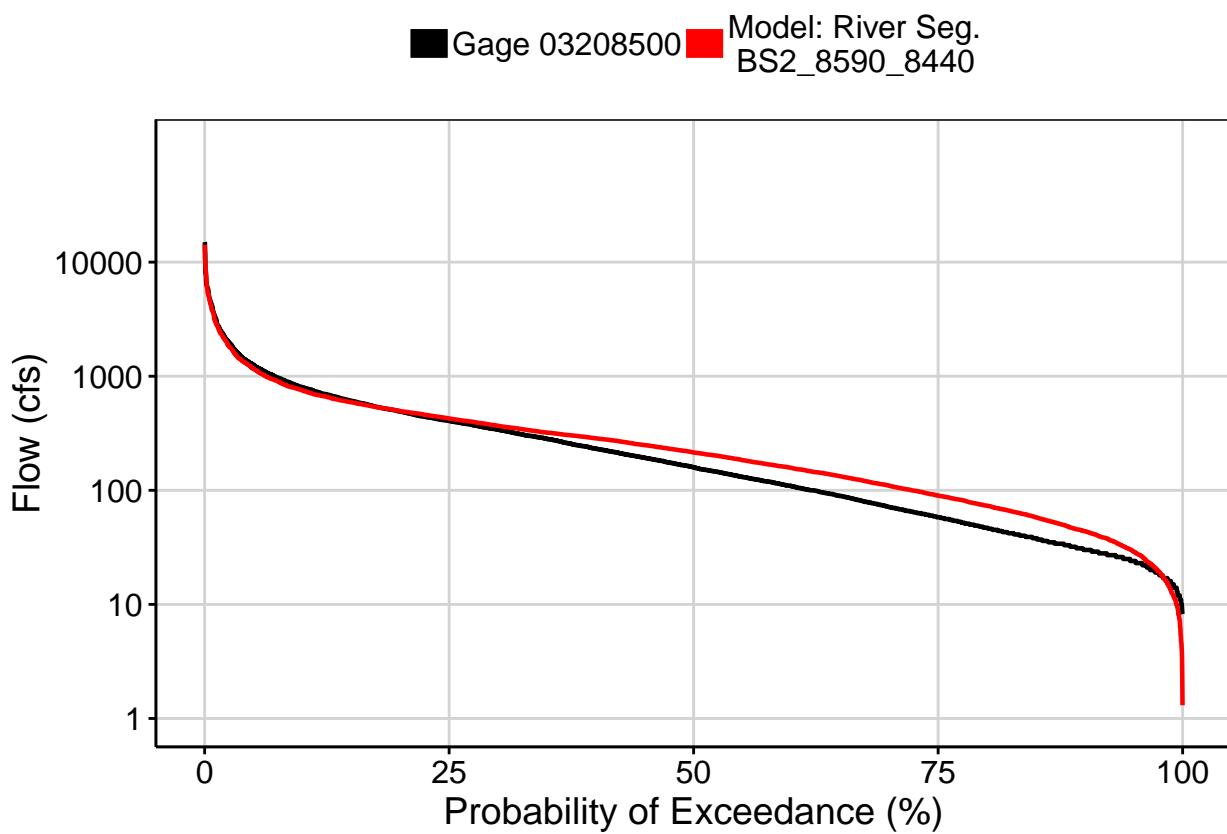


Fig. 4: Baseflow

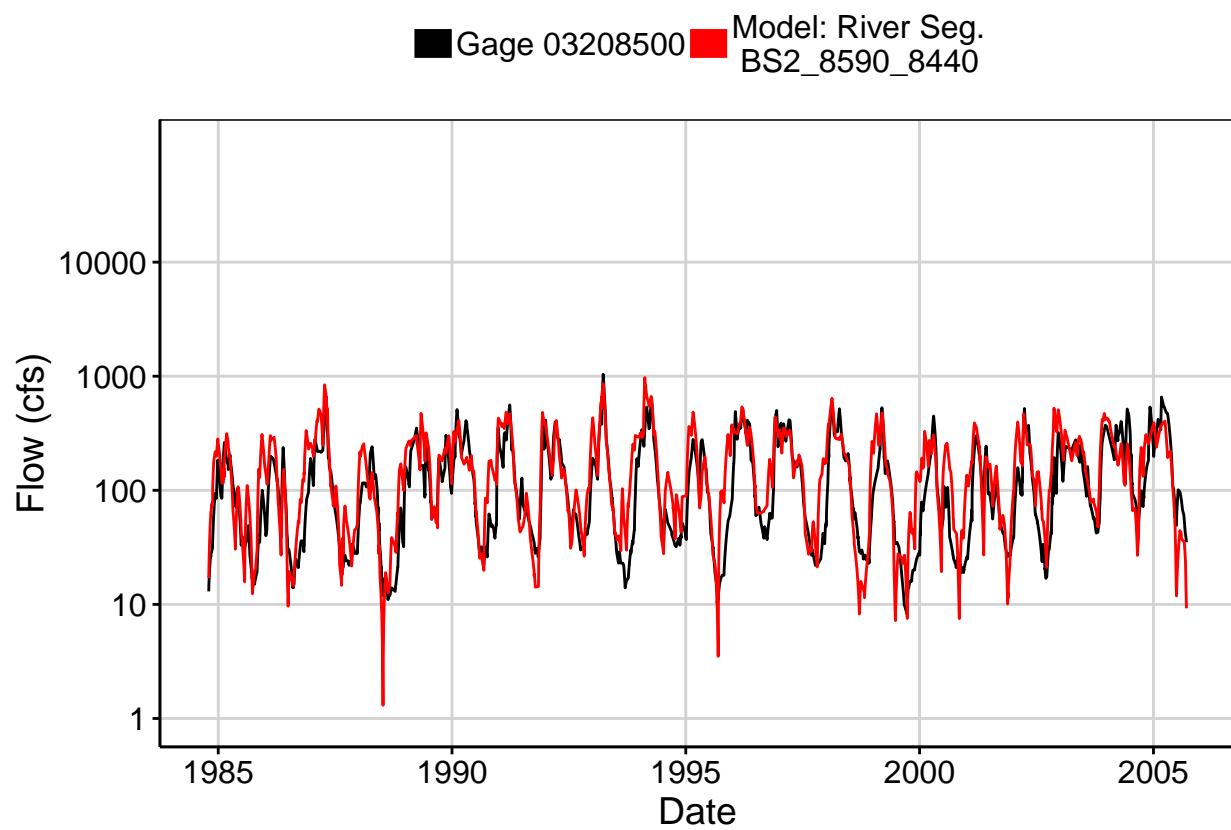


Fig. 5: Combined Baseflow

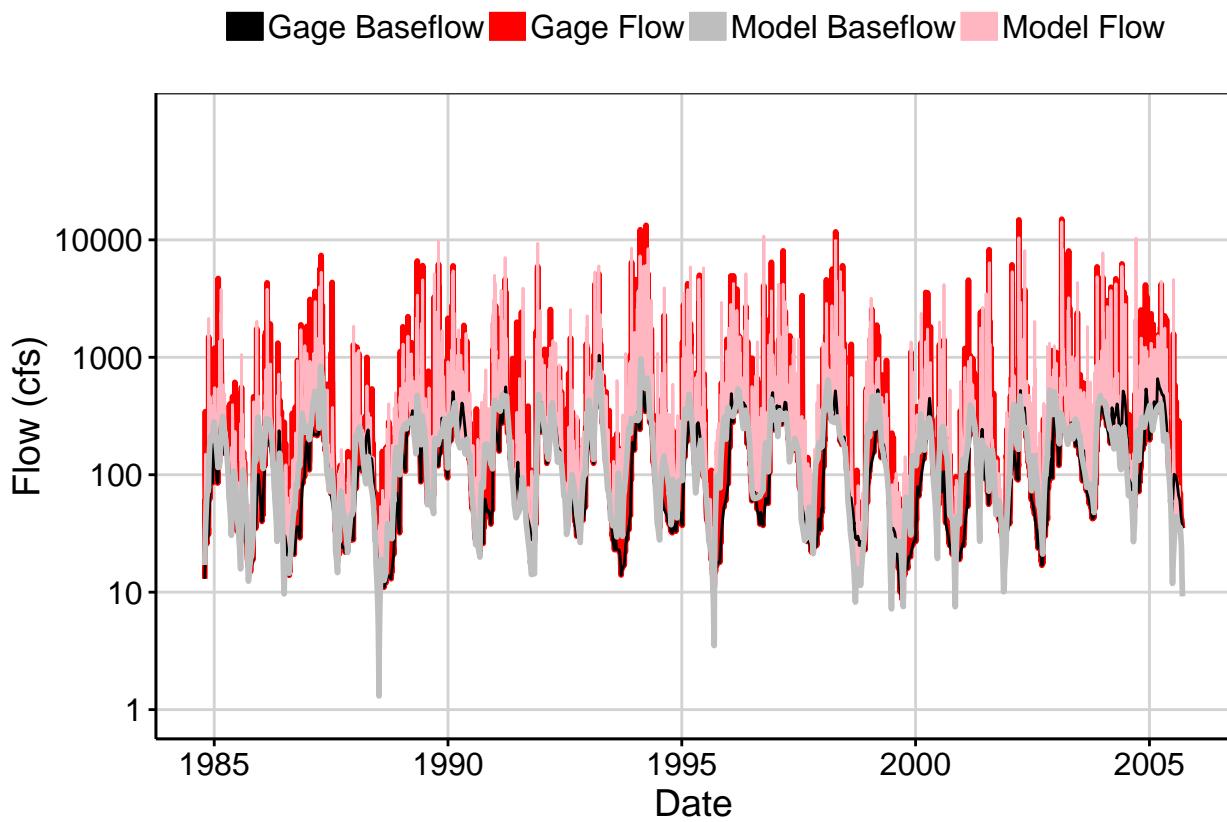


Fig. 6: Largest Error Segment

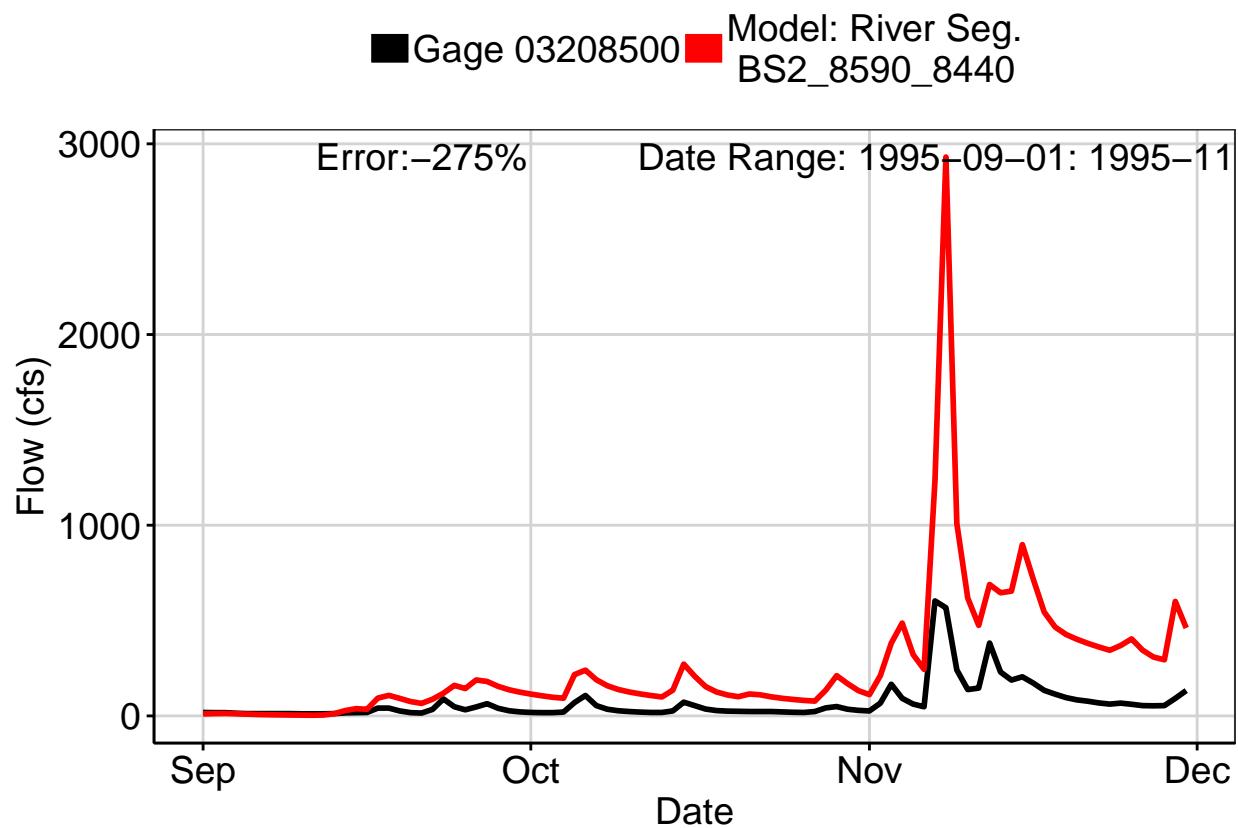


Fig. 7: Second Largest Error Segment

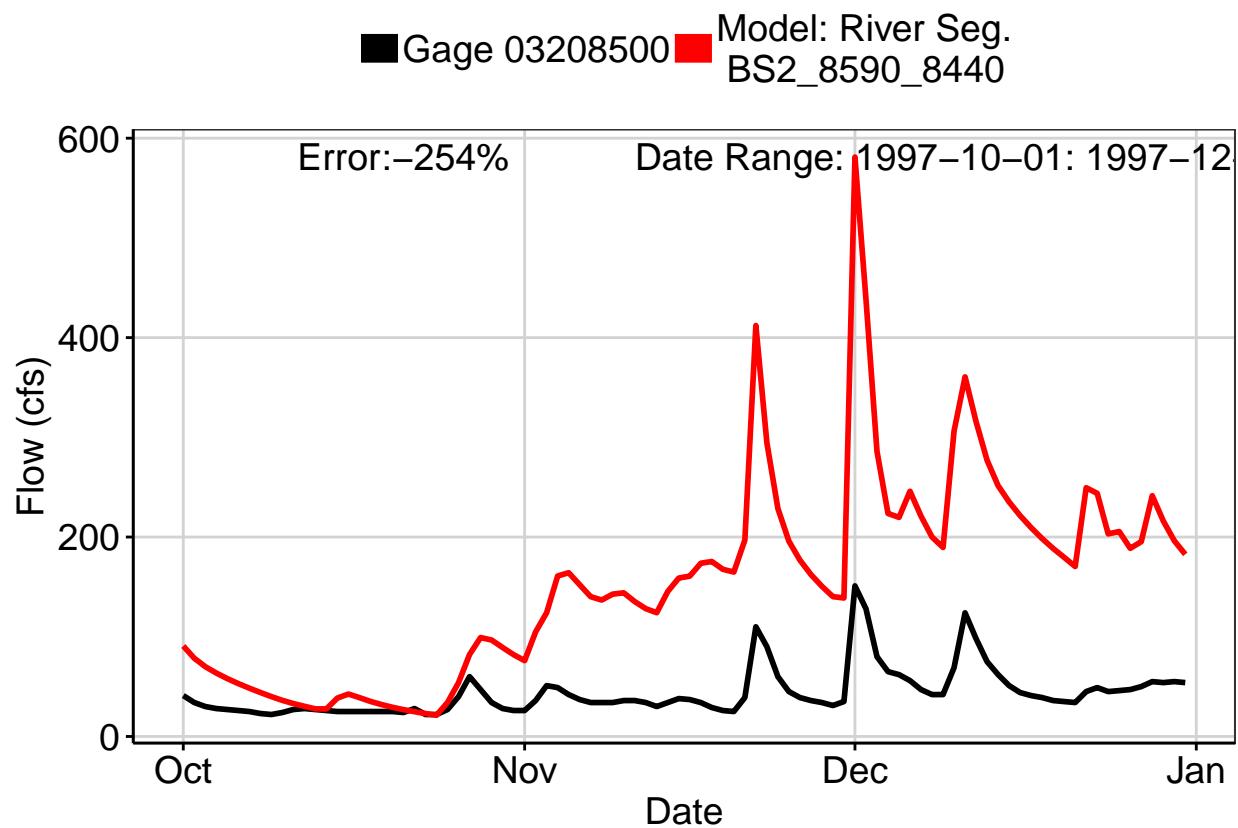


Fig. 8: Third Largest Error Segment

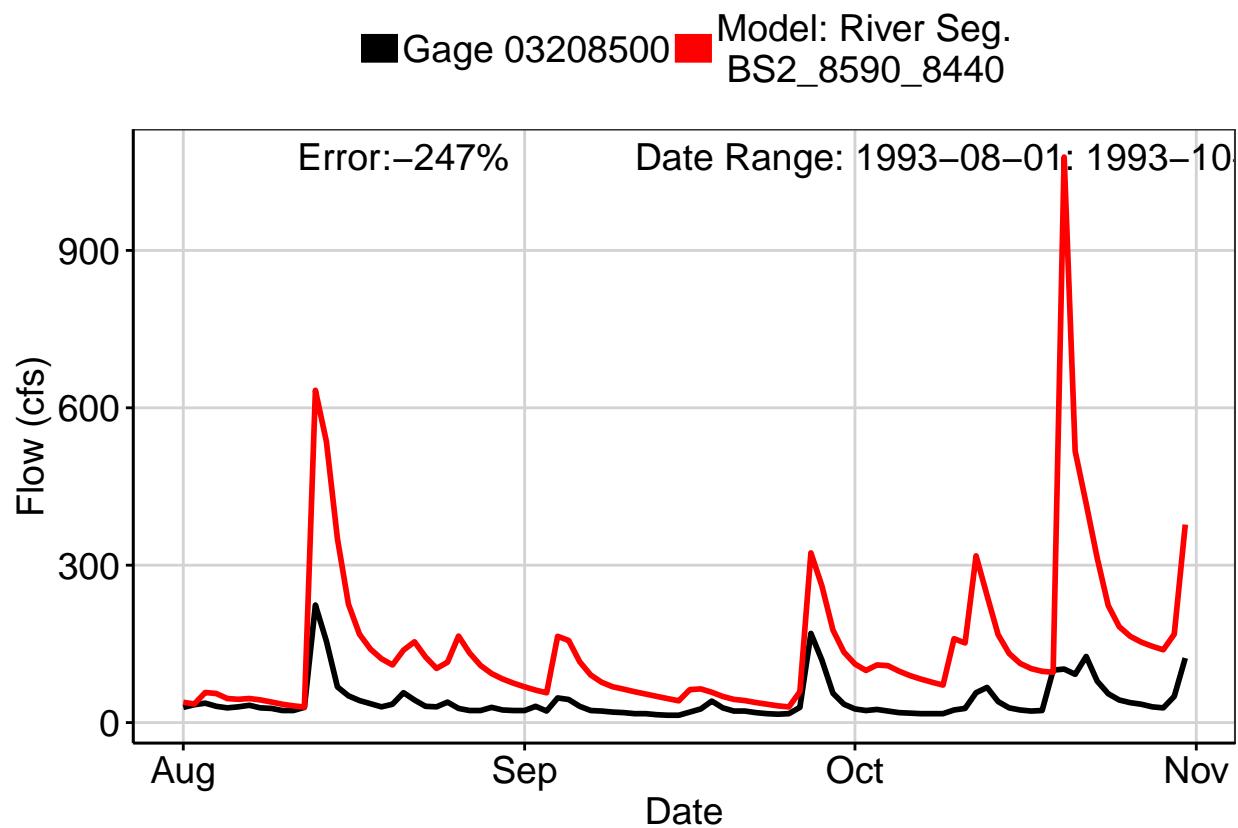
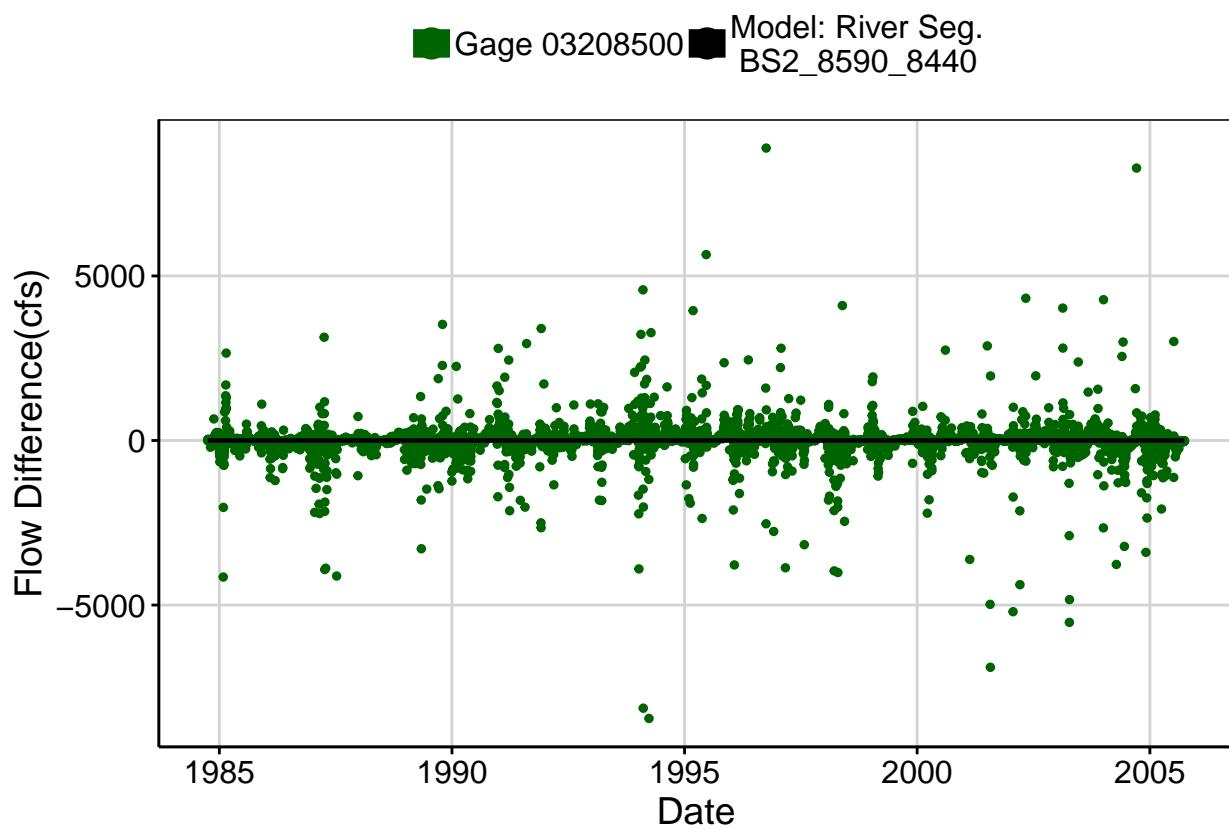
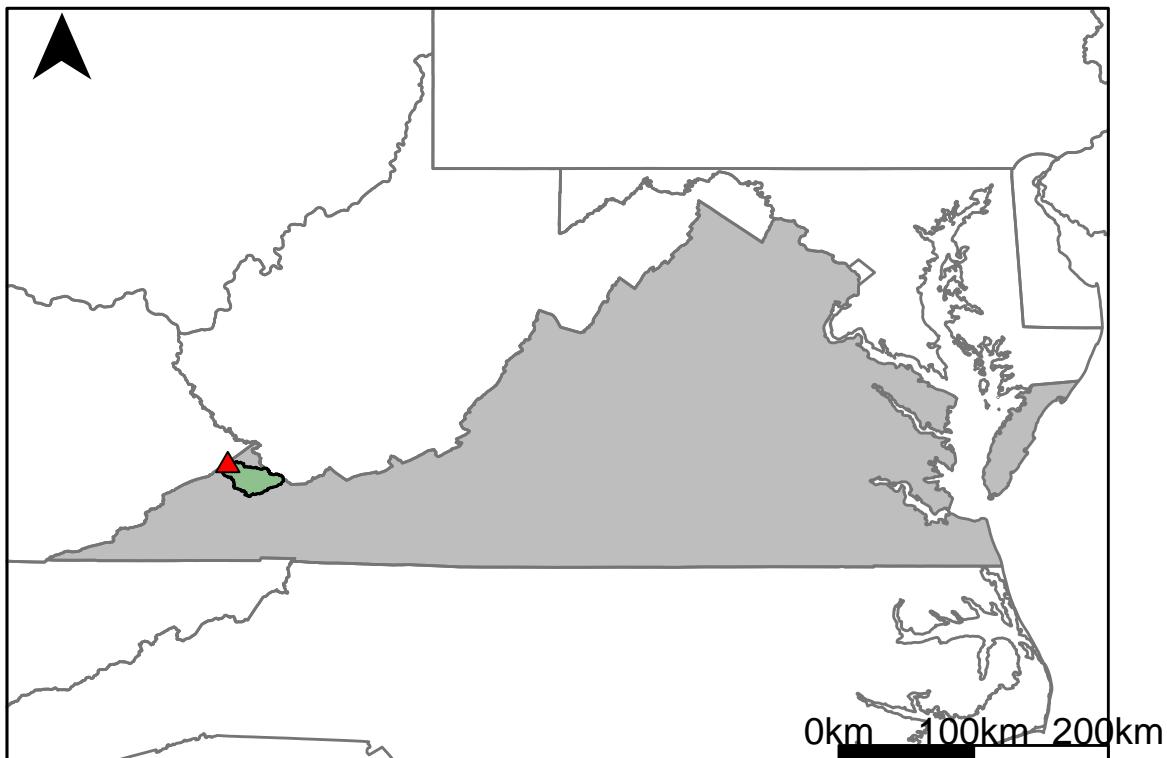


Fig. 9: Residuals Plot



## Appendix A.4: USGS Gage 03207800 vs. BS3\_8350\_8330



This river segment follows part of the flow of the Levisa Fork of the Big Sandy River. The gage is located in Buchanan County, VA (Lat 37°21'13", Long 82°11'45") approximately 40 miles northeast of Norton, VA. Drainage area is 297 sq. miles. This gage started taking data in 1967 and is still taking data. This area is not regulated and should not have any anthropogenic alterations to the flow. The average daily discharge error between the model and gage data for the 20 year timespan was -0.8%, with 56.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	32	54.7	-70.9
Feb. Low Flow	38	63.8	-67.9
Mar. Low Flow	88	169	-92
Apr. Low Flow	140	265	-89.3
May Low Flow	250	327	-30.8
Jun. Low Flow	264	321	-21.6
Jul. Low Flow	272	253	6.99
Aug. Low Flow	154	167	-8.44
Sep. Low Flow	90	118	-31.1
Oct. Low Flow	62.8	6.21	90.1
Nov. Low Flow	53	18.6	64.9
Dec. Low Flow	33	12	63.6

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	377	380	-0.8
Jan. Mean Flow	495	523	-5.66
Feb. Mean Flow	728	714	1.92
Mar. Mean Flow	742	664	10.5
Apr. Mean Flow	691	555	19.7
May Mean Flow	505	465	7.92
Jun. Mean Flow	295	283	4.07
Jul. Mean Flow	193	192	0.52
Aug. Mean Flow	138	172	-24.6
Sep. Mean Flow	88	136	-54.5
Oct. Mean Flow	110	185	-68.2
Nov. Mean Flow	199	271	-36.2
Dec. Mean Flow	362	423	-16.9

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	186	225	-21
Feb. High Flow	696	811	-16.5
Mar. High Flow	1160	958	17.4
Apr. High Flow	1650	1360	17.6
May High Flow	2960	1590	46.3
Jun. High Flow	2010	1710	14.9
Jul. High Flow	1270	1130	11
Aug. High Flow	1700	1270	25.3
Sep. High Flow	507	583	-15
Oct. High Flow	588	422	28.2
Nov. High Flow	385	222	42.3
Dec. High Flow	207	230	-11.1

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	14	0	100
Med. 1 Day Min	25.2	1.62	93.6
Min. 3 Day Min	14.3	0	100
Med. 3 Day Min	26.7	1.92	92.8
Min. 7 Day Min	15.6	0	100
Med. 7 Day Min	28.3	3.23	88.6
Min. 30 Day Min	22.1	2.16	90.2
Med. 30 Day Min	39.3	27.7	29.5
Min. 90 Day Min	36.1	8.26	77.1
Med. 90 Day Min	99.6	90	9.64
7Q10	20.2	0	100
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	121	380	-214
Mean Baseflow	175	201	-14.9

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	11200	11800	-5.36
Med. 1 Day Max	4510	5350	-18.6
Max. 3 Day Max	5880	6980	-18.7
Med. 3 Day Max	3110	3340	-7.4
Max. 7 Day Max	3520	4880	-38.6
Med. 7 Day Max	2040	2160	-5.88
Max. 30 Day Max	2370	2330	1.69
Med. 30 Day Max	1120	986	12
Max. 90 Day Max	1360	1490	-9.56
Med. 90 Day Max	778	716	7.97

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	23	0.7	96.9
5% Non-Exceedance	32	7.71	75.9
50% Non-Exceedance	188	245	-30.3
95% Non-Exceedance	1250	1120	10.4
99% Non-Exceedance	2820	2850	-1.06
Sept. 10% Non-Exceedance	2.43	2.36	2.88

**Fig. 1: Hydrograph**

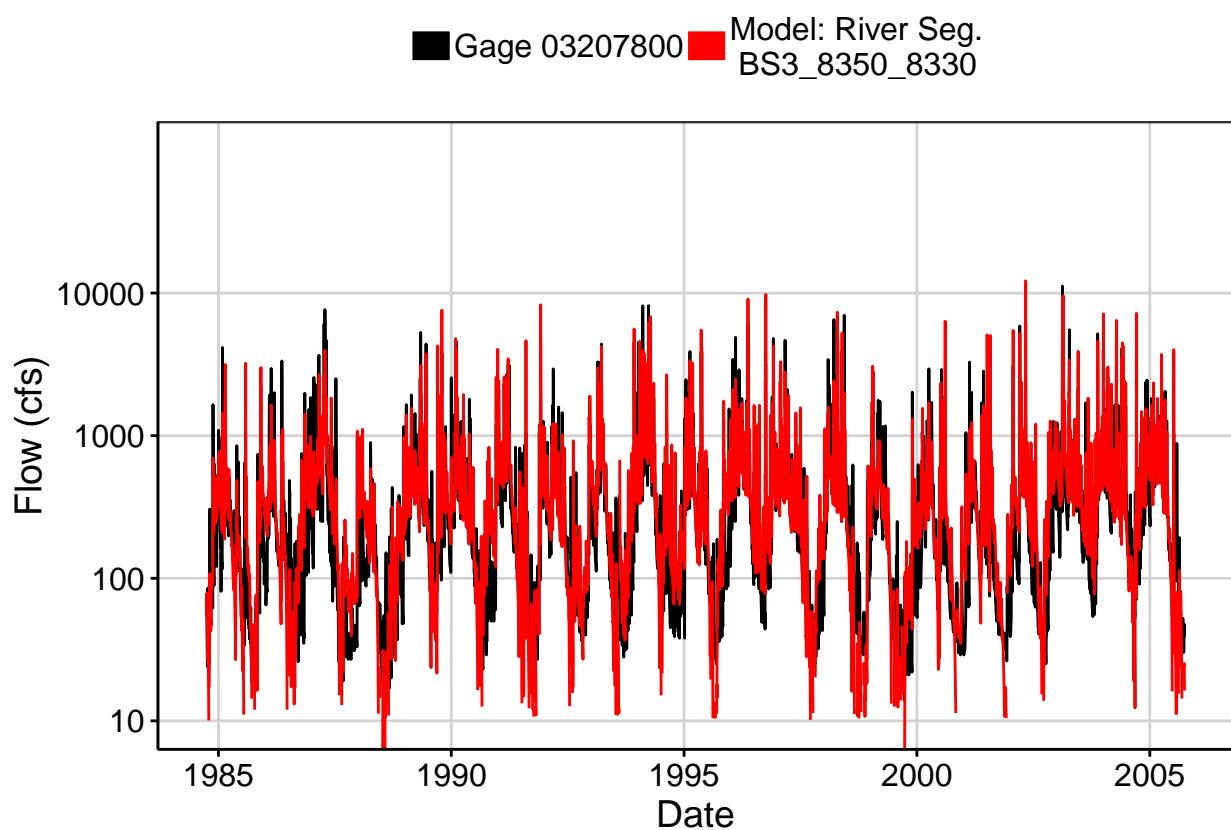


Fig. 2: Zoomed Hydrograph

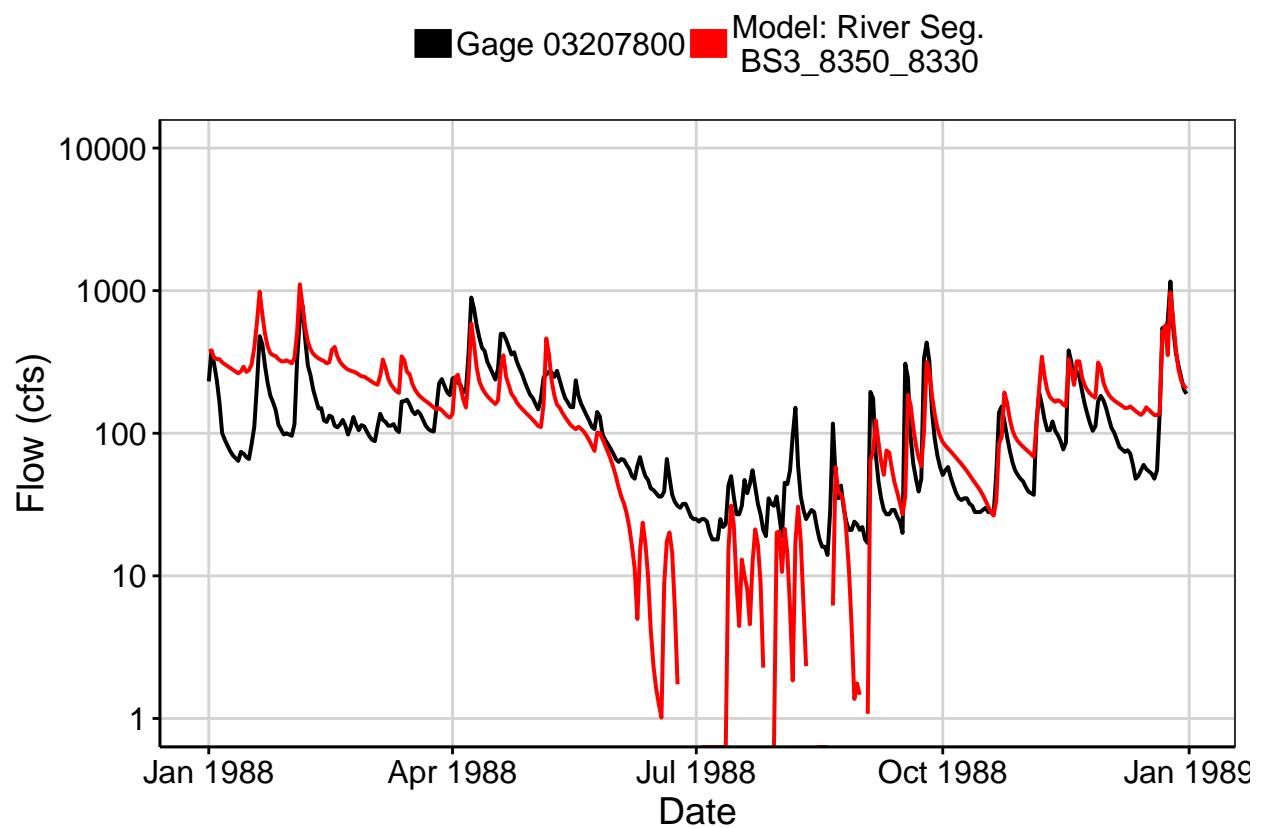


Fig. 3: Flow Exceedance

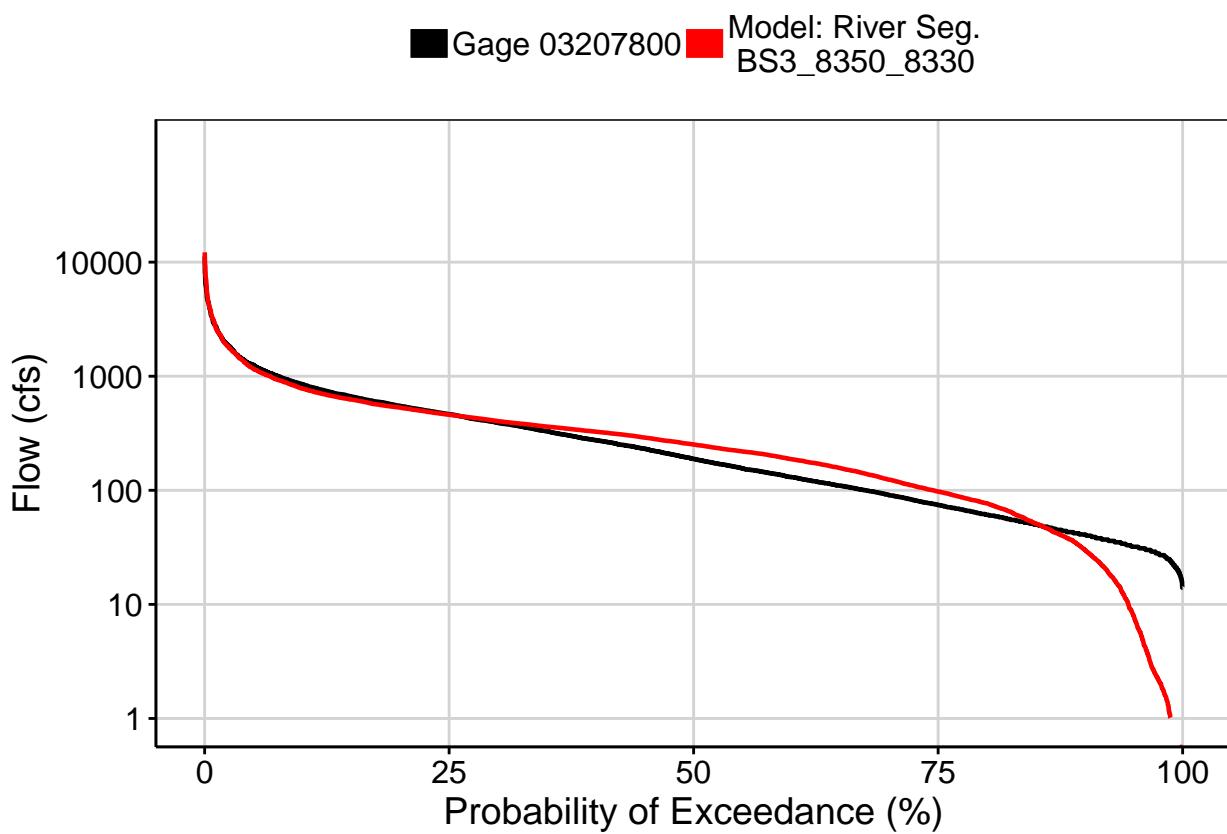


Fig. 4: Baseflow

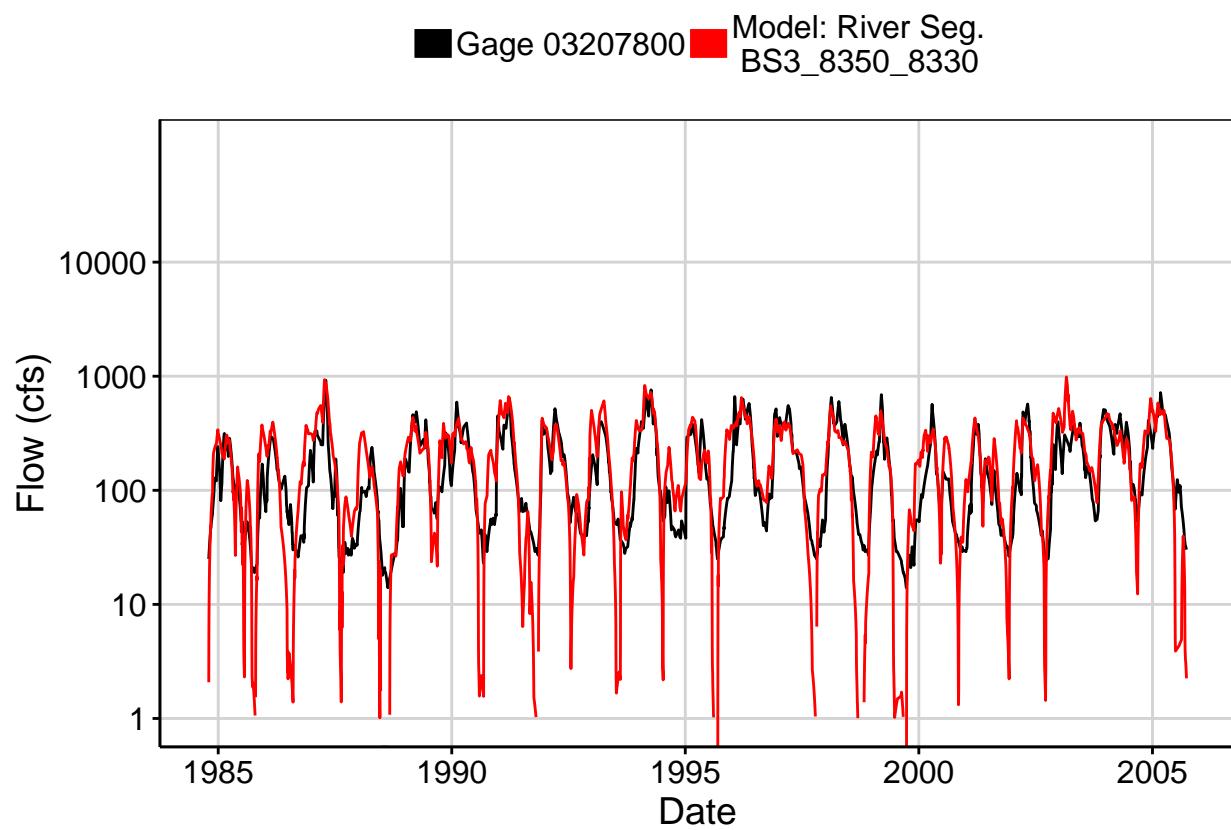


Fig. 5: Combined Baseflow

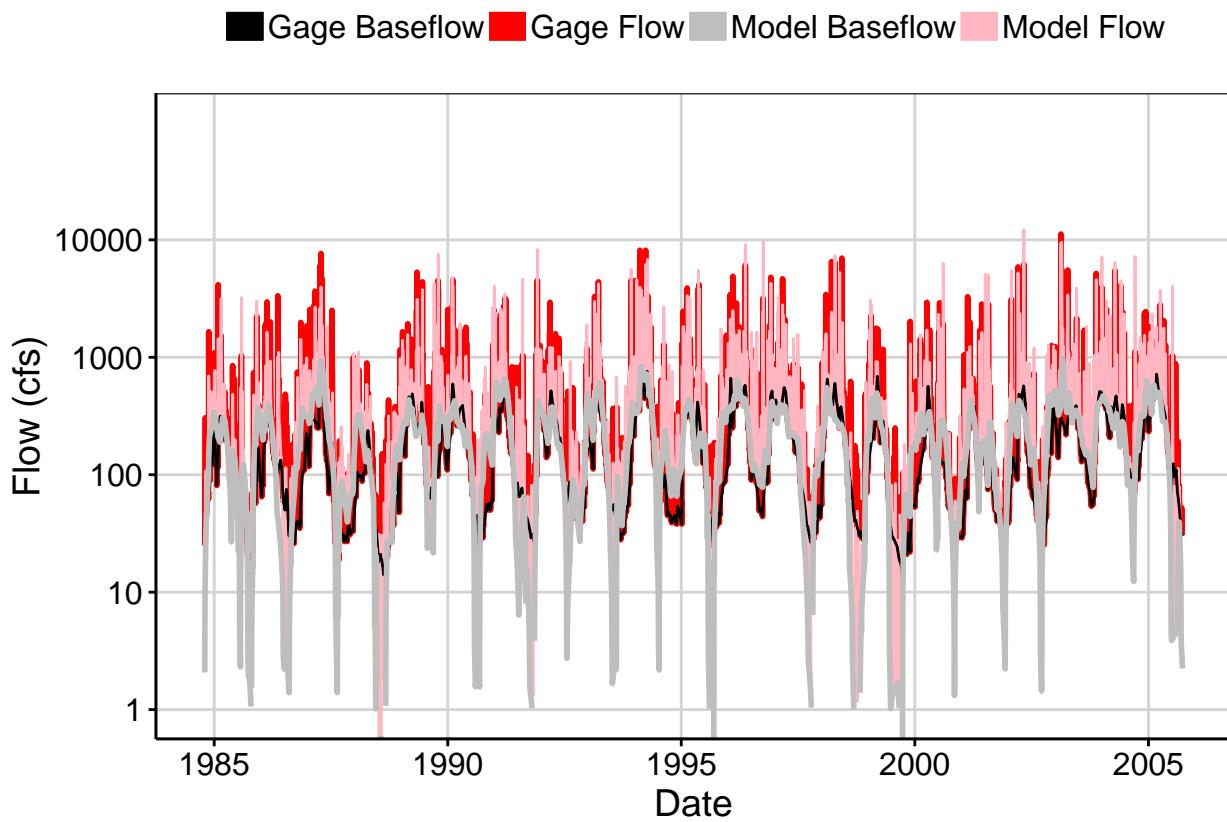


Fig. 6: Largest Error Segment

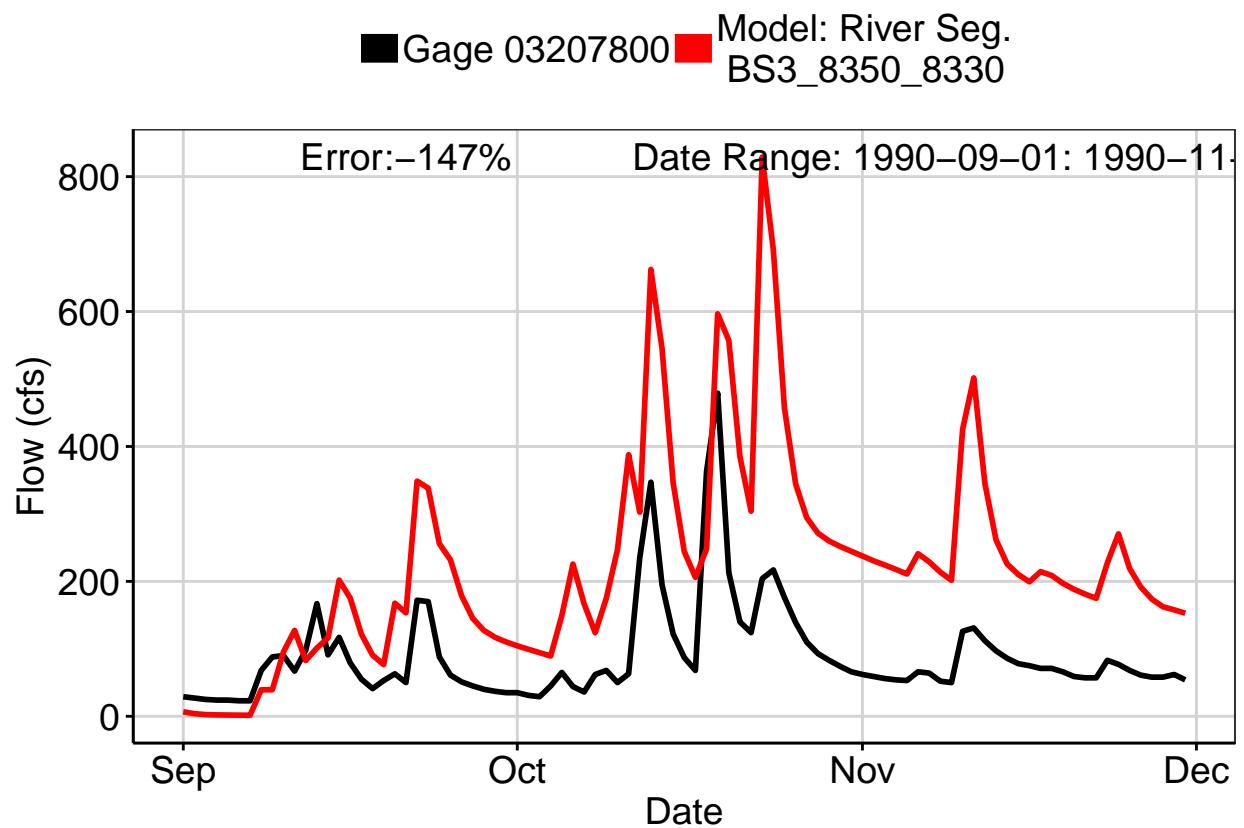


Fig. 7: Second Largest Error Segment

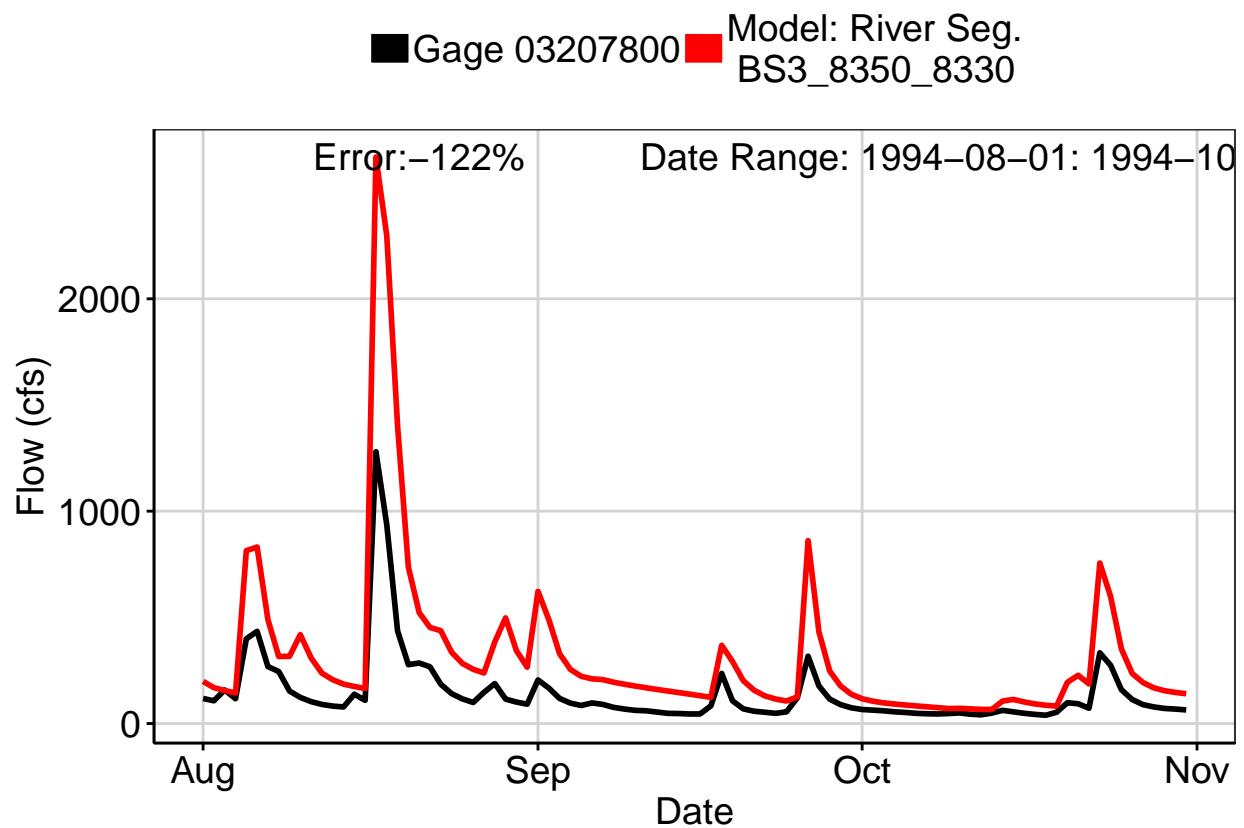


Fig. 8: Third Largest Error Segment

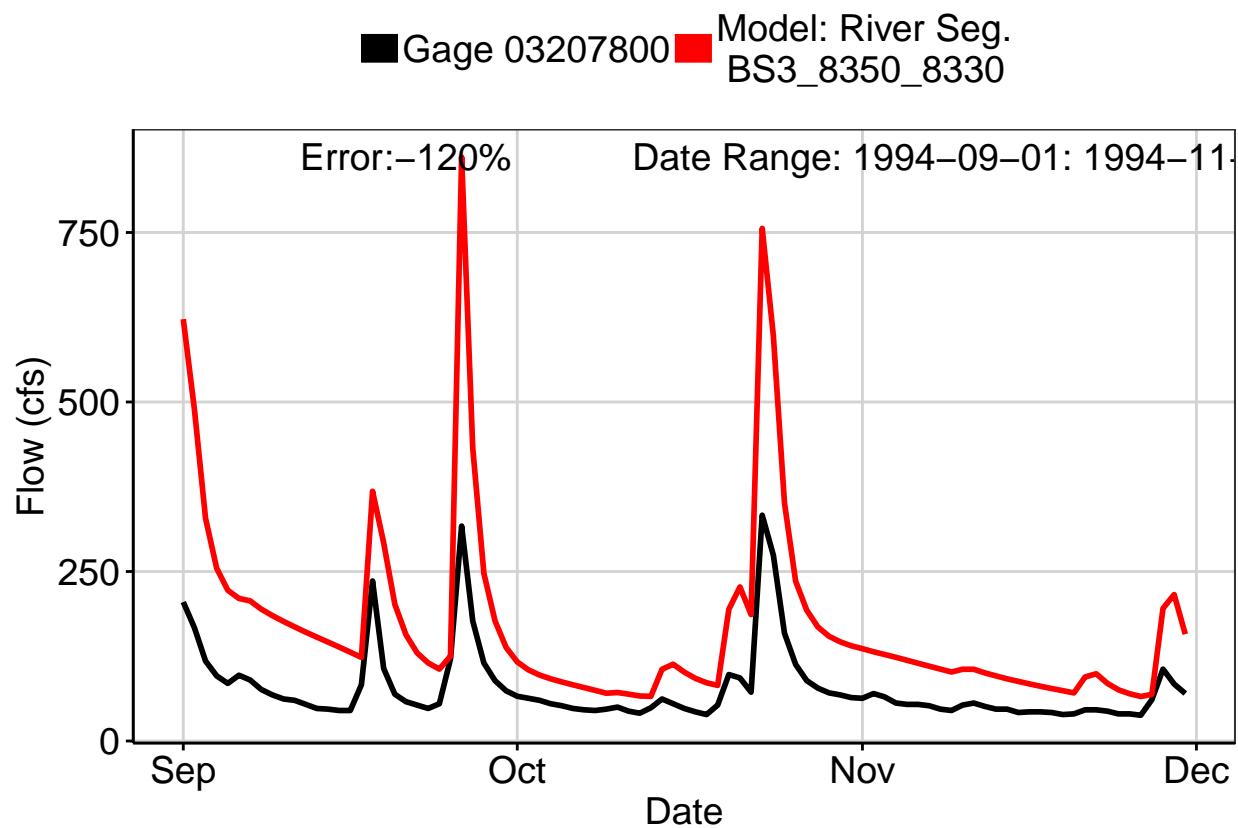
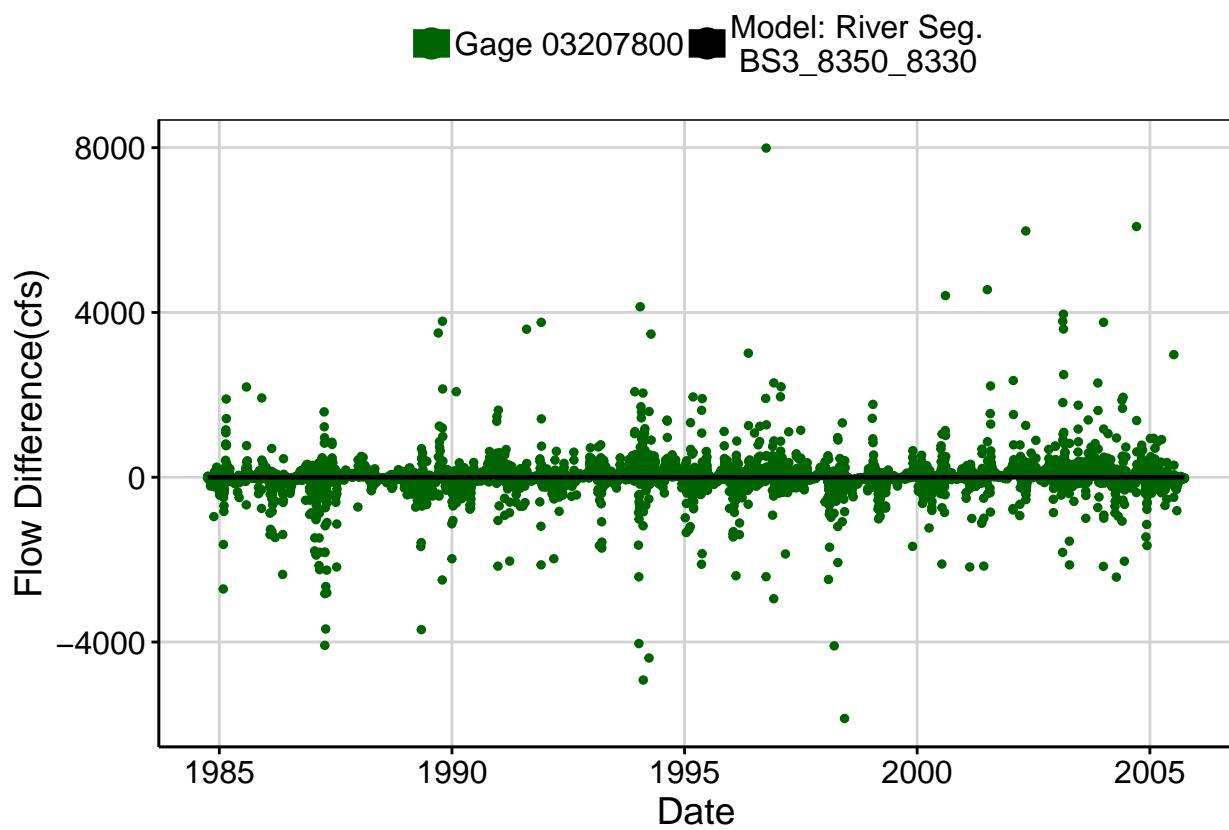
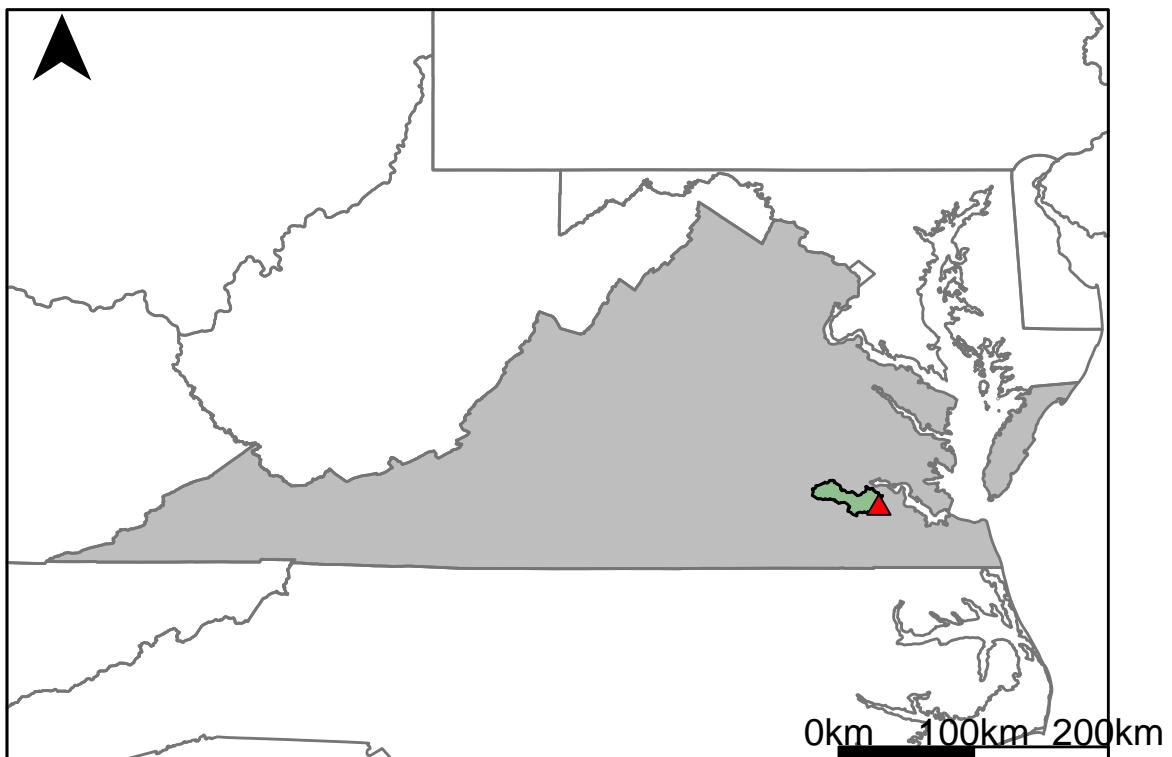


Fig. 9: Residuals Plot



## Appendix B: Blackwater River Gages

### Appendix B.1: USGS Gage 02047500 vs. MN3\_7540\_7680



This river segment follows part of the flow of the Blackwater River, a tributary of the Meherrin River. The gage is located in Surry County, VA (Lat 37°01'30", Long 76°52'30") approximately 32 miles southeast of Petersburg, VA. Drainage area is 290 sq. miles. This gage started taking data in 1941 and is still taking data but there is a gap from 1987-01-09 to 1988-07-27. The average daily discharge error between the model and gage data for the 20 year timespan was 0.96%, with 56.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	8.98	13	-44.8
Feb. Low Flow	44	59.9	-36.1
Mar. Low Flow	90.5	94.5	-4.42
Apr. Low Flow	150	169	-12.7
May Low Flow	191	244	-27.7
Jun. Low Flow	202	185	8.42
Jul. Low Flow	150	103	31.3
Aug. Low Flow	49	52.7	-7.55
Sep. Low Flow	8.43	15.3	-81.5
Oct. Low Flow	0.66	13.7	-1960
Nov. Low Flow	2.33	16.9	-625
Dec. Low Flow	0.02	15.5	-77400

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	314	311	0.96
Jan. Mean Flow	421	441	-4.75
Feb. Mean Flow	523	522	0.19
Mar. Mean Flow	630	572	9.21
Apr. Mean Flow	498	426	14.5
May Mean Flow	242	246	-1.65
Jun. Mean Flow	122	149	-22.1
Jul. Mean Flow	114	110	3.51
Aug. Mean Flow	207	228	-10.1
Sep. Mean Flow	391	374	4.35
Oct. Mean Flow	162	179	-10.5
Nov. Mean Flow	198	202	-2.02
Dec. Mean Flow	301	298	1

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	110	178	-61.8
Feb. High Flow	266	403	-51.5
Mar. High Flow	546	456	16.5
Apr. High Flow	672	848	-26.2
May High Flow	899	891	0.89
Jun. High Flow	960	980	-2.08
Jul. High Flow	1040	986	5.19
Aug. High Flow	549	494	10
Sep. High Flow	344	260	24.4
Oct. High Flow	337	146	56.7
Nov. High Flow	331	293	11.5
Dec. High Flow	110	227	-106

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	0	0.27	-Inf
Med. 1 Day Min	0	2.78	-Inf
Min. 3 Day Min	0	0.31	-Inf
Med. 3 Day Min	0	3.14	-Inf
Min. 7 Day Min	0	0.43	-Inf
Med. 7 Day Min	0	3.98	-Inf
Min. 30 Day Min	0	2.83	-Inf
Med. 30 Day Min	1.74	10.4	-498
Min. 90 Day Min	1.07	14	-1210
Med. 90 Day Min	40.2	53	-31.8
7Q10	0	1.35	-Inf
Year of 90-Day Min. Flow	2002	1993	100
Drought Year Mean	55.1	311	-464
Mean Baseflow	142	144	-1.41

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	11400	13900	-21.9
Med. 1 Day Max	2350	2570	-9.36
Max. 3 Day Max	10700	12500	-16.8
Med. 3 Day Max	2210	2160	2.26
Max. 7 Day Max	7710	9140	-18.5
Med. 7 Day Max	1930	1700	11.9
Max. 30 Day Max	2350	2740	-16.6
Med. 30 Day Max	823	793	3.65
Max. 90 Day Max	1410	1230	12.8
Med. 90 Day Max	582	592	-1.72

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	0	3.14	-Inf
5% Non-Exceedance	0	7.16	-Inf
50% Non-Exceedance	154	179	-16.2
95% Non-Exceedance	1150	1030	10.4
99% Non-Exceedance	2150	2030	5.58
Sept. 10% Non-Exceedance	6.88	7.2	-4.65

**Fig. 1: Hydrograph**

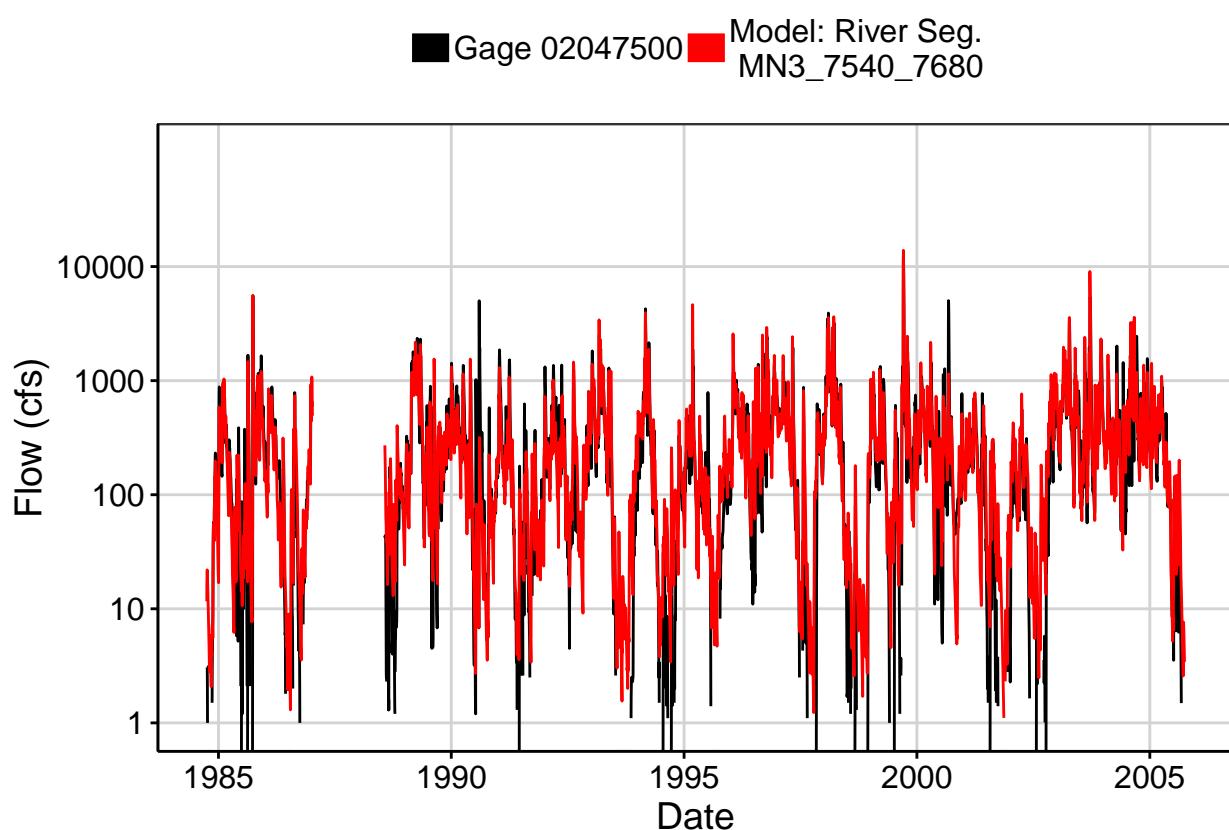


Fig. 2: Zoomed Hydrograph

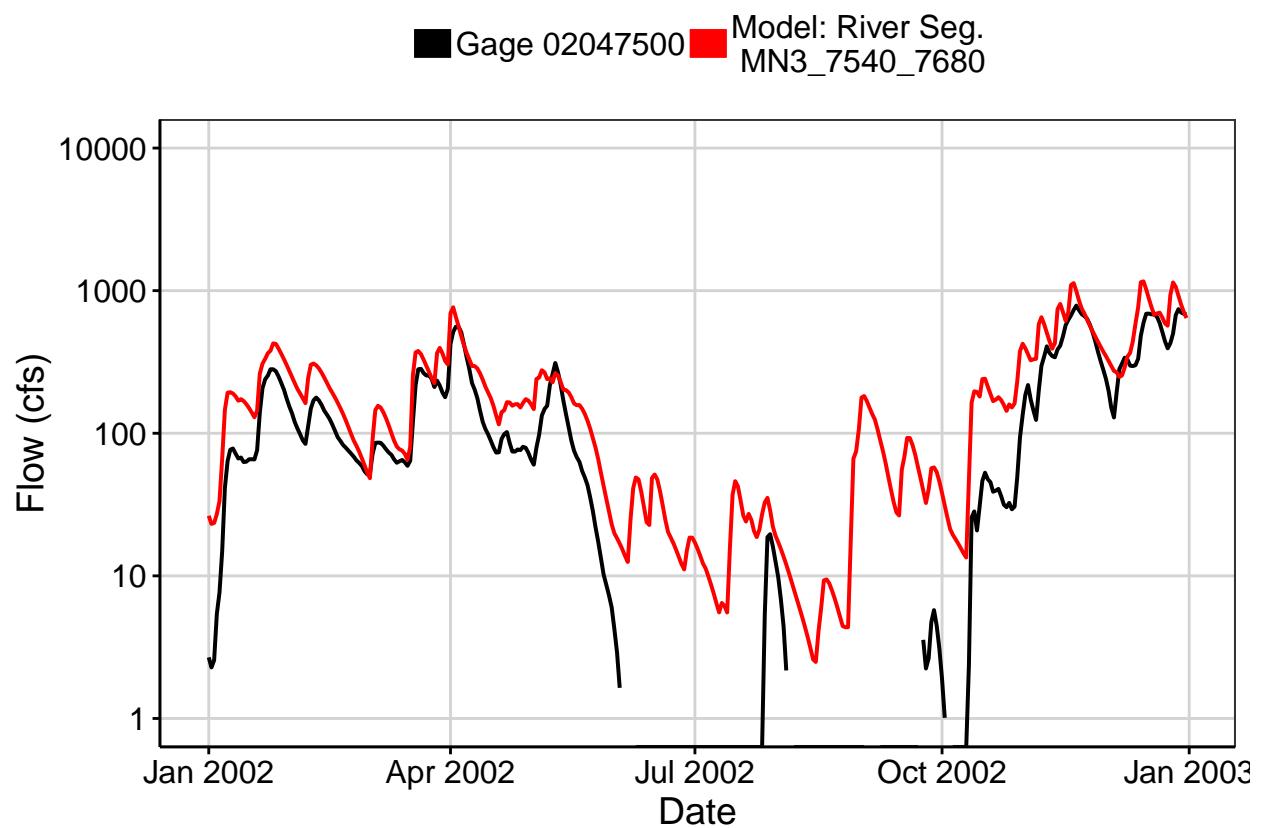


Fig. 3: Flow Exceedance

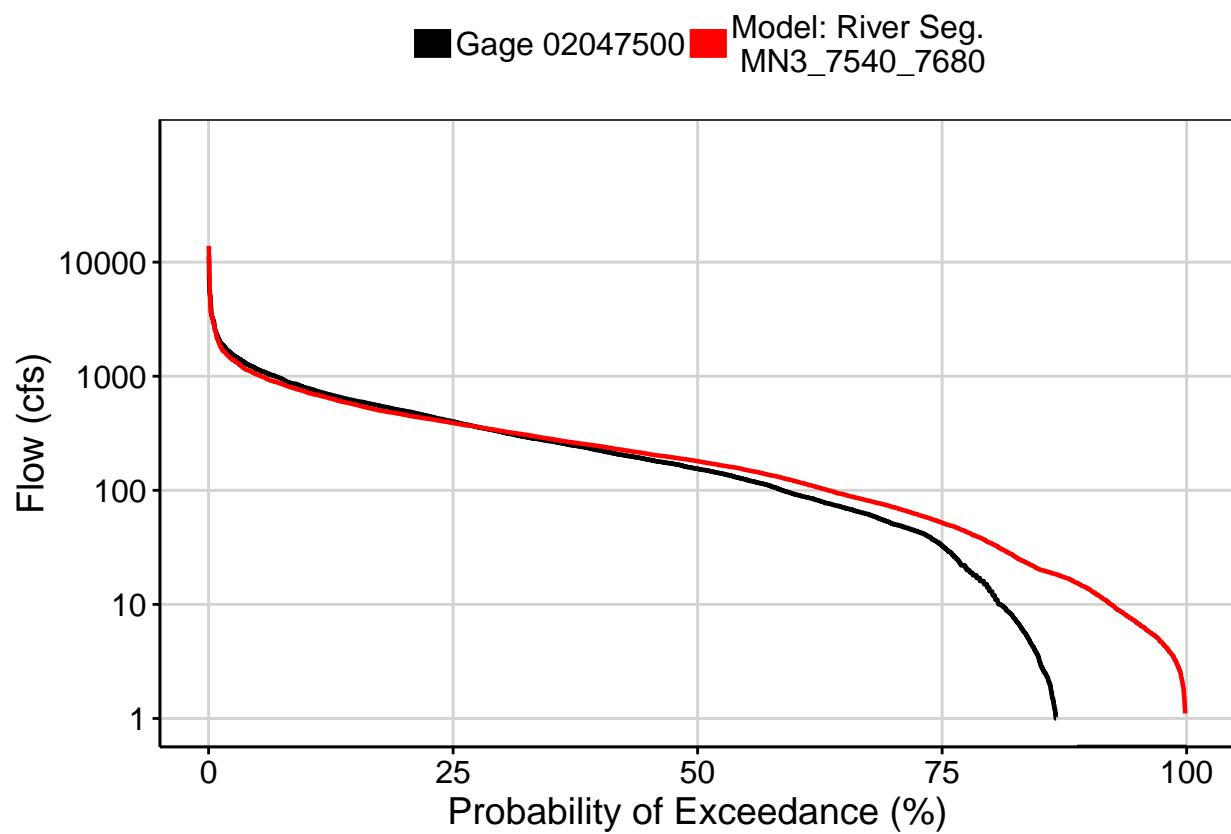


Fig. 4: Baseflow

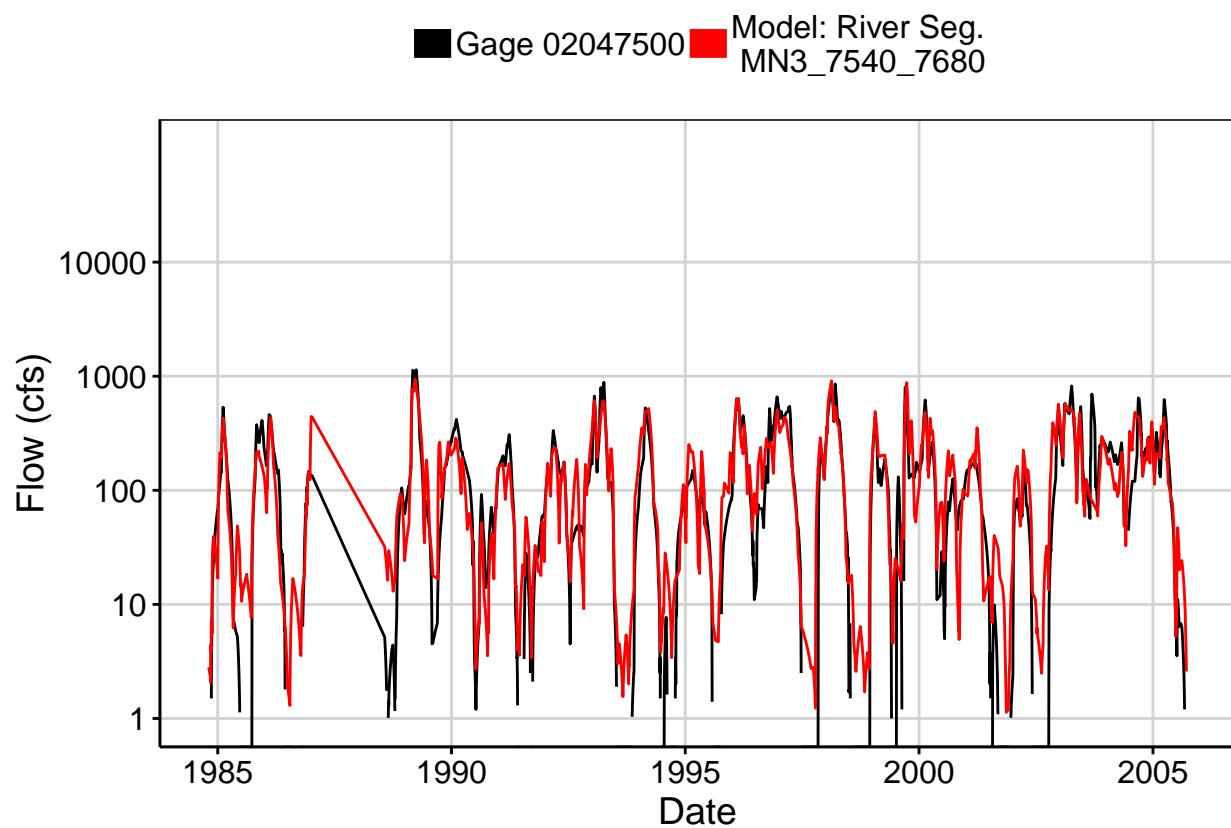


Fig. 5: Combined Baseflow

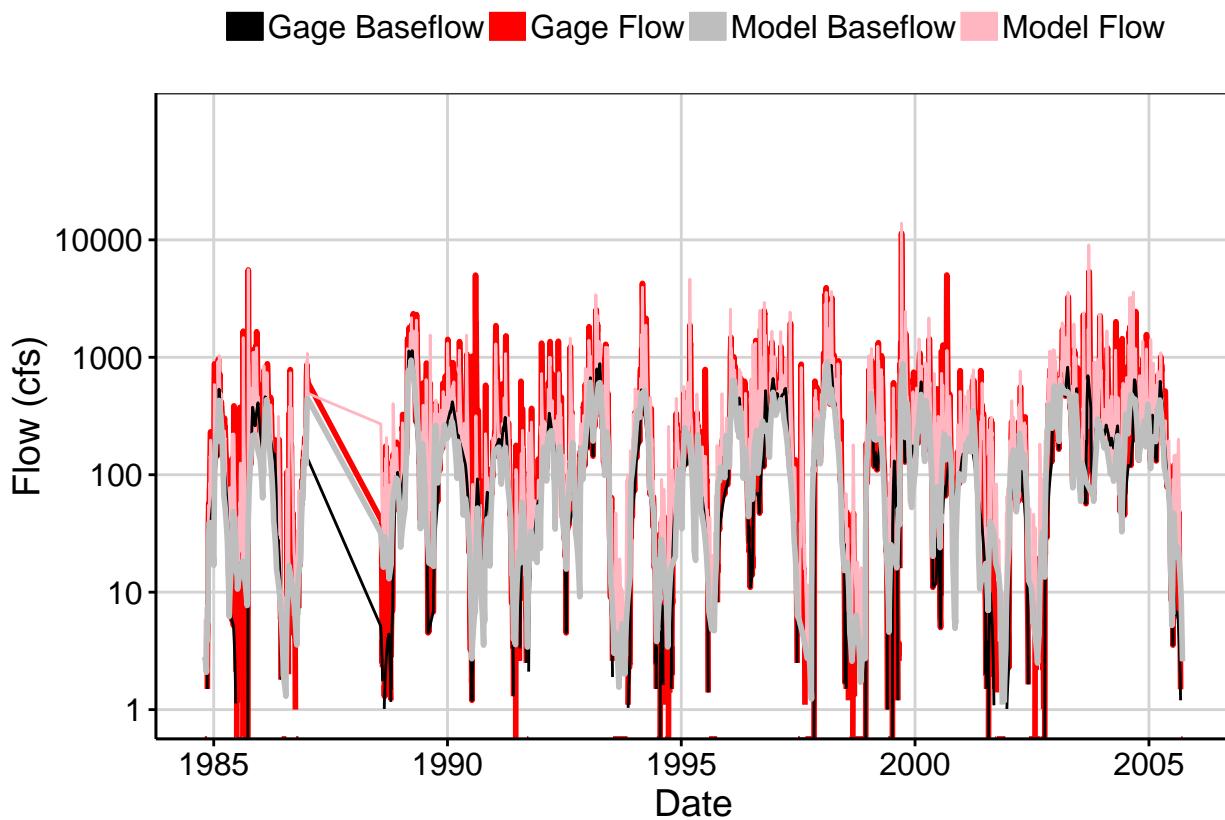


Fig. 6: Largest Error Segment

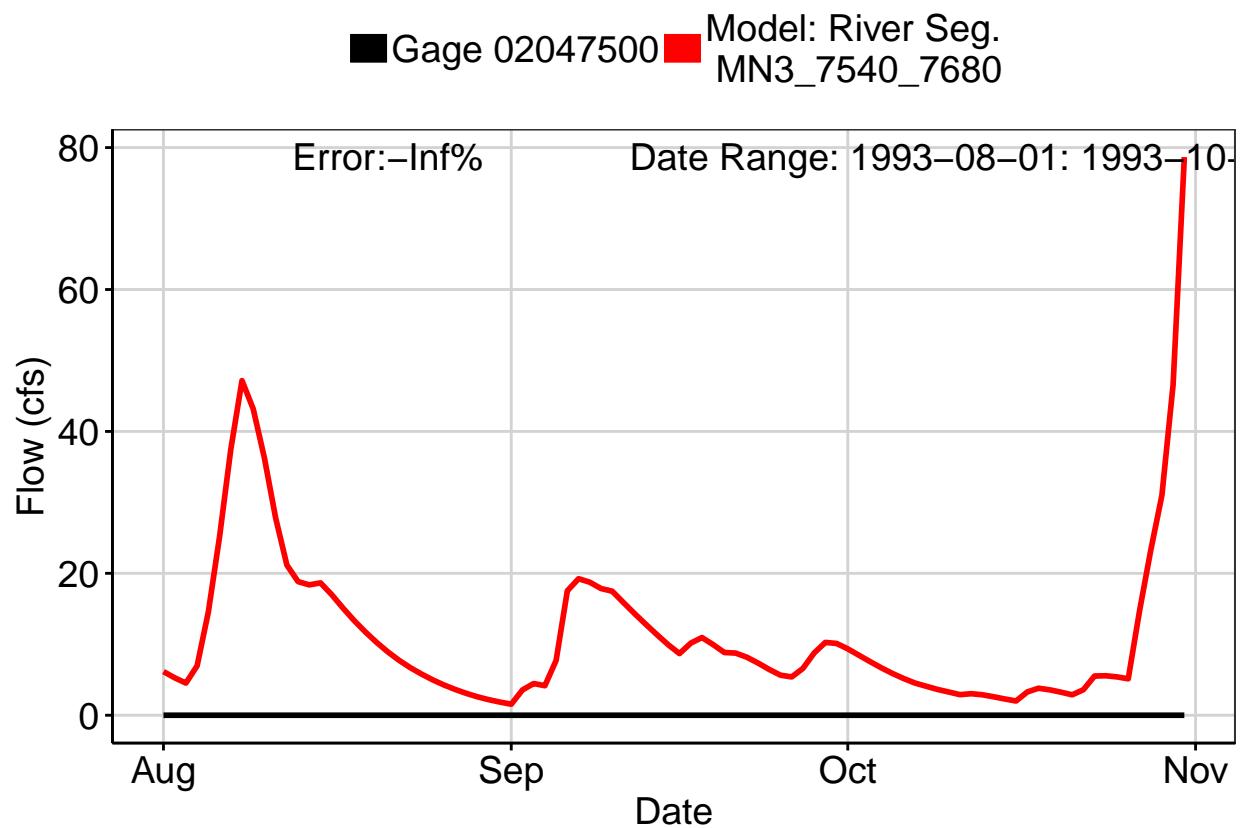


Fig. 7: Second Largest Error Segment

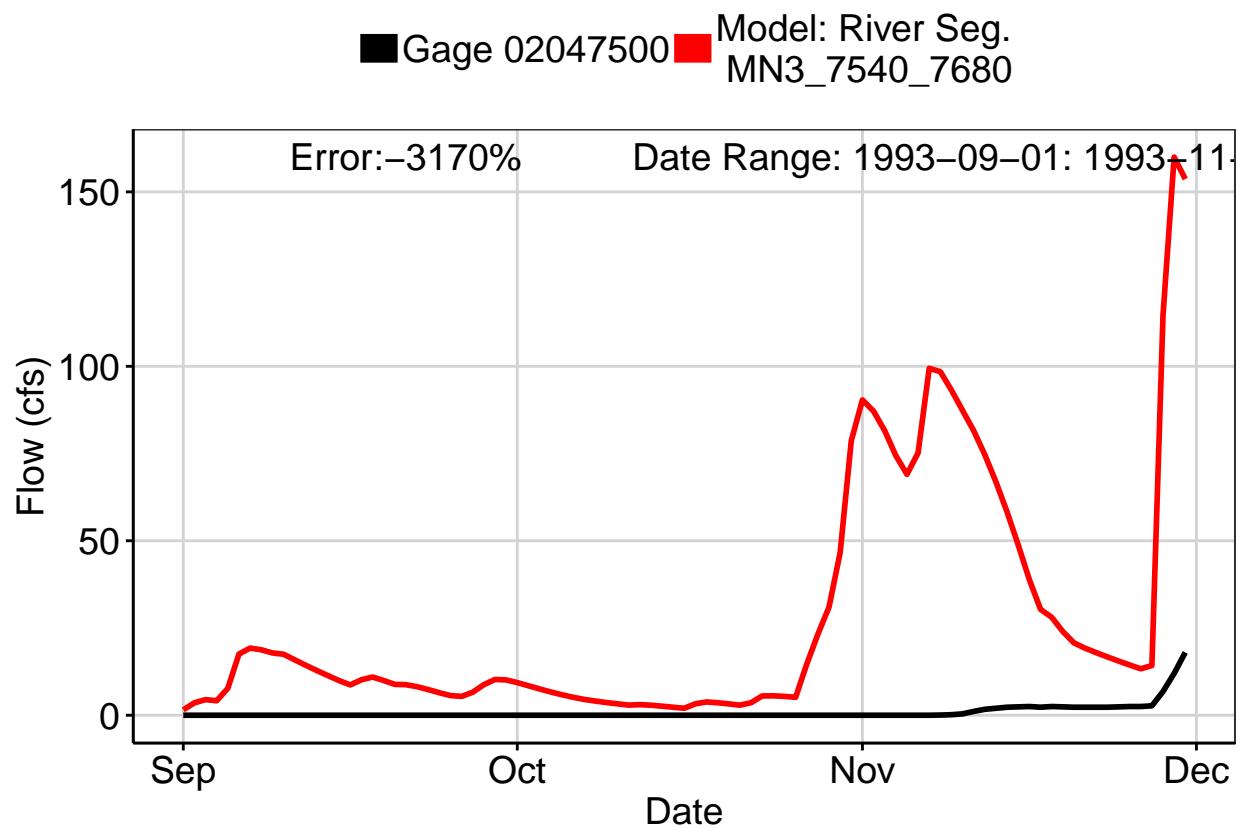


Fig. 8: Third Largest Error Segment

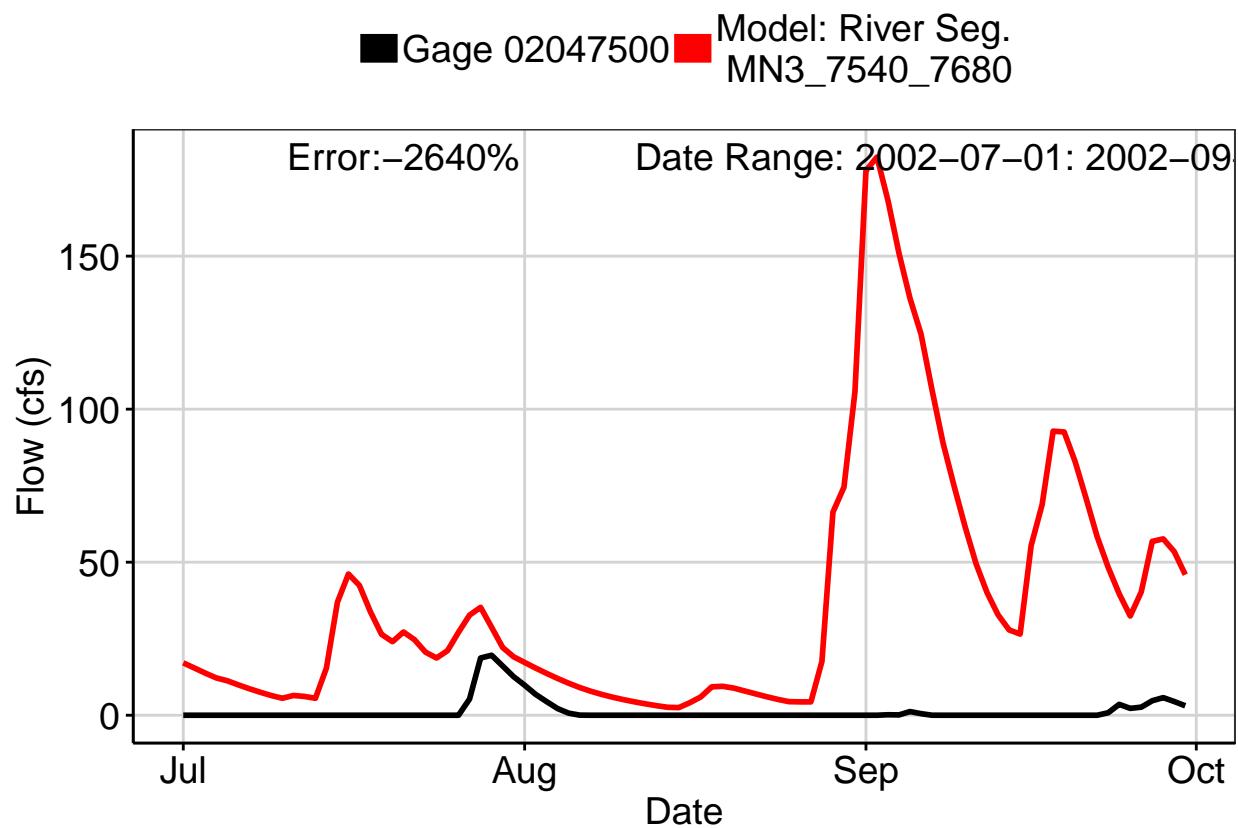
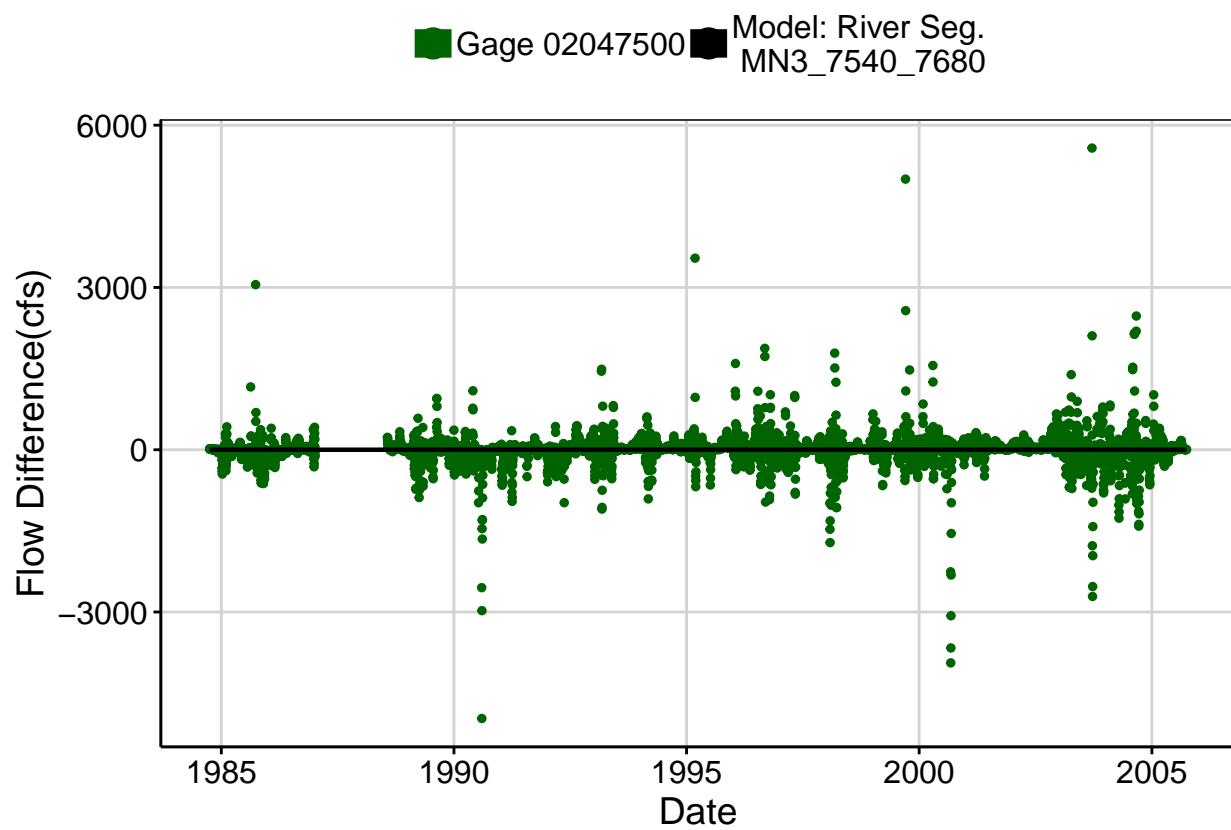
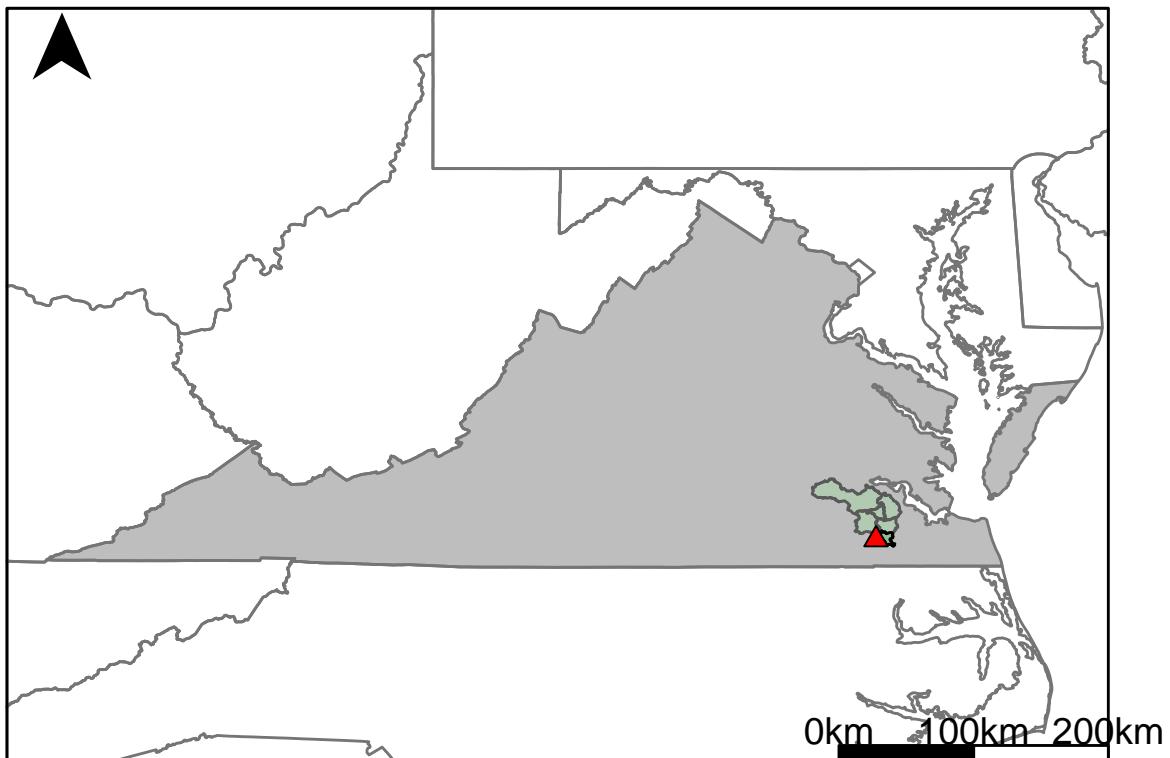


Fig. 9: Residuals Plot



## Appendix B.2: USGS Gage 02049500 vs. MN4\_8080\_8110



This river segment follows part of the flow of the Blackwater River, a tributary of the Meherrin River. The gage is located in Southampton County, VA (Lat 36°45'45", Long 76°53'55") approximately 17 miles west of Suffolk, VA. Drainage area is 613 sq. miles. This gage started taking data in 1944 and is still taking data. Water is diverted from this area to the City of Norfolk by a pumping station upstream of the gage. It is also believed that in extreme low flow conditions, water can be lost to storage, especially between Zuni and Franklin. The average daily discharge error between the model and gage data for the 20 year timespan was -0.31%, with 51.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	4.92	22.4	-355
Feb. Low Flow	19	159	-737
Mar. Low Flow	118	155	-31.4
Apr. Low Flow	346	340	1.73
May Low Flow	519	513	1.16
Jun. Low Flow	534	451	15.5
Jul. Low Flow	369	241	34.7
Aug. Low Flow	62.5	175	-180
Sep. Low Flow	11	53.3	-385
Oct. Low Flow	2.8	23.3	-732
Nov. Low Flow	5.3	37.8	-613
Dec. Low Flow	3.34	23.9	-616

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	648	650	-0.31
Jan. Mean Flow	882	895	-1.47
Feb. Mean Flow	1140	1100	3.51
Mar. Mean Flow	1210	1180	2.48
Apr. Mean Flow	1030	887	13.9
May Mean Flow	485	519	-7.01
Jun. Mean Flow	330	328	0.61
Jul. Mean Flow	207	245	-18.4
Aug. Mean Flow	476	464	2.52
Sep. Mean Flow	750	796	-6.13
Oct. Mean Flow	330	400	-21.2
Nov. Mean Flow	368	413	-12.2
Dec. Mean Flow	615	611	0.65

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	114	307	-169
Feb. High Flow	481	813	-69
Mar. High Flow	813	932	-14.6
Apr. High Flow	1300	1460	-12.3
May High Flow	1600	1900	-18.8
Jun. High Flow	1600	1630	-1.88
Jul. High Flow	1760	1900	-7.95
Aug. High Flow	855	939	-9.82
Sep. High Flow	745	619	16.9
Oct. High Flow	431	318	26.2
Nov. High Flow	812	589	27.5
Dec. High Flow	371	446	-20.2

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	0	0	NaN
Med. 1 Day Min	0.77	5.17	-571
Min. 3 Day Min	0.17	0	100
Med. 3 Day Min	1.11	7.37	-564
Min. 7 Day Min	0.26	0.05	80.9
Med. 7 Day Min	1.59	12.4	-680
Min. 30 Day Min	0.88	3.91	-343
Med. 30 Day Min	3.51	34.6	-886
Min. 90 Day Min	5.85	30.3	-418
Med. 90 Day Min	65.6	131	-99.7
7Q10	0.44	0.41	6.64
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	174	650	-274
Mean Baseflow	323	318	1.55

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	22000	26200	-19.1
Med. 1 Day Max	4320	5300	-22.7
Max. 3 Day Max	20800	25000	-20.2
Med. 3 Day Max	4150	4650	-12
Max. 7 Day Max	17500	20300	-16
Med. 7 Day Max	3140	3280	-4.46
Max. 30 Day Max	5920	6650	-12.3
Med. 30 Day Max	1730	1770	-2.31
Max. 90 Day Max	2560	2530	1.17
Med. 90 Day Max	1330	1220	8.27

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	0.62	4.22	-581
5% Non-Exceedance	2	15	-650
50% Non-Exceedance	369	384	-4.07
95% Non-Exceedance	2320	2090	9.91
99% Non-Exceedance	4160	4240	-1.92
Sept. 10% Non-Exceedance	16.6	16.7	-0.6

**Fig. 1: Hydrograph**

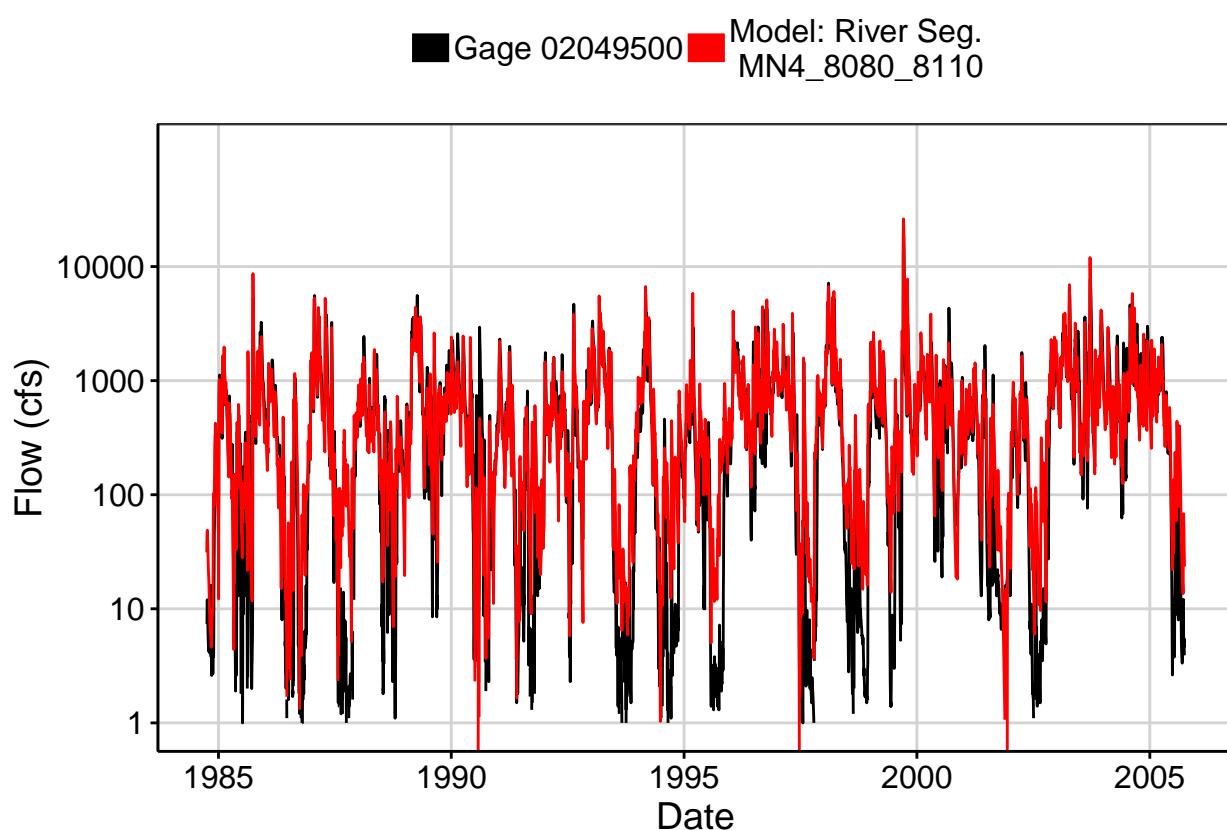


Fig. 2: Zoomed Hydrograph

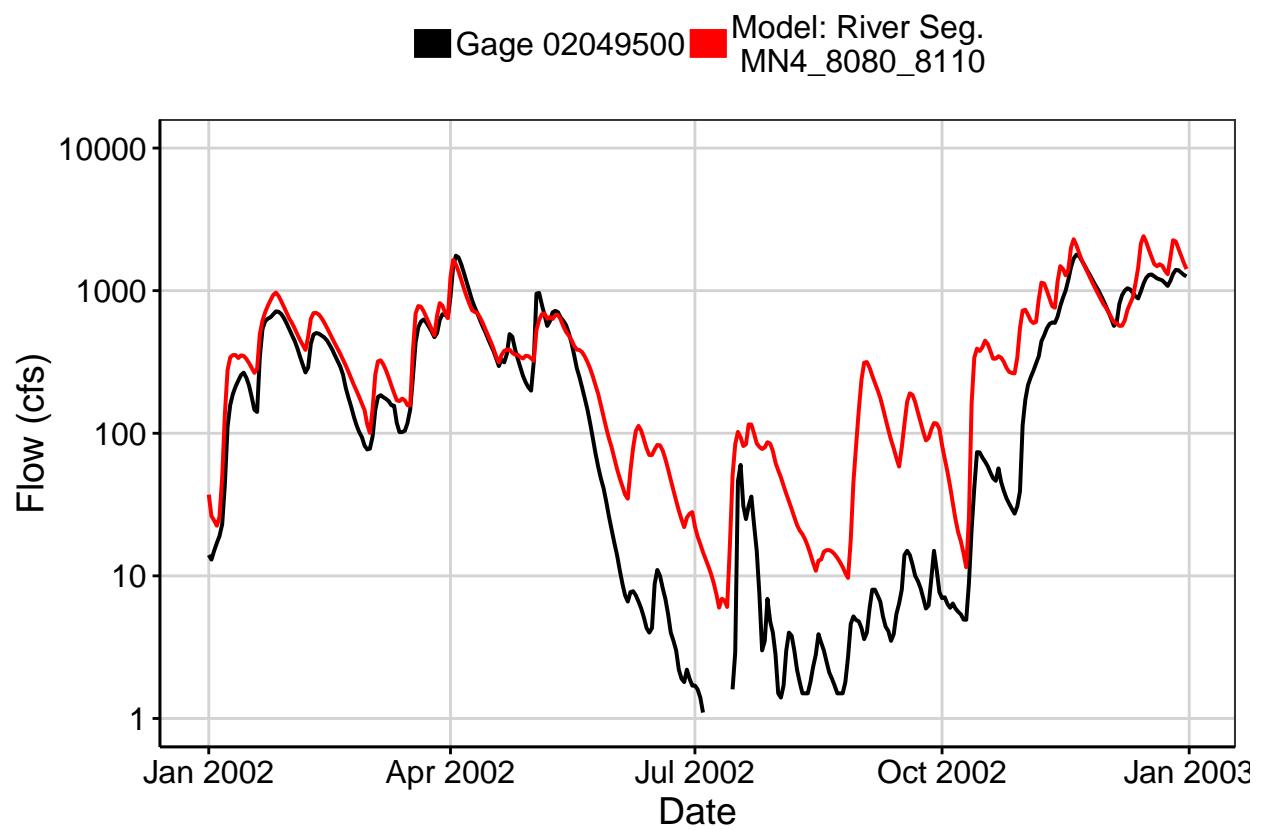


Fig. 3: Flow Exceedance

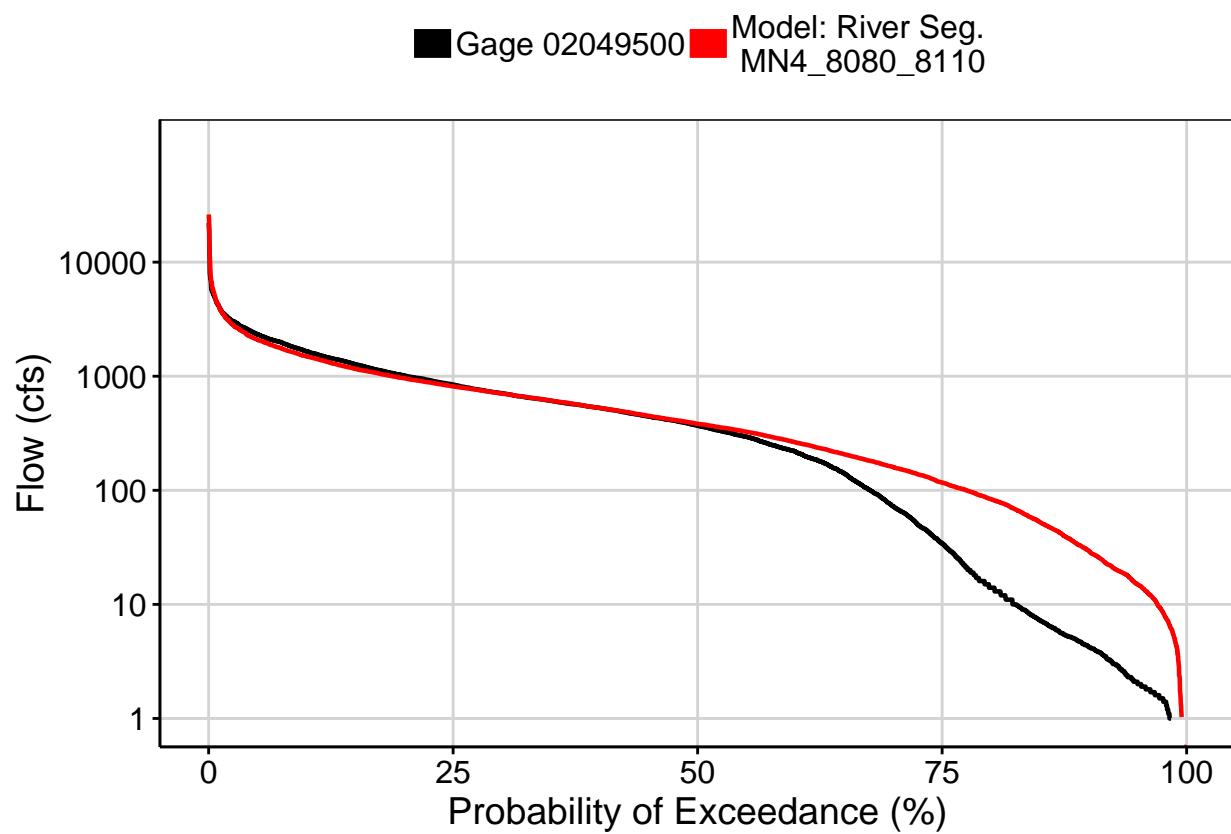


Fig. 4: Baseflow

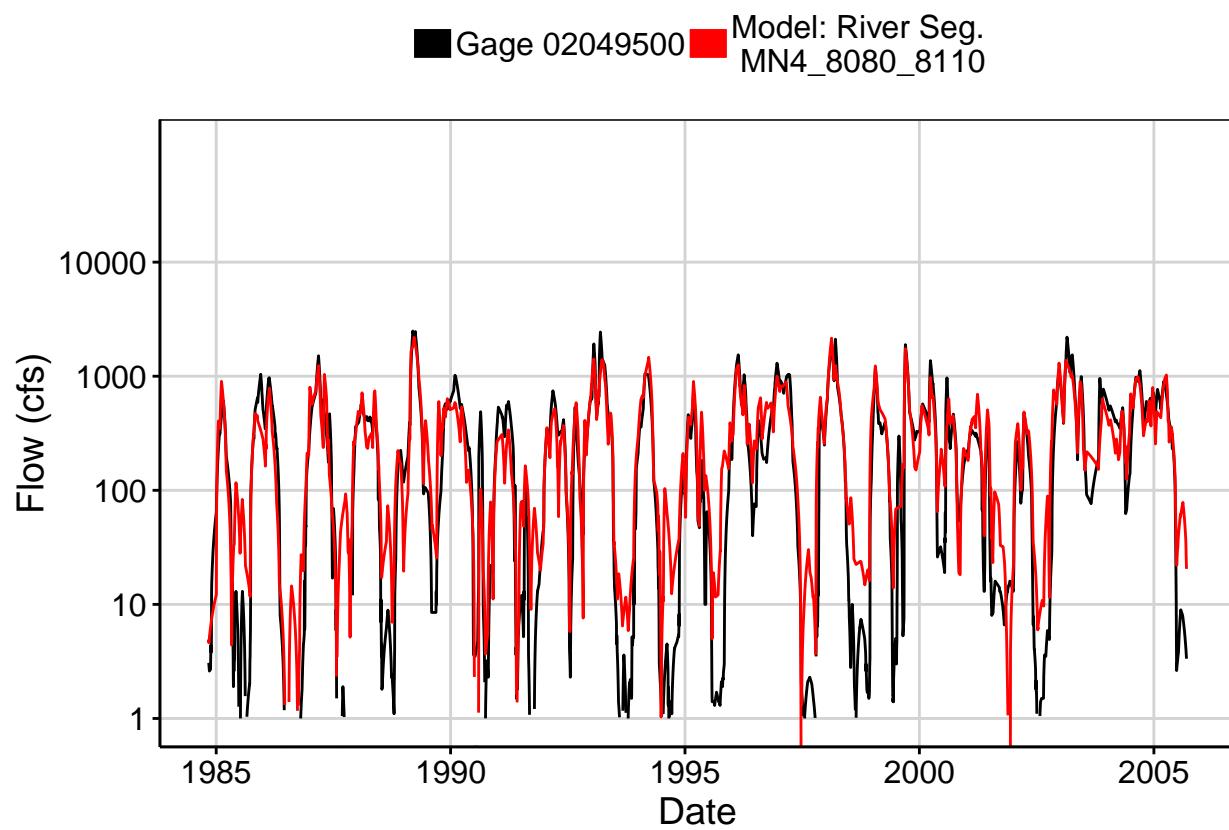


Fig. 5: Combined Baseflow

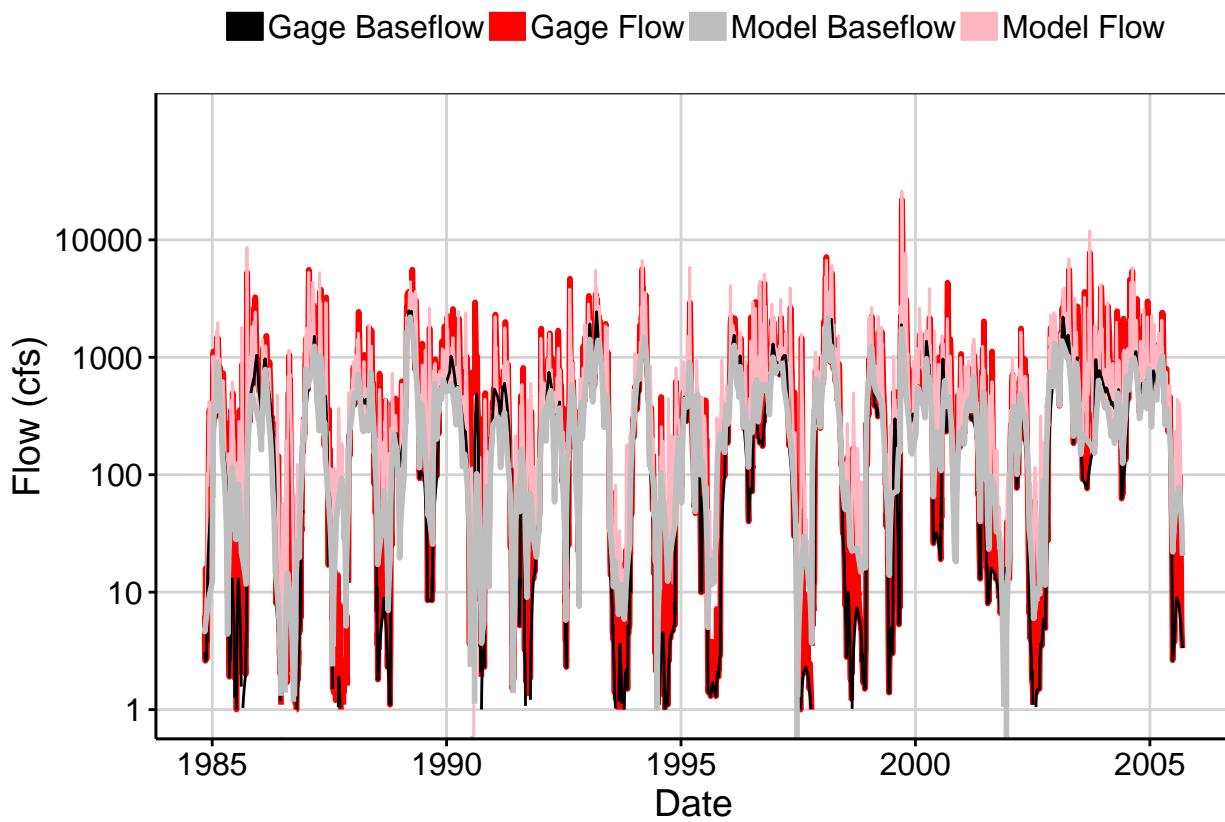


Fig. 6: Largest Error Segment

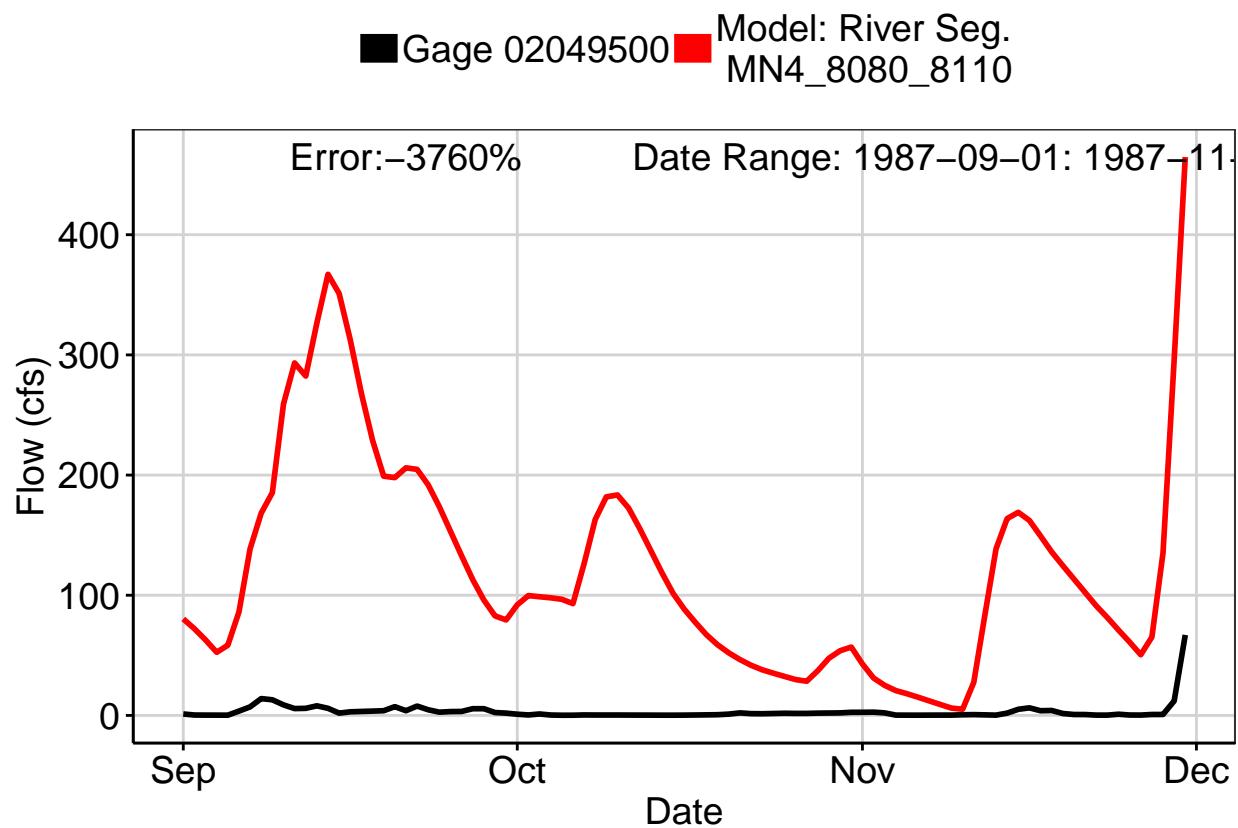


Fig. 7: Second Largest Error Segment

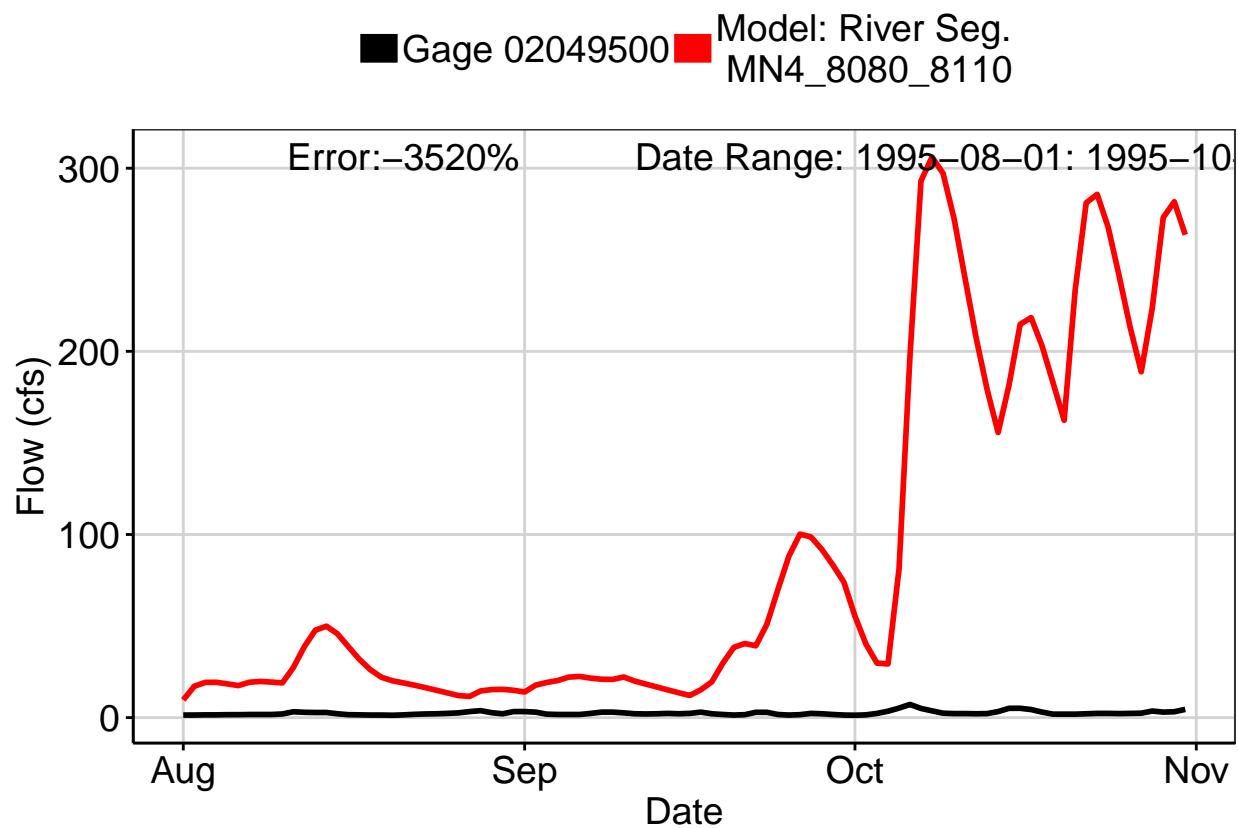


Fig. 8: Third Largest Error Segment

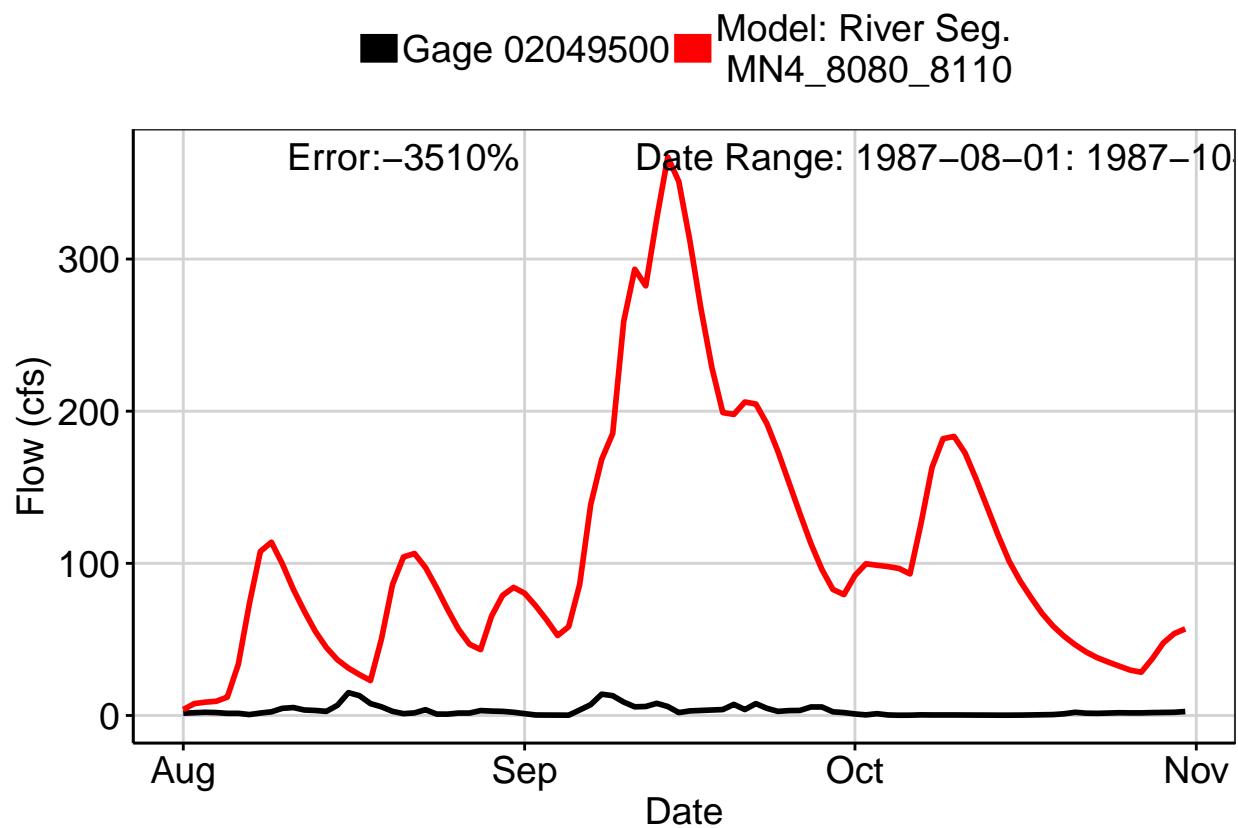
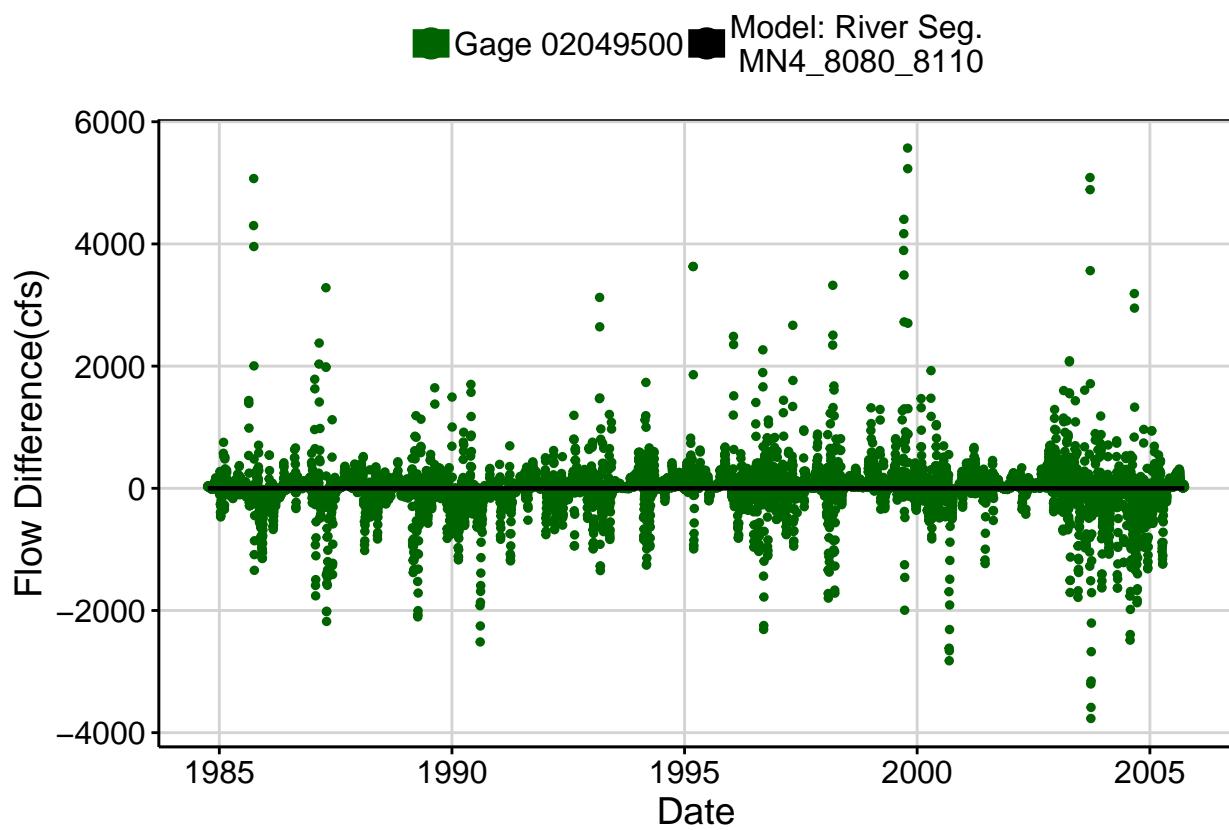
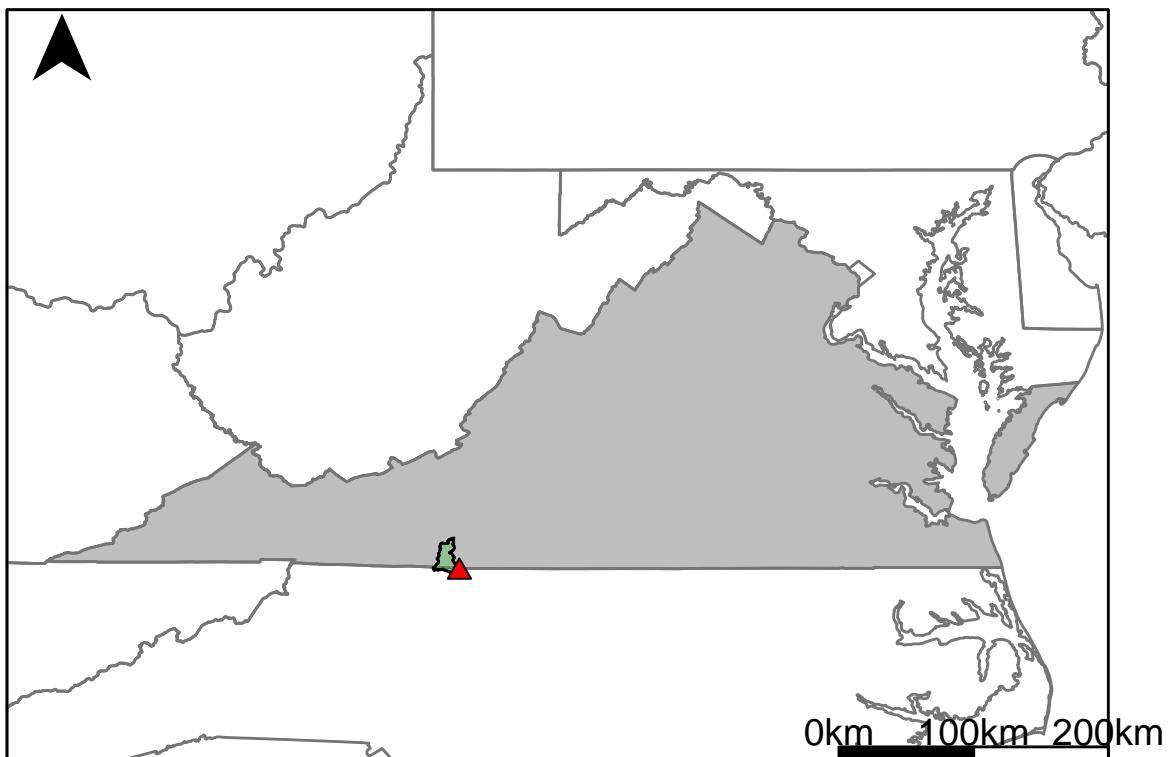


Fig. 9: Residuals Plot



## Appendix C: Dan River Gages

### Appendix C.1: USGS Gage 02068500 vs. OD2\_8840\_9020



This river segment follows part of the flow of the Dan River. The gage is located in Stokes County, NC (Lat 36°30'54", Long 80°18'11") approximately 26 miles southwest of Martinsville, VA. Drainage area is 129 sq. miles. This gage started taking data in 1924 and is still taking data but there is a gap from 1987-10-13 to 1991-11-30. The Talbot and Townes reservoirs are located above the Pinnacles Hydroelectric Plant in Virginia 28 miles above the station. There are also several gristmills but they are not expected to affect the flow. The average daily discharge error between the model and gage data for the 20 year timespan was 2.59%, with 54.6% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	75	55.4	26.1
Feb. Low Flow	88.1	64.8	26.4
Mar. Low Flow	90.9	98.7	-8.58
Apr. Low Flow	106	108	-1.89
May Low Flow	133	148	-11.3
Jun. Low Flow	131	155	-18.3
Jul. Low Flow	134	117	12.7
Aug. Low Flow	120	90.7	24.4
Sep. Low Flow	108	72	33.3
Oct. Low Flow	97.1	59.9	38.3
Nov. Low Flow	84	58.2	30.7
Dec. Low Flow	76	57.5	24.3

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	193	188	2.59
Jan. Mean Flow	208	227	-9.13
Feb. Mean Flow	212	243	-14.6
Mar. Mean Flow	268	303	-13.1
Apr. Mean Flow	267	248	7.12
May Mean Flow	197	182	7.61
Jun. Mean Flow	197	172	12.7
Jul. Mean Flow	161	119	26.1
Aug. Mean Flow	181	143	21
Sep. Mean Flow	160	160	0
Oct. Mean Flow	123	131	-6.5
Nov. Mean Flow	158	157	0.63
Dec. Mean Flow	185	175	5.41

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	174	148	14.9
Feb. High Flow	286	390	-36.4
Mar. High Flow	441	304	31.1
Apr. High Flow	420	707	-68.3
May High Flow	413	385	6.78
Jun. High Flow	497	1010	-103
Jul. High Flow	465	501	-7.74
Aug. High Flow	371	436	-17.5
Sep. High Flow	311	221	28.9
Oct. High Flow	233	188	19.3
Nov. High Flow	261	199	23.8
Dec. High Flow	274	212	22.6

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	21	15.3	27.1
Med. 1 Day Min	60.5	35.3	41.7
Min. 3 Day Min	25.7	15.7	38.9
Med. 3 Day Min	63.7	36	43.5
Min. 7 Day Min	41	16.6	59.5
Med. 7 Day Min	71.1	37.4	47.4
Min. 30 Day Min	52.7	22.4	57.5
Med. 30 Day Min	87.2	49	43.8
Min. 90 Day Min	66.3	40.6	38.8
Med. 90 Day Min	117	69	41
7Q10	46.4	21.7	53.2
Year of 90-Day Min. Flow	2002	1986	100
Drought Year Mean	93.6	188	-101
Mean Baseflow	130	117	10

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	6430	5300	17.6
Med. 1 Day Max	1820	2350	-29.1
Max. 3 Day Max	3010	2900	3.65
Med. 3 Day Max	1000	1480	-48
Max. 7 Day Max	1540	1500	2.6
Med. 7 Day Max	675	923	-36.7
Max. 30 Day Max	768	718	6.51
Med. 30 Day Max	403	475	-17.9
Max. 90 Day Max	551	544	1.27
Med. 90 Day Max	276	303	-9.78

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	51	26.7	47.6
5% Non-Exceedance	65	41.4	36.3
50% Non-Exceedance	143	131	8.39
95% Non-Exceedance	446	497	-11.4
99% Non-Exceedance	929	1040	-11.9
Sept. 10% Non-Exceedance	45.8	44	3.93

**Fig. 1: Hydrograph**

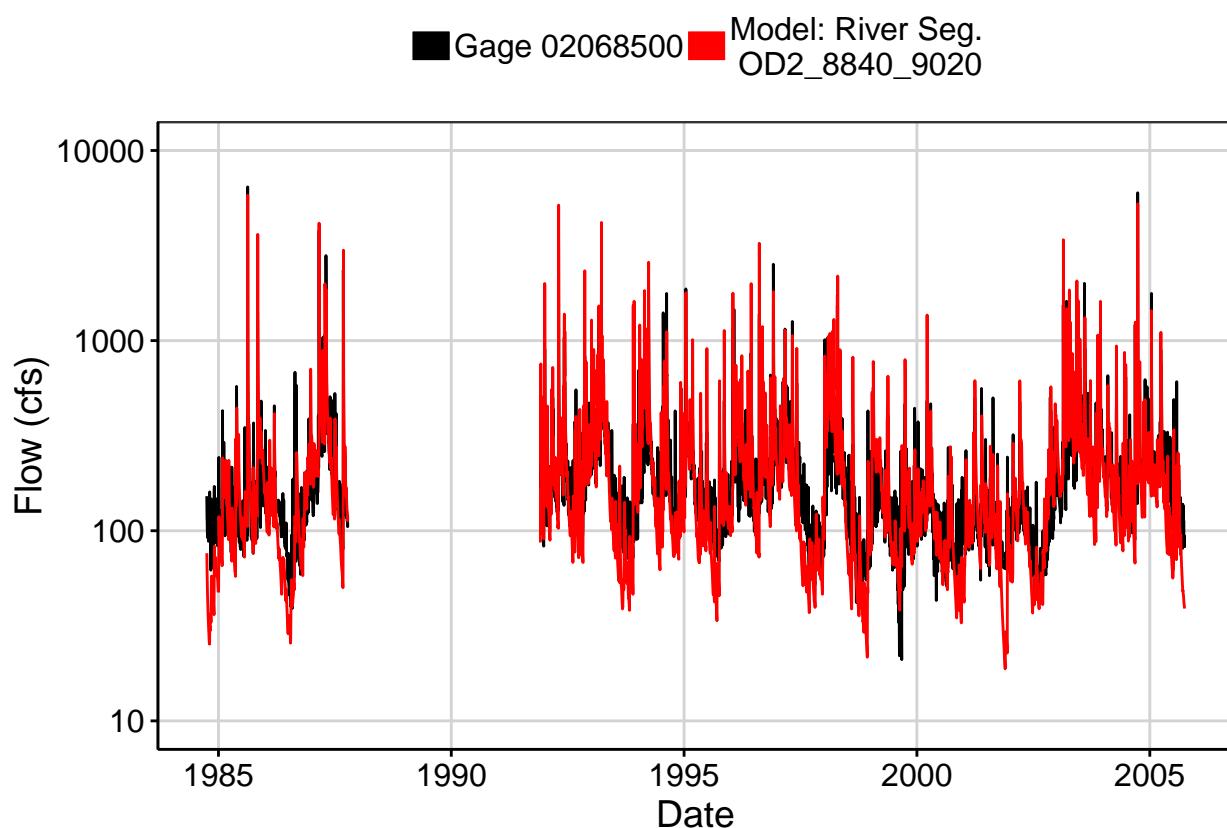


Fig. 2: Zoomed Hydrograph

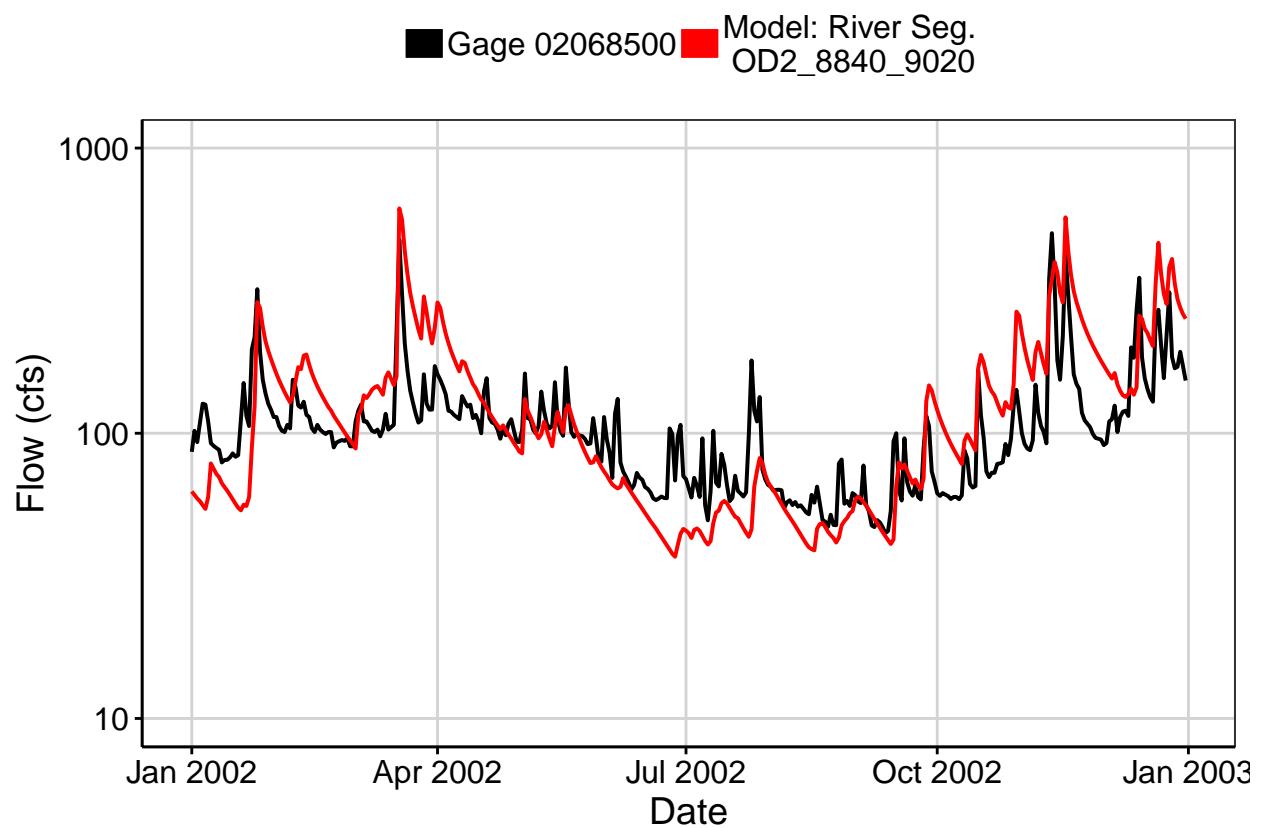


Fig. 3: Flow Exceedance

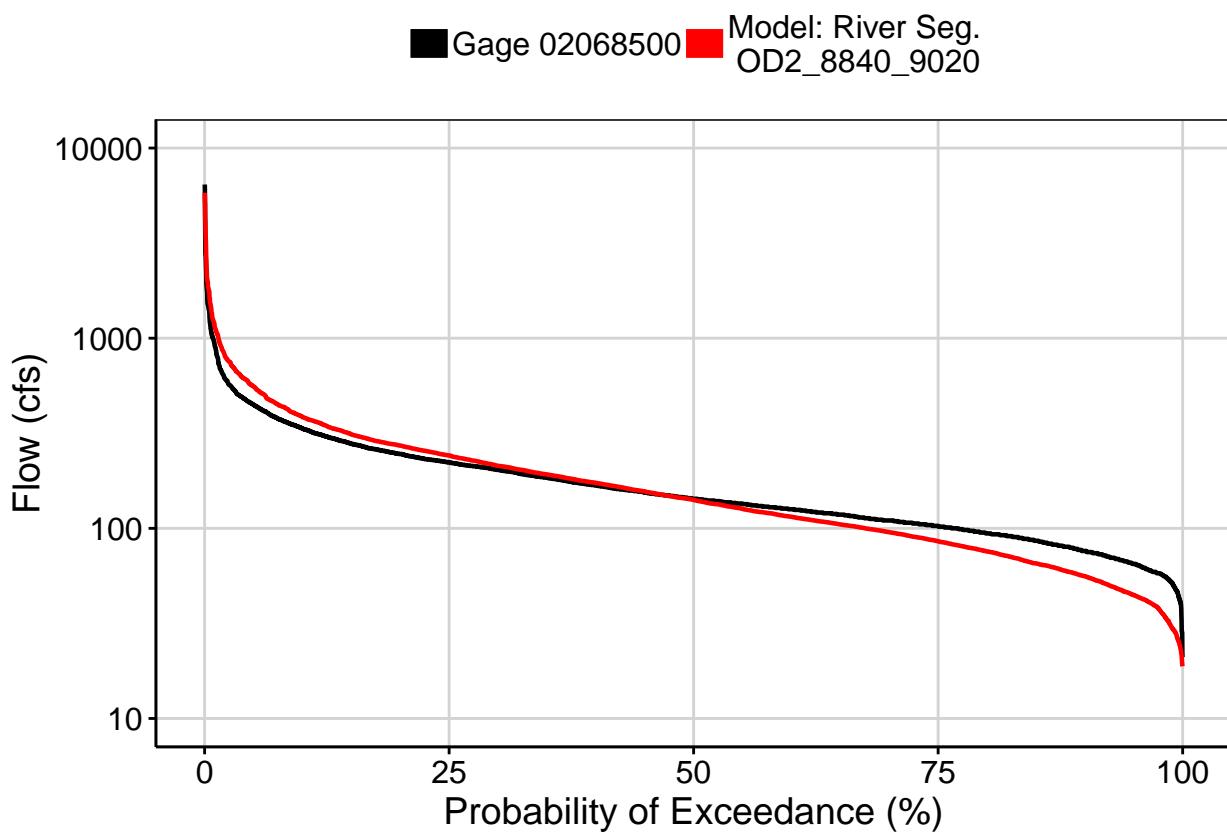


Fig. 4: Baseflow

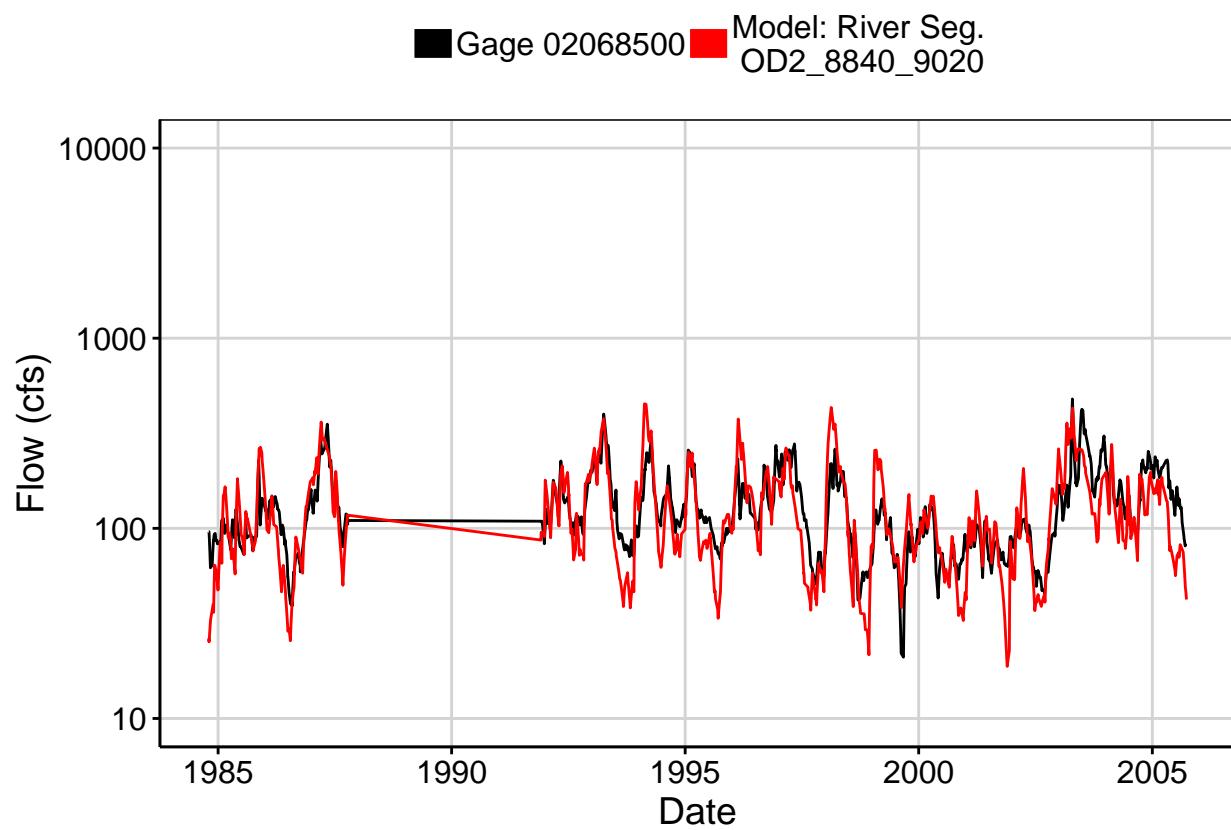


Fig. 5: Combined Baseflow

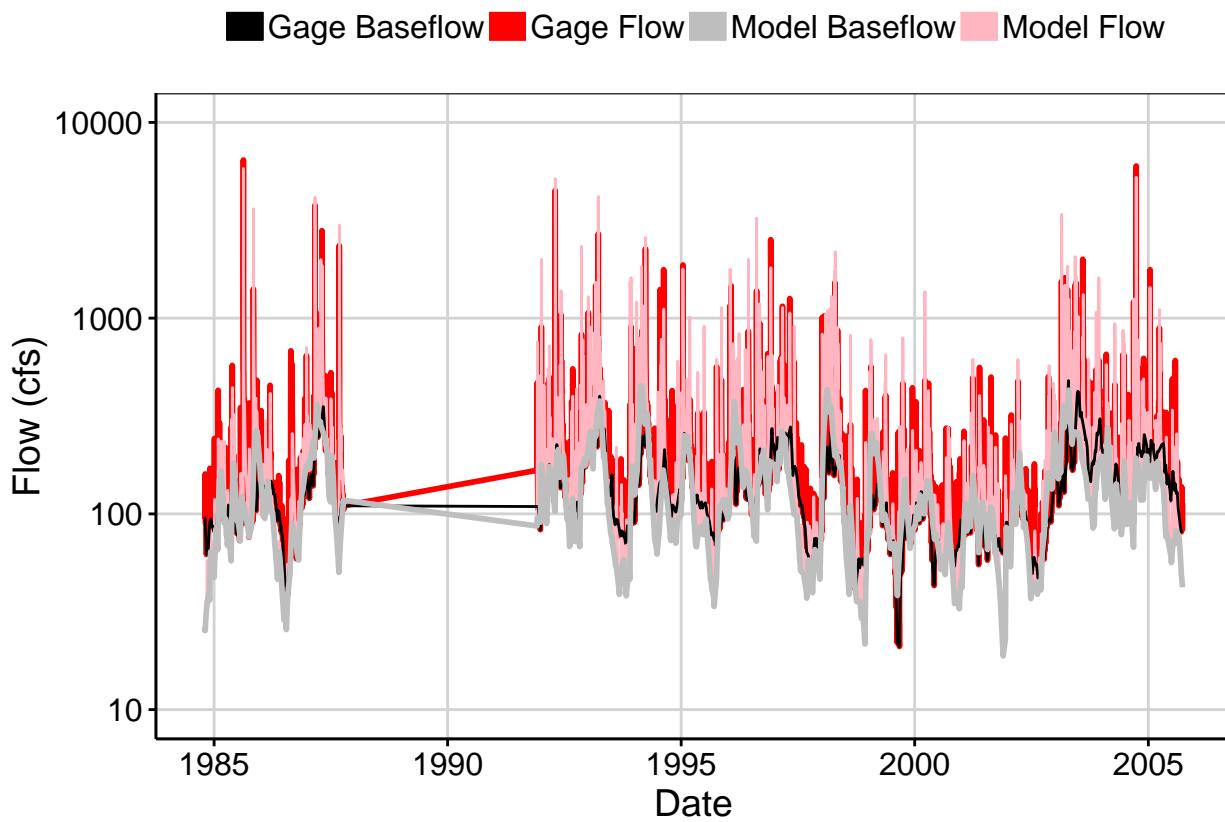


Fig. 6: Largest Error Segment

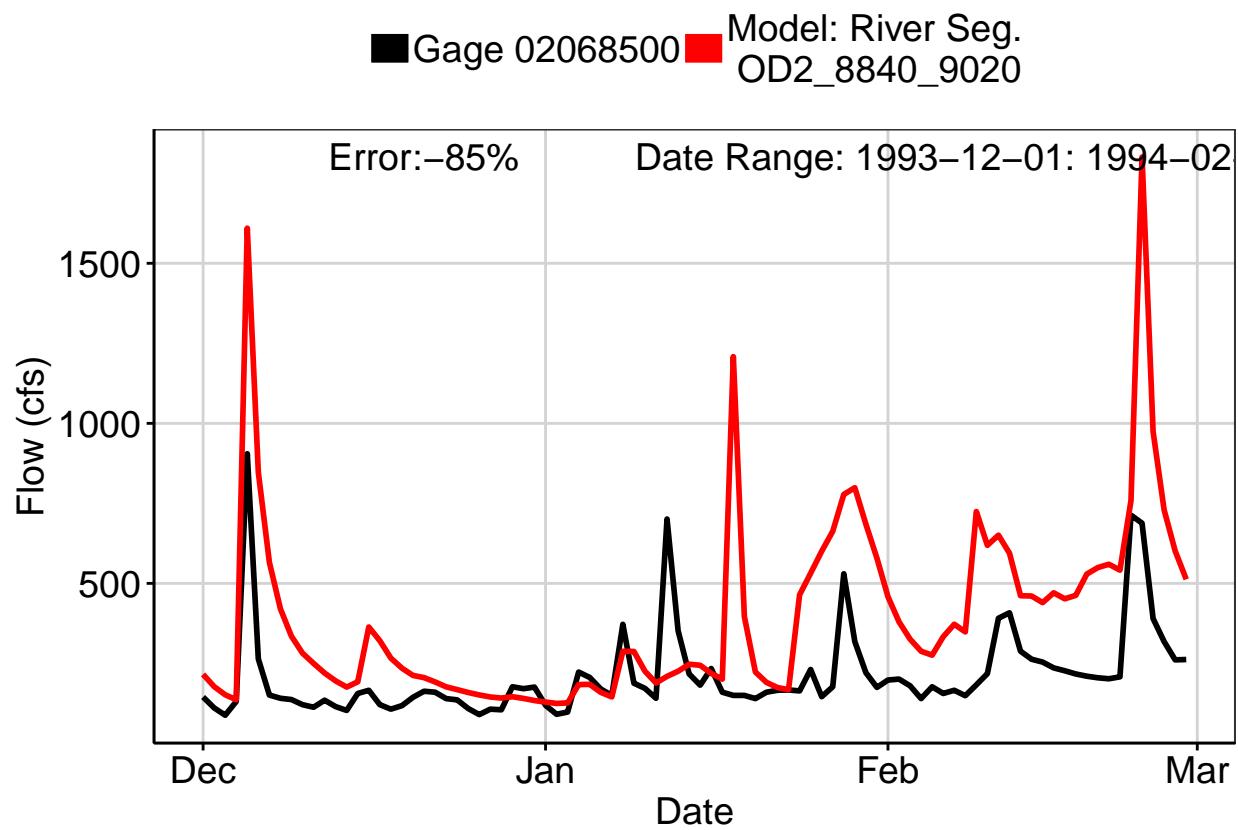


Fig. 7: Second Largest Error Segment

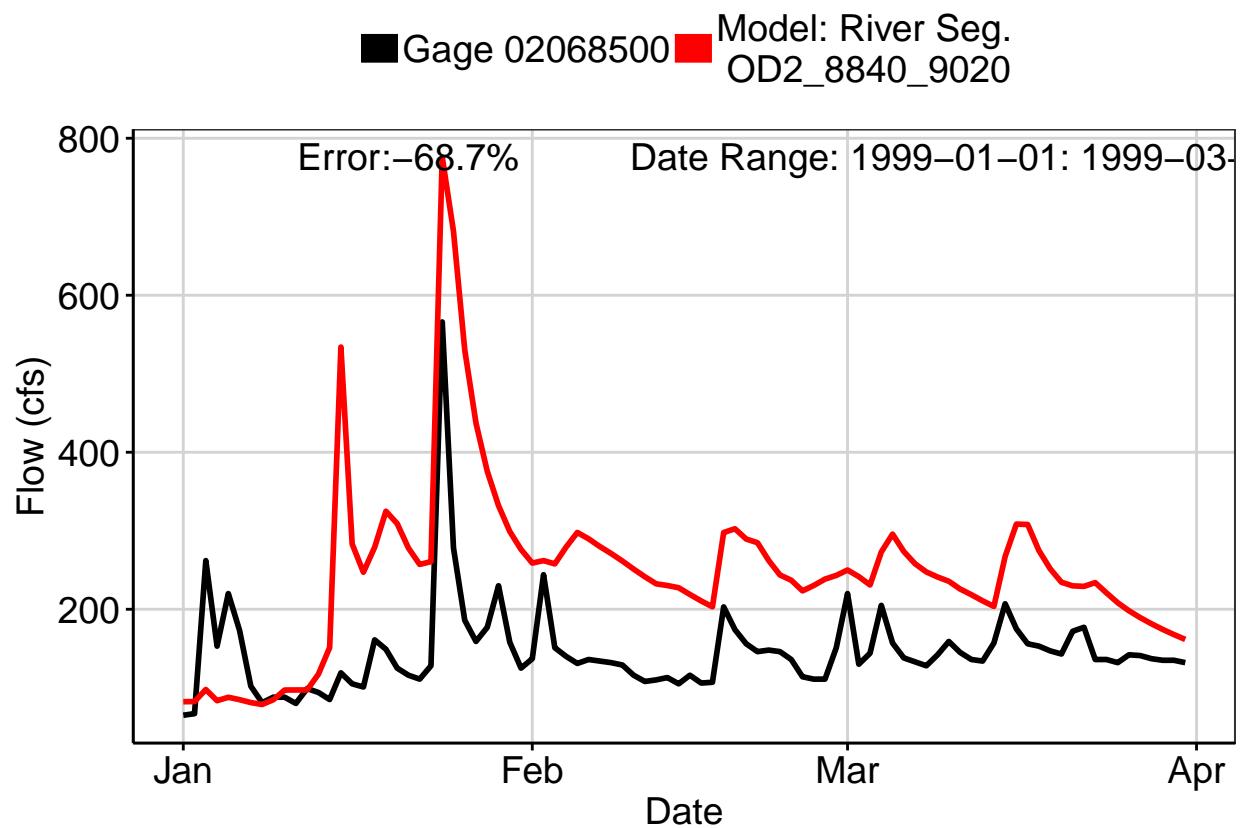


Fig. 8: Third Largest Error Segment

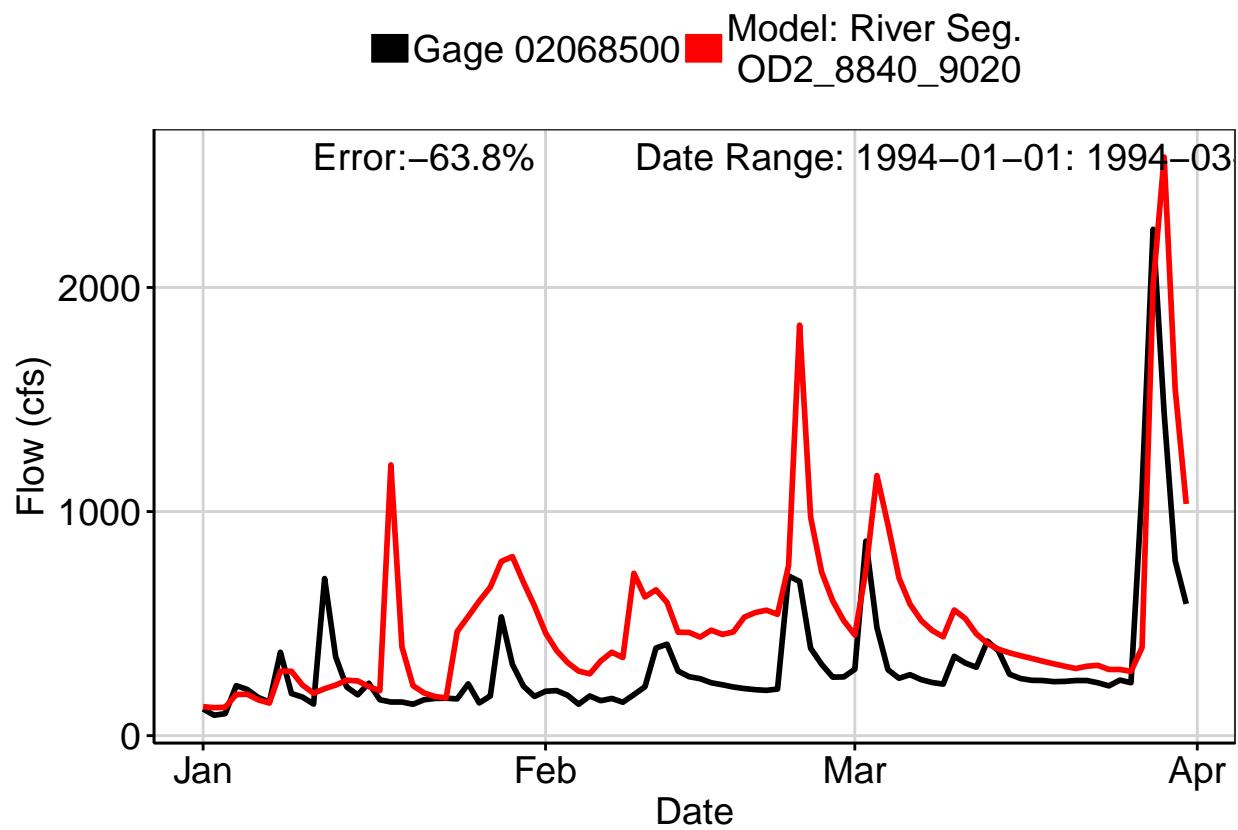
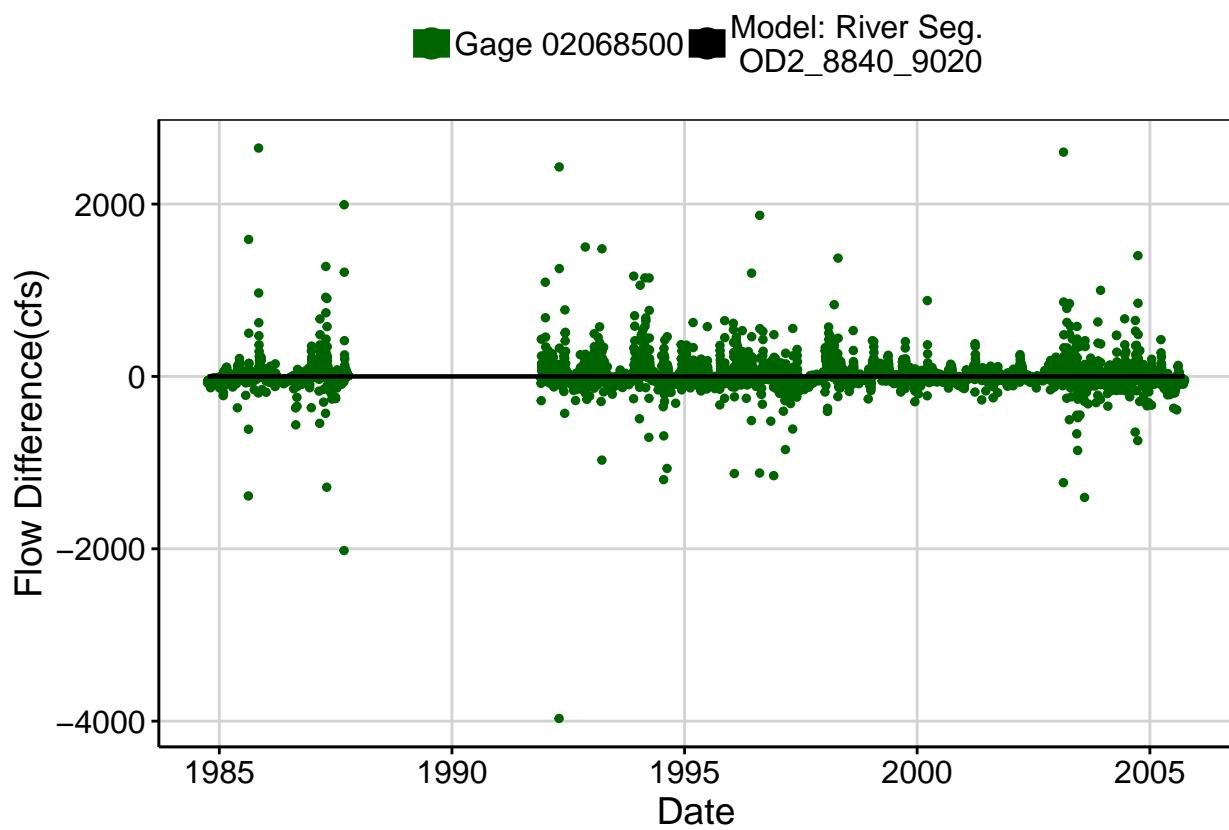
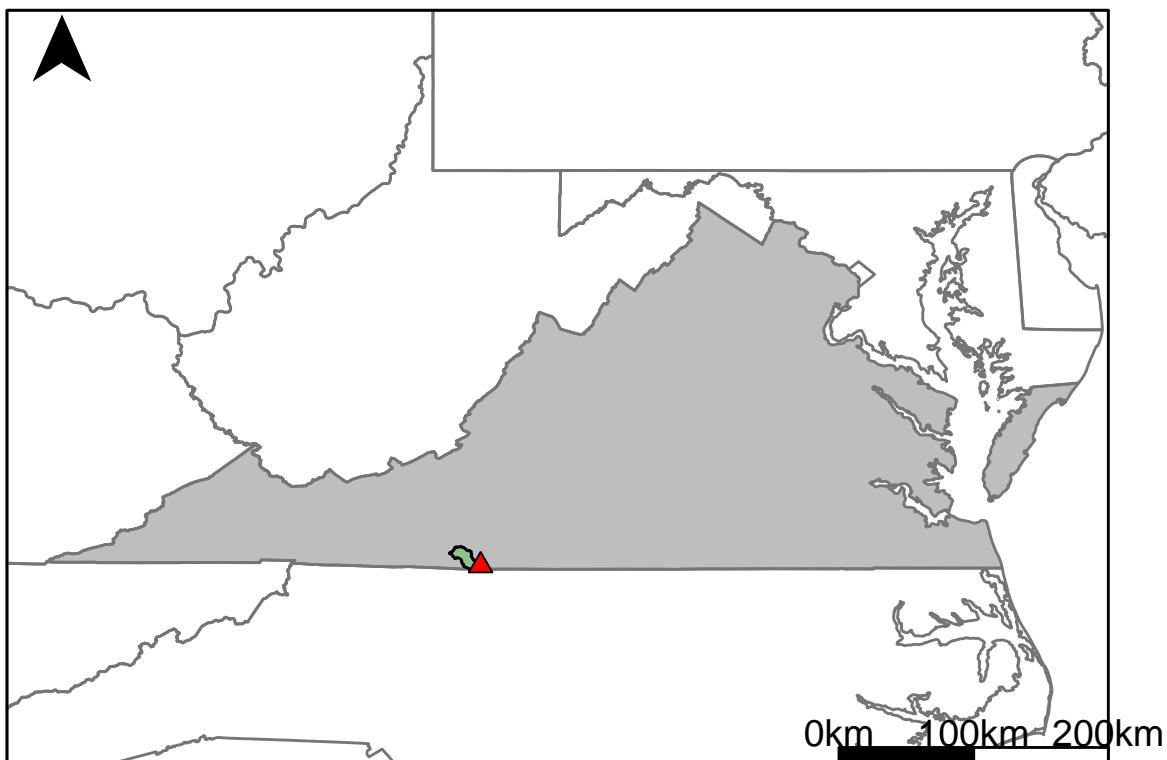


Fig. 9: Residuals Plot



## Appendix C.2: USGS Gage 02069700 vs. OD1\_8910\_8930



This river segment follows part of the flow of the South Mayo River, a tributary of the Dan River. The gage is located in Patrick County, VA (Lat 36°34'15", Long 80°07'47") approximately 17 miles southwest of Martinsville, VA. Drainage area is 85.5 sq. miles. This gage started taking data in 1962 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 3.91%, with 45% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	54	33.8	37.4
Feb. Low Flow	60	43.4	27.7
Mar. Low Flow	70	61.9	11.6
Apr. Low Flow	75	78.8	-5.07
May Low Flow	91	99.4	-9.23
Jun. Low Flow	96	101	-5.21
Jul. Low Flow	94	84.9	9.68
Aug. Low Flow	97	71.2	26.6
Sep. Low Flow	73	59.2	18.9
Oct. Low Flow	67.7	44.9	33.7
Nov. Low Flow	56	42.7	23.7
Dec. Low Flow	50	36.8	26.4

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	128	123	3.91
Jan. Mean Flow	136	145	-6.62
Feb. Mean Flow	143	158	-10.5
Mar. Mean Flow	181	206	-13.8
Apr. Mean Flow	173	169	2.31
May Mean Flow	140	123	12.1
Jun. Mean Flow	135	117	13.3
Jul. Mean Flow	113	79.5	29.6
Aug. Mean Flow	111	90.3	18.6
Sep. Mean Flow	97.8	99.2	-1.43
Oct. Mean Flow	90.2	80.8	10.4
Nov. Mean Flow	105	96.5	8.1
Dec. Mean Flow	113	113	0

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	159	97.3	38.8
Feb. High Flow	226	224	0.88
Mar. High Flow	237	210	11.4
Apr. High Flow	328	379	-15.5
May High Flow	334	252	24.6
Jun. High Flow	467	775	-66
Jul. High Flow	330	331	-0.3
Aug. High Flow	343	280	18.4
Sep. High Flow	275	159	42.2
Oct. High Flow	178	107	39.9
Nov. High Flow	250	97.2	61.1
Dec. High Flow	175	111	36.6

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	8.67	11.1	-28
Med. 1 Day Min	39	25.7	34.1
Min. 3 Day Min	9.2	11.3	-22.8
Med. 3 Day Min	40	26.3	34.2
Min. 7 Day Min	10.1	11.8	-16.8
Med. 7 Day Min	43.7	28.3	35.2
Min. 30 Day Min	16.6	13.7	17.5
Med. 30 Day Min	50.6	33.6	33.6
Min. 90 Day Min	21.3	23.8	-11.7
Med. 90 Day Min	67.4	45.9	31.9
7Q10	20.6	14.6	29.1
Year of 90-Day Min. Flow	2002	1985	100
Drought Year Mean	44.9	123	-174
Mean Baseflow	87.1	82.2	5.63

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	6580	3790	42.4
Med. 1 Day Max	1270	1390	-9.45
Max. 3 Day Max	2660	2200	17.3
Med. 3 Day Max	870	955	-9.77
Max. 7 Day Max	1420	1010	28.9
Med. 7 Day Max	516	634	-22.9
Max. 30 Day Max	514	501	2.53
Med. 30 Day Max	264	284	-7.58
Max. 90 Day Max	362	374	-3.31
Med. 90 Day Max	193	202	-4.66

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	23.2	17.1	26.3
5% Non-Exceedance	36	27.3	24.2
50% Non-Exceedance	97	86.2	11.1
95% Non-Exceedance	298	304	-2.01
99% Non-Exceedance	682	736	-7.92
Sept. 10% Non-Exceedance	30.2	30.1	0.33

**Fig. 1: Hydrograph**

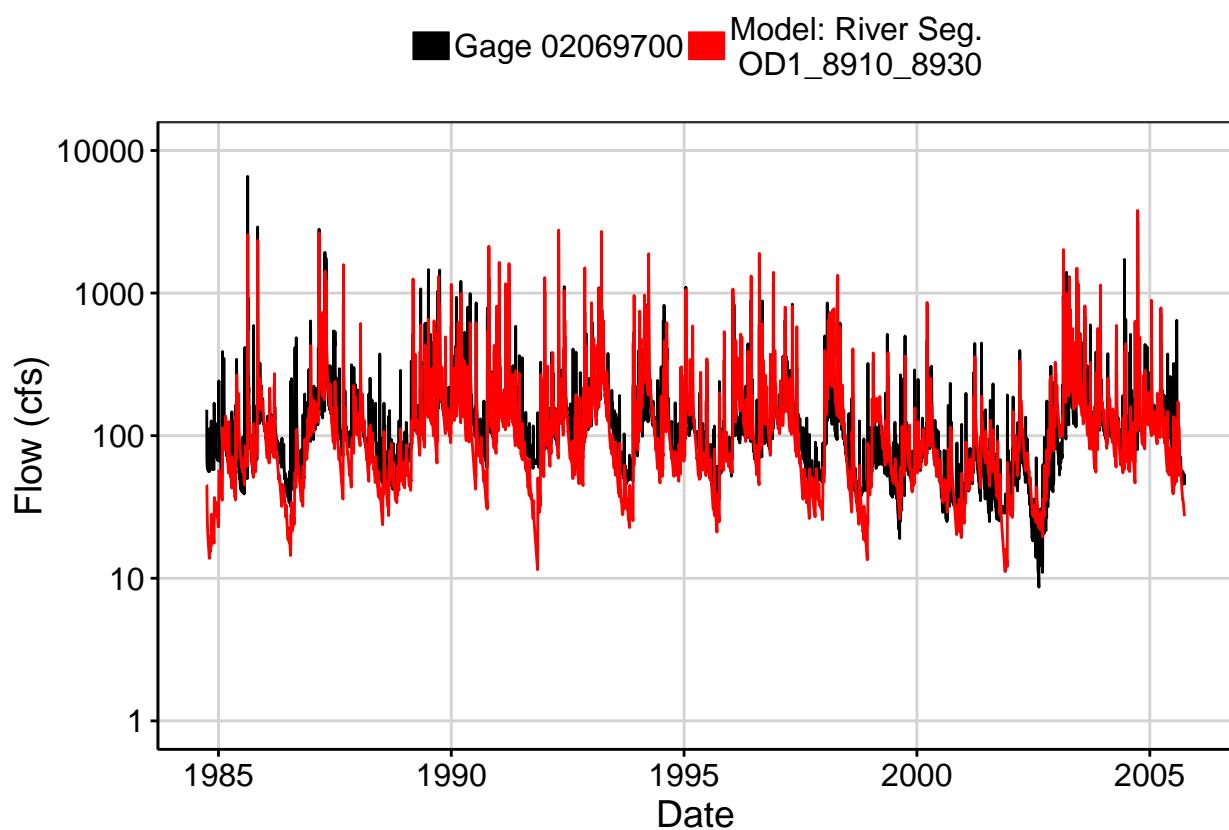


Fig. 2: Zoomed Hydrograph

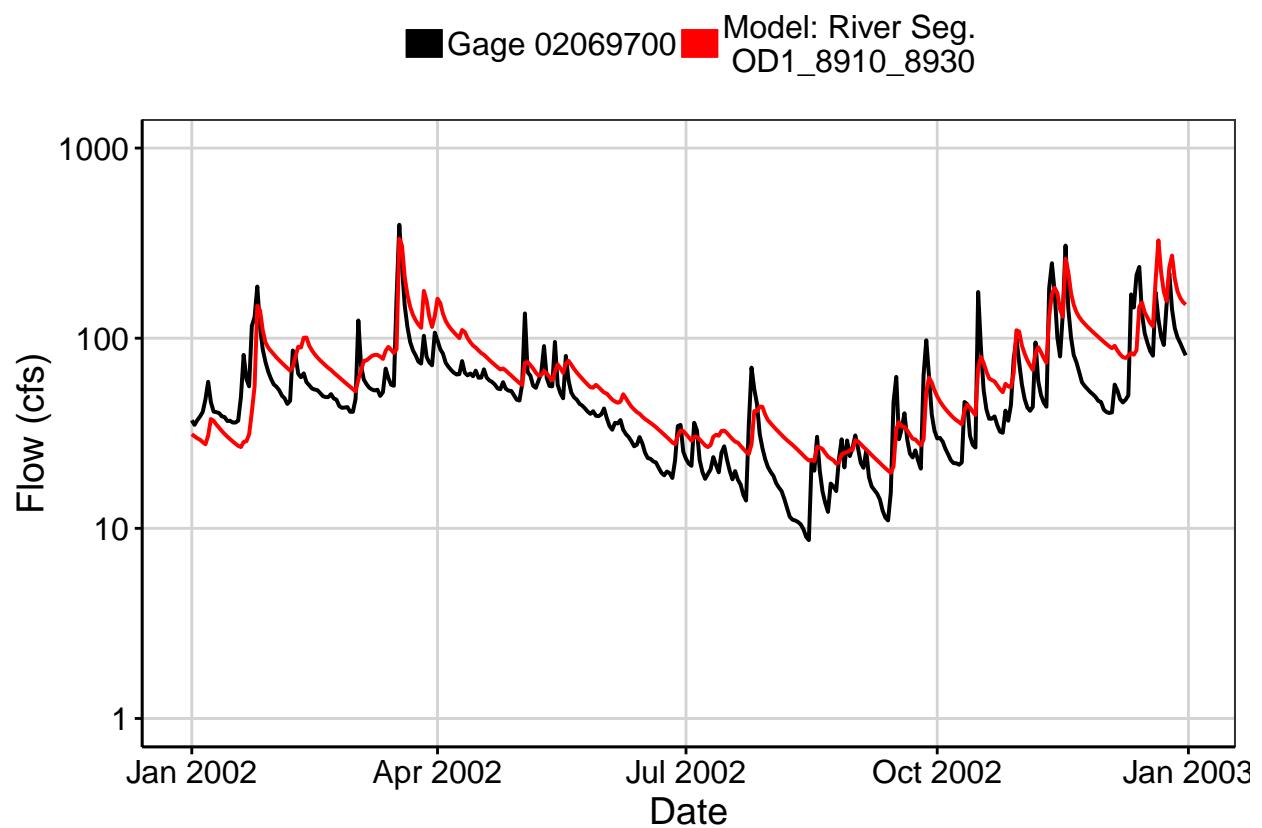


Fig. 3: Flow Exceedance

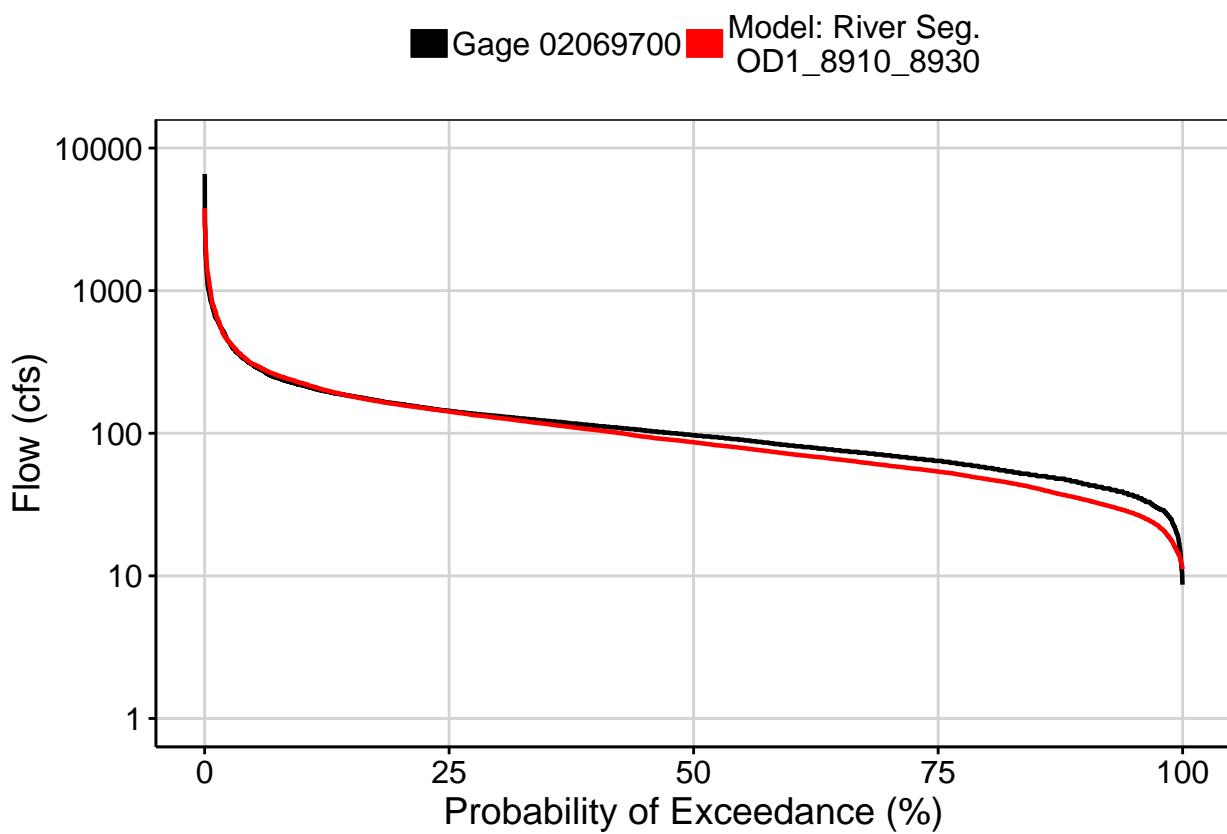


Fig. 4: Baseflow

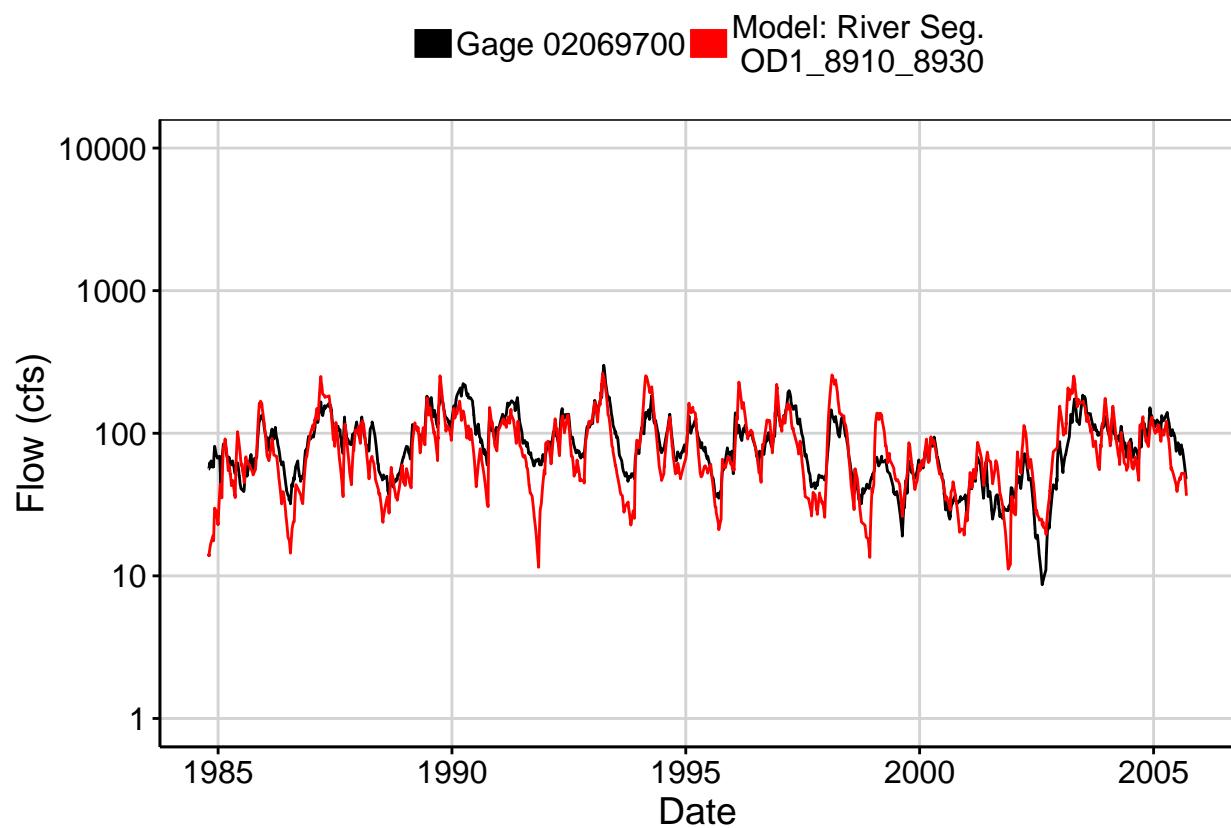


Fig. 5: Combined Baseflow

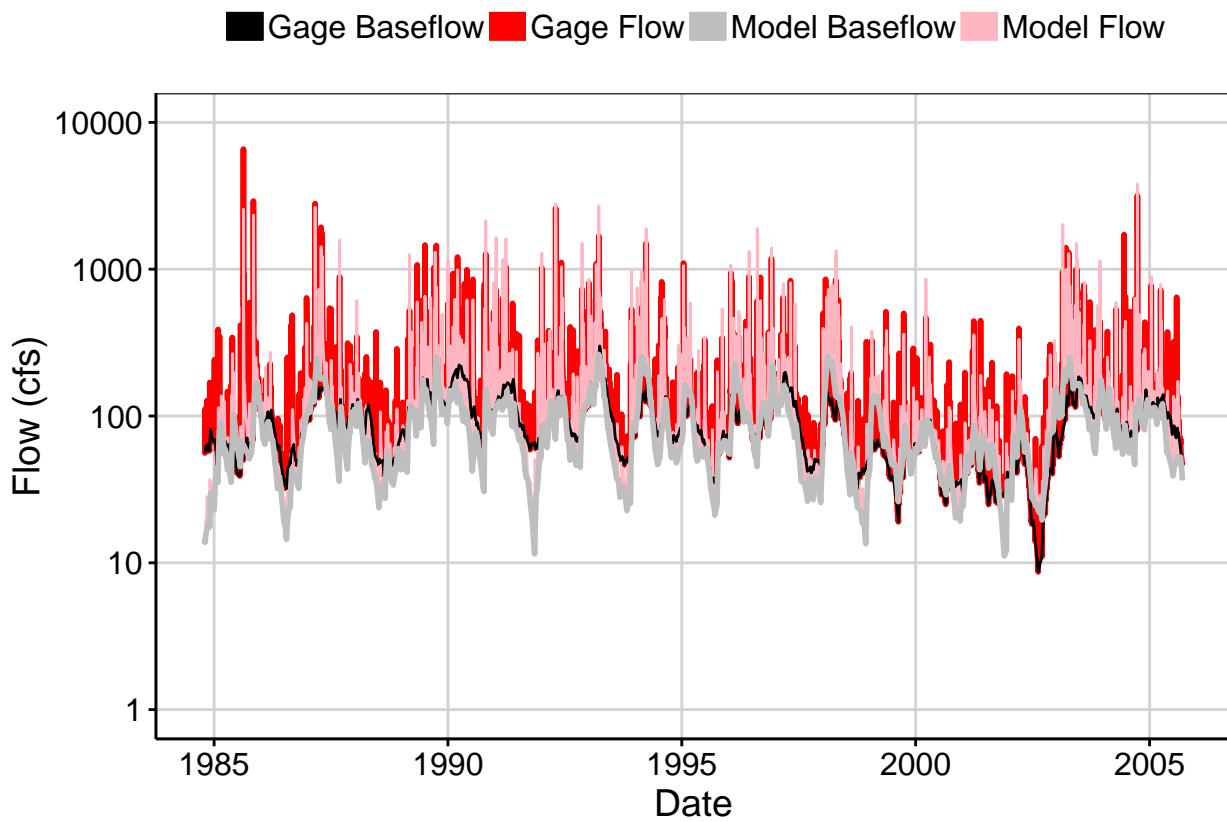


Fig. 6: Largest Error Segment

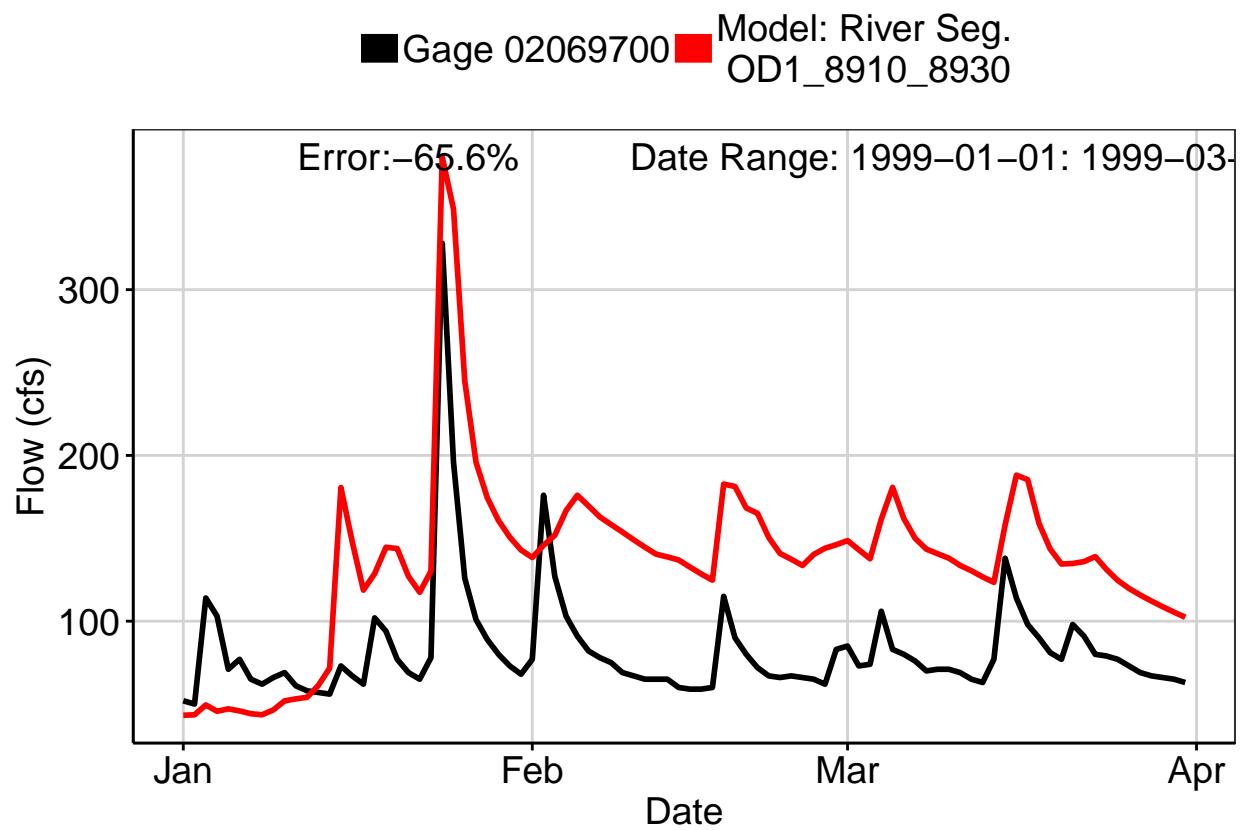


Fig. 7: Second Largest Error Segment

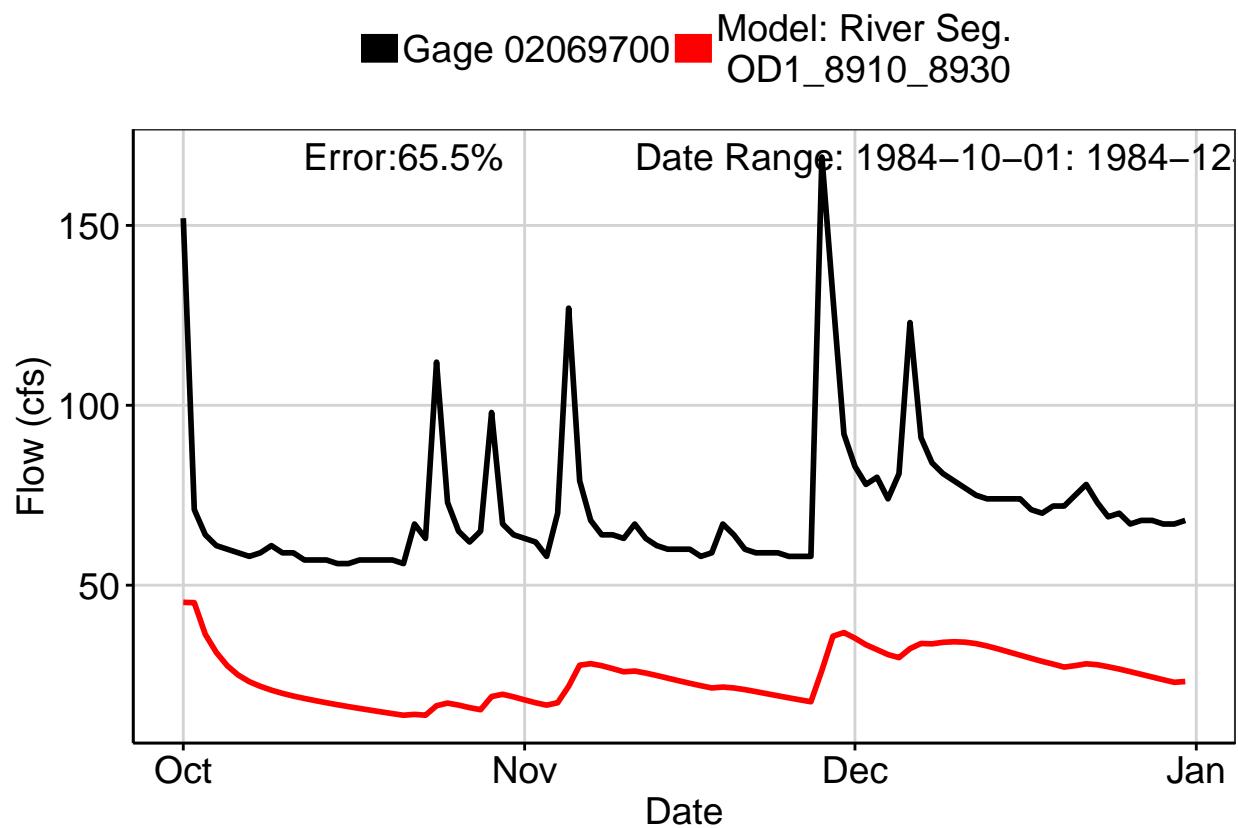


Fig. 8: Third Largest Error Segment

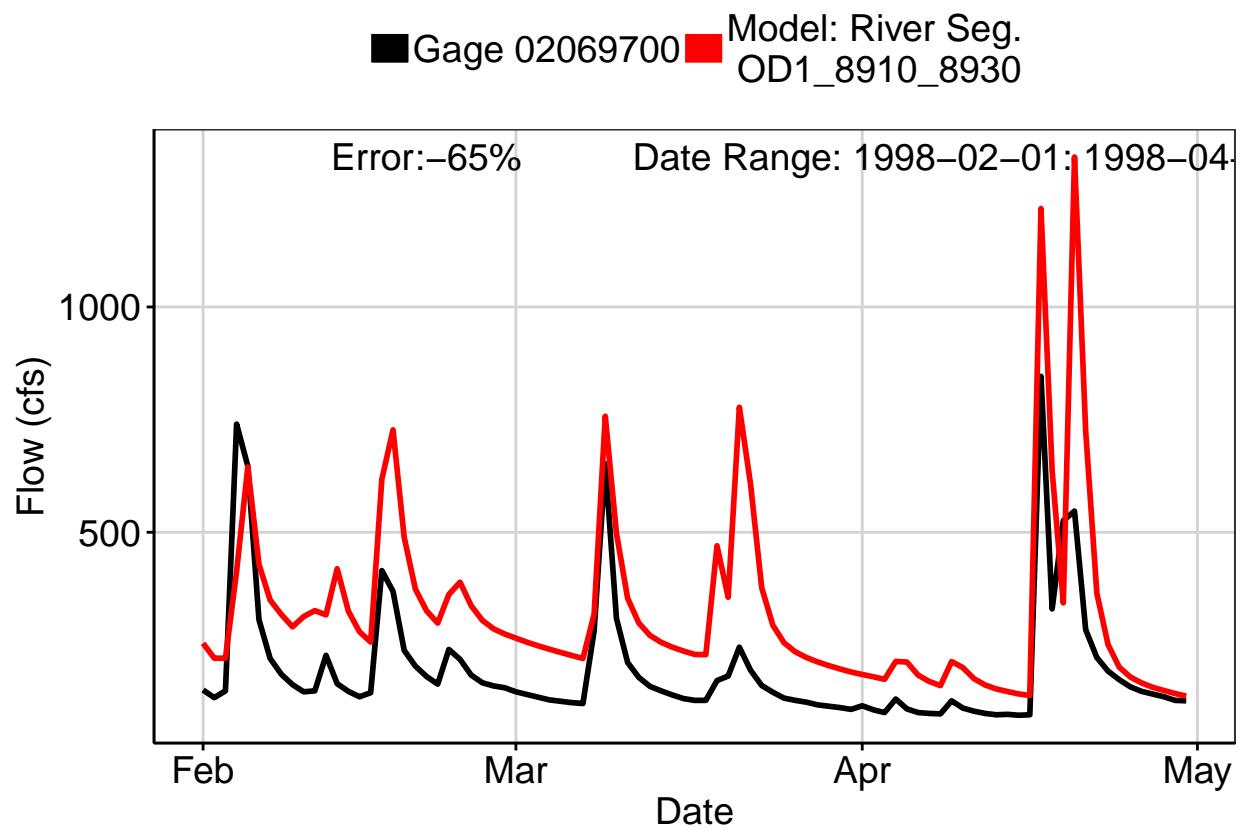
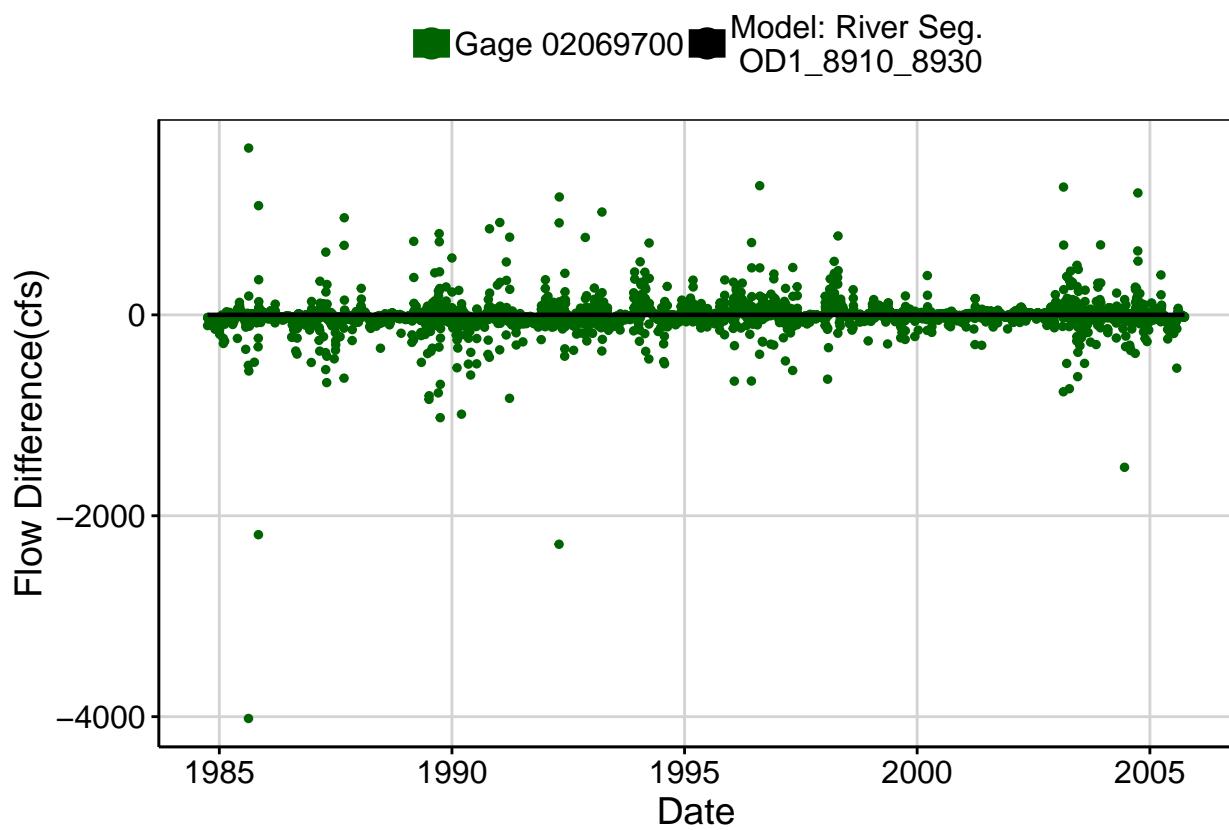
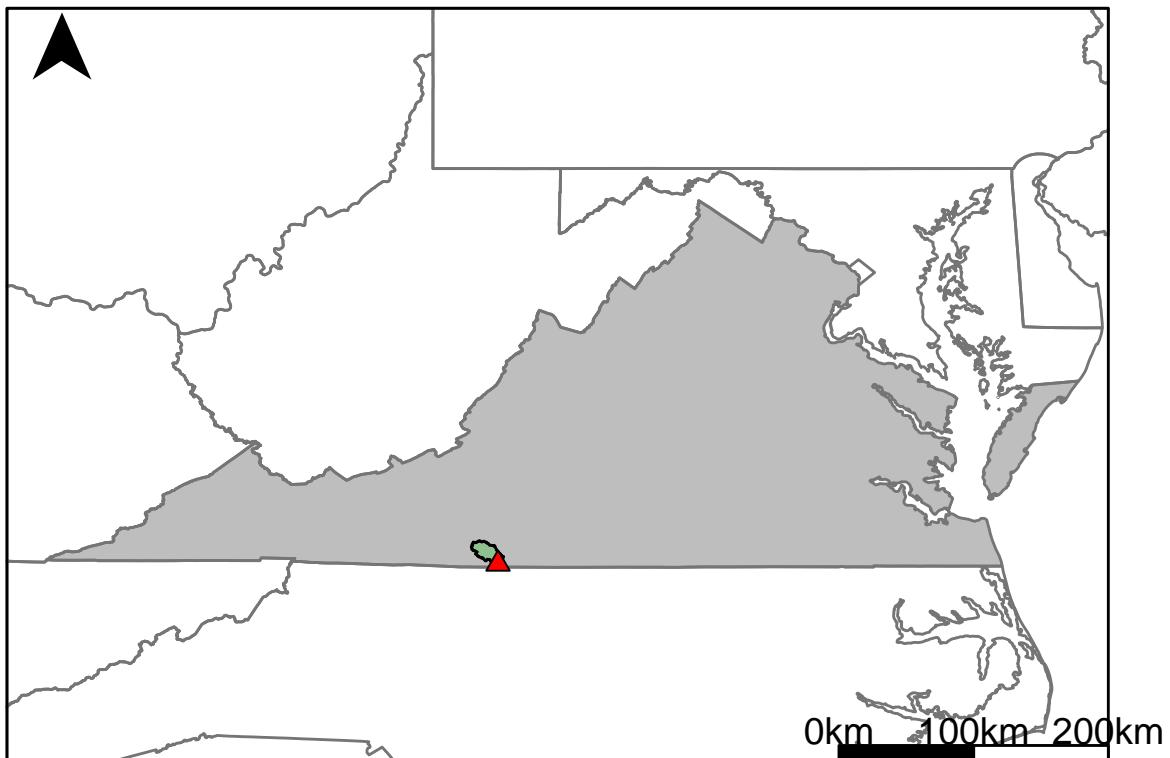


Fig. 9: Residuals Plot



## Appendix C.3: USGS Gage 02070000 vs. OD3\_8850\_8931



This river segment follows part of the flow of the North Mayo River, a tributary of the Dan River. The gage is located in Henry County, VA (Lat 36°34'05", Long 79°59'15") approximately 10 miles southwest of Martinsville, VA. Drainage area is 108 sq. miles. This gage started taking data in 1928 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was -6.62%, with 57.9% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	61	30.9	49.3
Feb. Low Flow	71	42.9	39.6
Mar. Low Flow	80	67.3	15.9
Apr. Low Flow	85	72	15.3
May Low Flow	97	119	-22.7
Jun. Low Flow	97	119	-22.7
Jul. Low Flow	94.4	87.1	7.73
Aug. Low Flow	83.2	66.8	19.7
Sep. Low Flow	73.5	54.3	26.1
Oct. Low Flow	71	39.8	43.9
Nov. Low Flow	63	35.1	44.3
Dec. Low Flow	54	34.9	35.4

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	136	145	-6.62
Jan. Mean Flow	149	177	-18.8
Feb. Mean Flow	153	204	-33.3
Mar. Mean Flow	199	261	-31.2
Apr. Mean Flow	167	202	-21
May Mean Flow	134	141	-5.22
Jun. Mean Flow	140	129	7.86
Jul. Mean Flow	126	80.7	36
Aug. Mean Flow	112	90.4	19.3
Sep. Mean Flow	123	116	5.69
Oct. Mean Flow	99.4	92.9	6.54
Nov. Mean Flow	116	109	6.03
Dec. Mean Flow	120	136	-13.3

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	148	101	31.8
Feb. High Flow	267	337	-26.2
Mar. High Flow	299	287	4.01
Apr. High Flow	520	485	6.73
May High Flow	412	375	8.98
Jun. High Flow	730	975	-33.6
Jul. High Flow	284	385	-35.6
Aug. High Flow	339	291	14.2
Sep. High Flow	336	163	51.5
Oct. High Flow	245	104	57.6
Nov. High Flow	222	80.9	63.6
Dec. High Flow	211	98.6	53.3

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	5.92	7.32	-23.6
Med. 1 Day Min	44	22.4	49.1
Min. 3 Day Min	5.97	7.5	-25.6
Med. 3 Day Min	45	23.2	48.4
Min. 7 Day Min	6.39	7.84	-22.7
Med. 7 Day Min	47.1	24.8	47.3
Min. 30 Day Min	11.7	9.84	15.9
Med. 30 Day Min	57.6	31.6	45.1
Min. 90 Day Min	16.9	20.4	-20.7
Med. 90 Day Min	74.2	46.7	37.1
7Q10	22.3	12.5	43.9
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	43.5	145	-233
Mean Baseflow	86.5	85.9	0.69

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	7460	4200	43.7
Med. 1 Day Max	2070	2100	-1.45
Max. 3 Day Max	3390	2320	31.6
Med. 3 Day Max	1180	1210	-2.54
Max. 7 Day Max	1600	1230	23.1
Med. 7 Day Max	684	830	-21.3
Max. 30 Day Max	539	658	-22.1
Med. 30 Day Max	330	368	-11.5
Max. 90 Day Max	379	463	-22.2
Med. 90 Day Max	214	257	-20.1

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	19.8	15.4	22.2
5% Non-Exceedance	39	24.1	38.2
50% Non-Exceedance	97	93	4.12
95% Non-Exceedance	308	381	-23.7
99% Non-Exceedance	925	1010	-9.19
Sept. 10% Non-Exceedance	26.9	27.4	-1.86

**Fig. 1: Hydrograph**

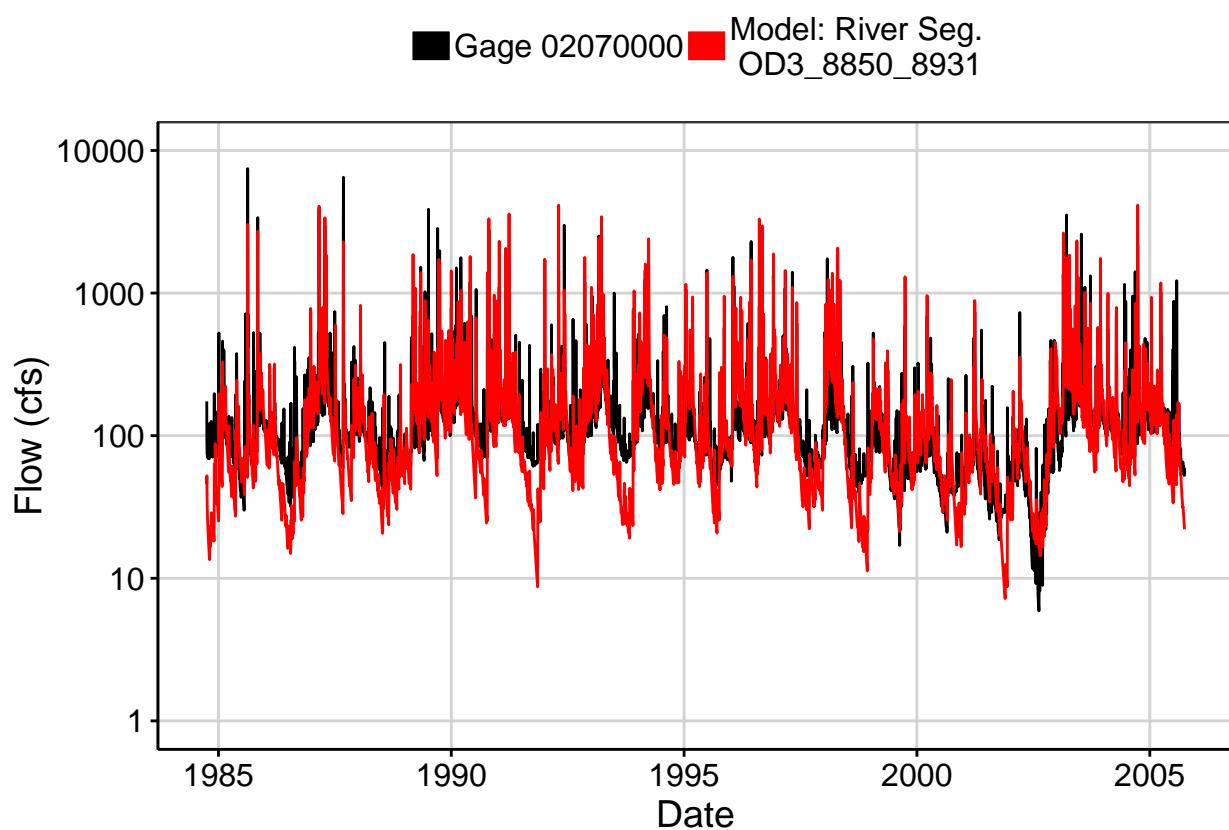


Fig. 2: Zoomed Hydrograph

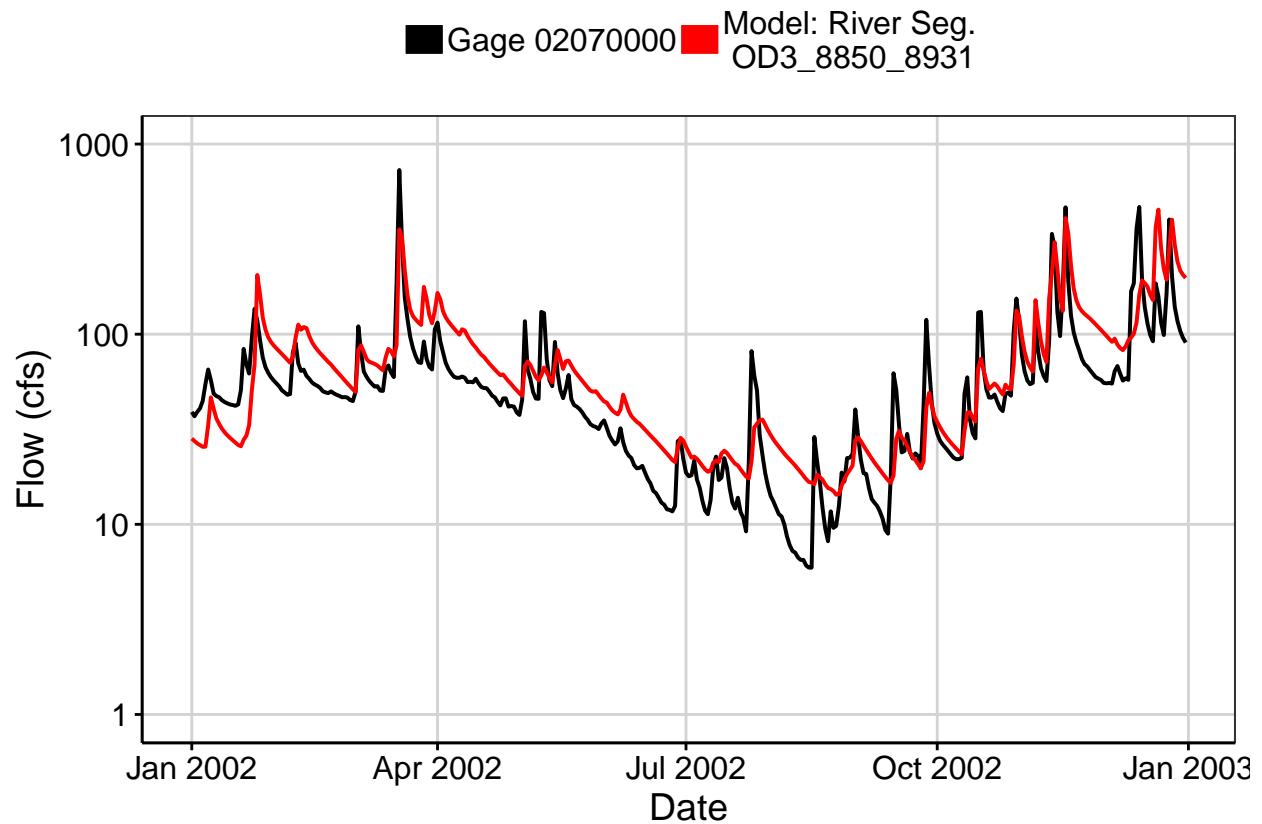


Fig. 3: Flow Exceedance

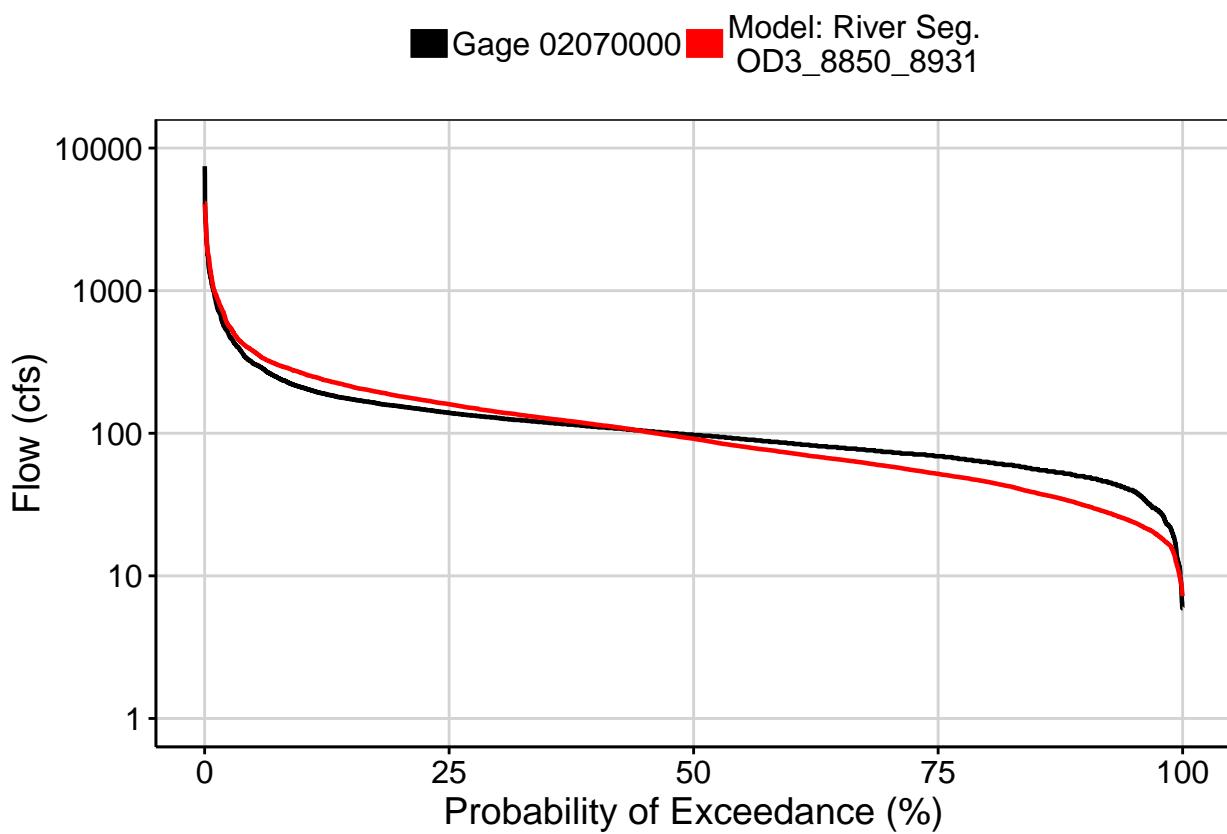


Fig. 4: Baseflow

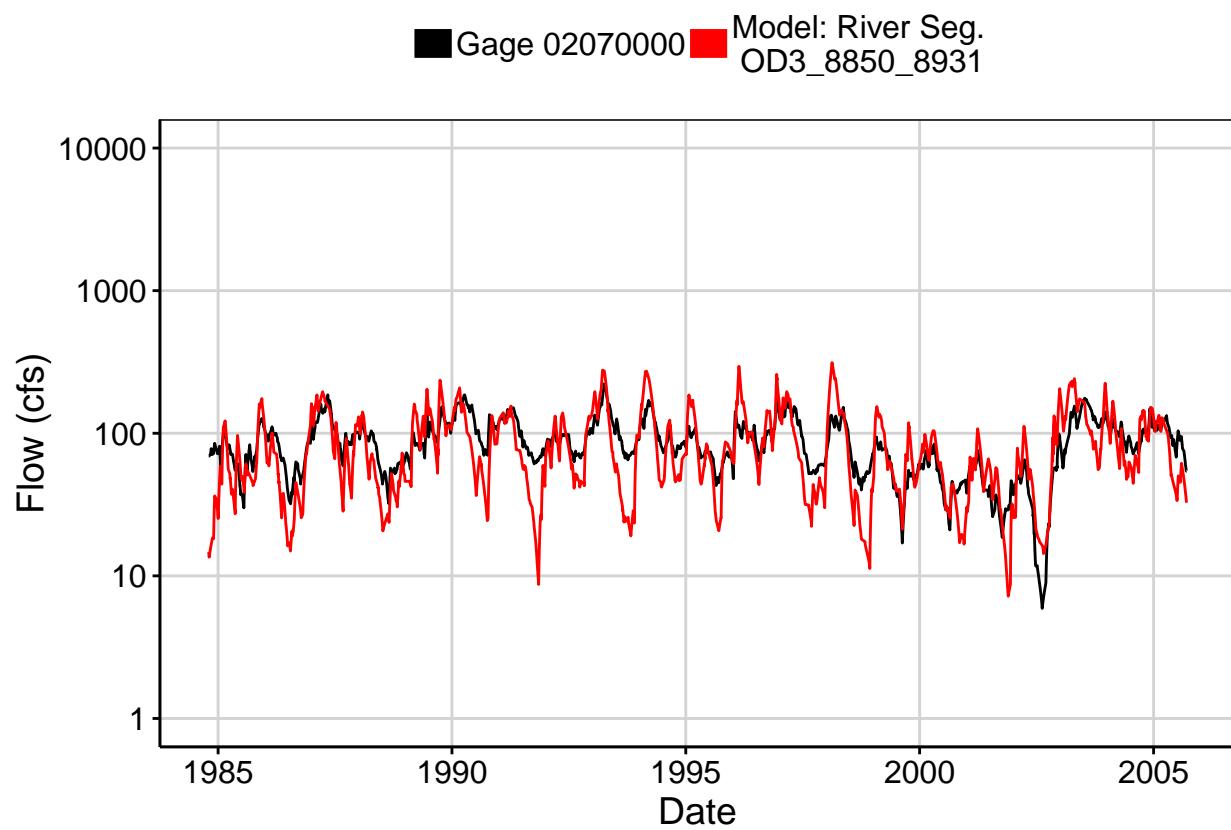


Fig. 5: Combined Baseflow

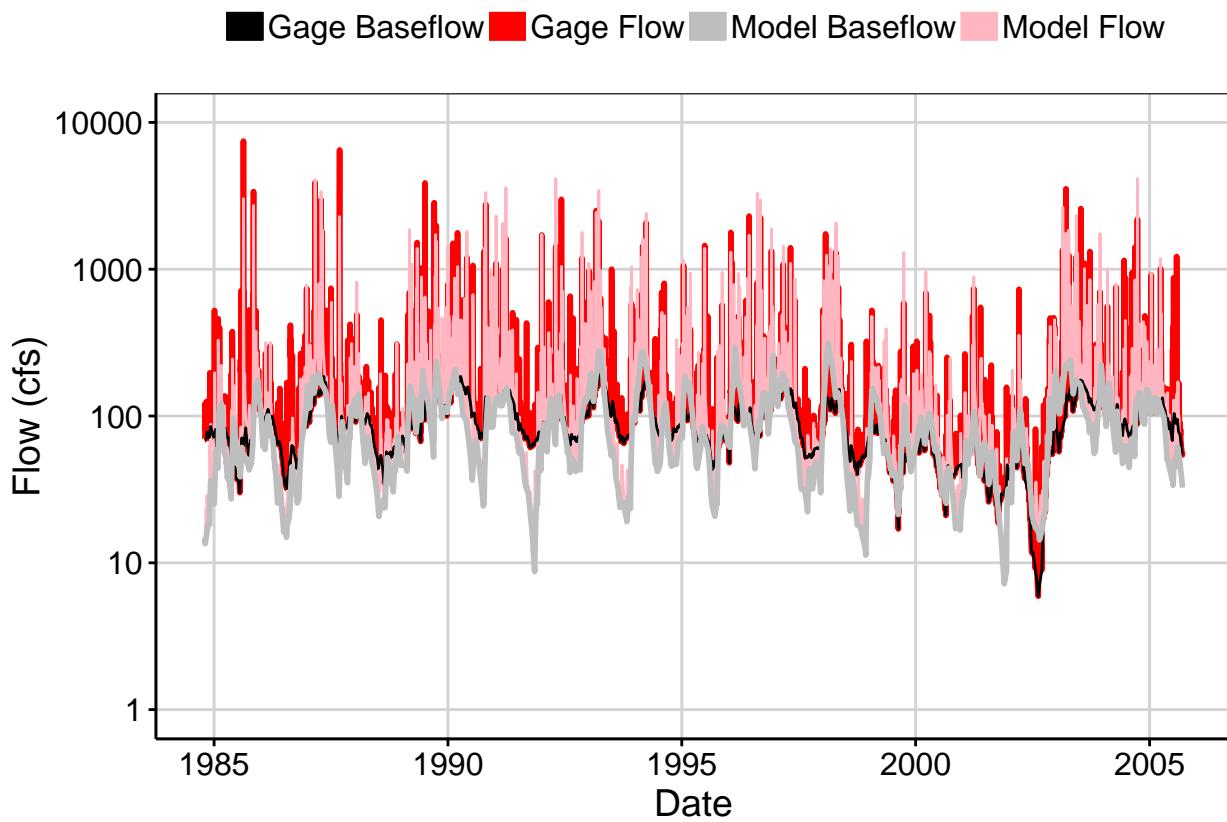


Fig. 6: Largest Error Segment

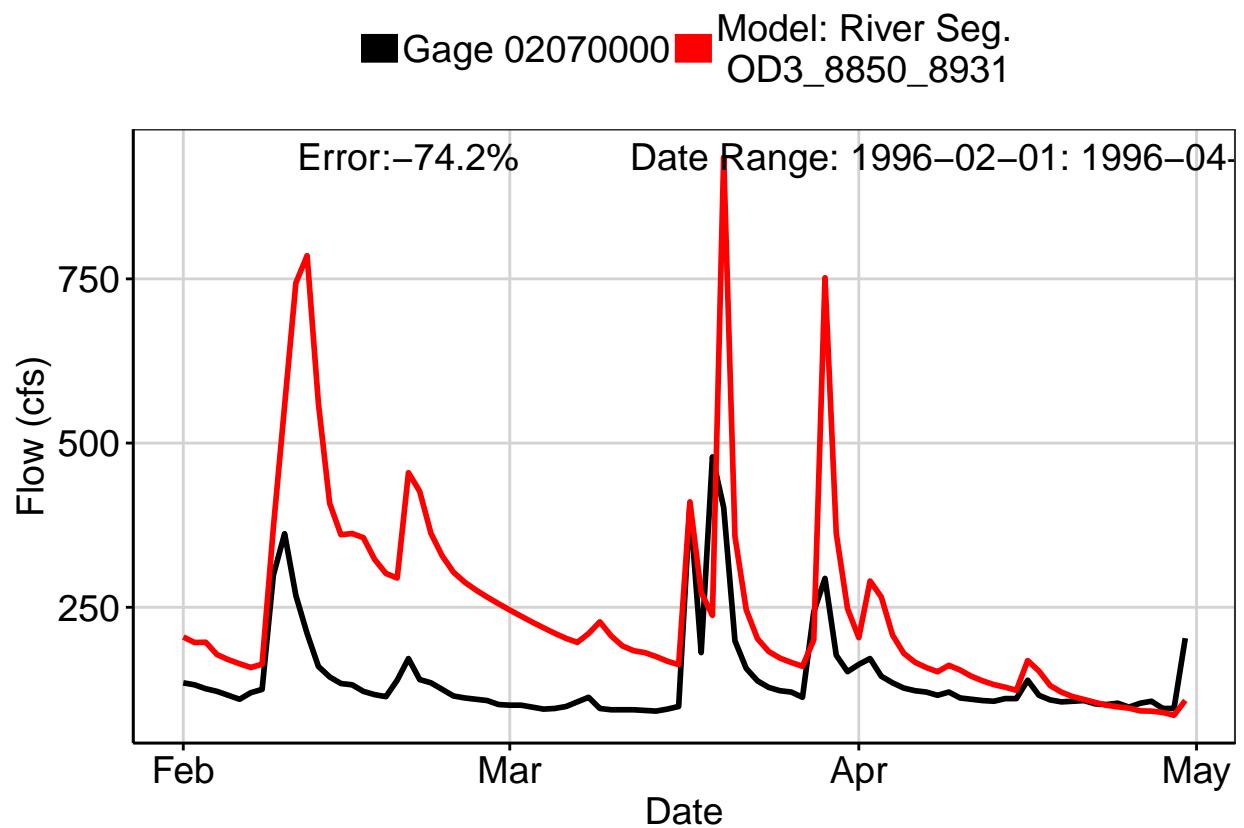


Fig. 7: Second Largest Error Segment

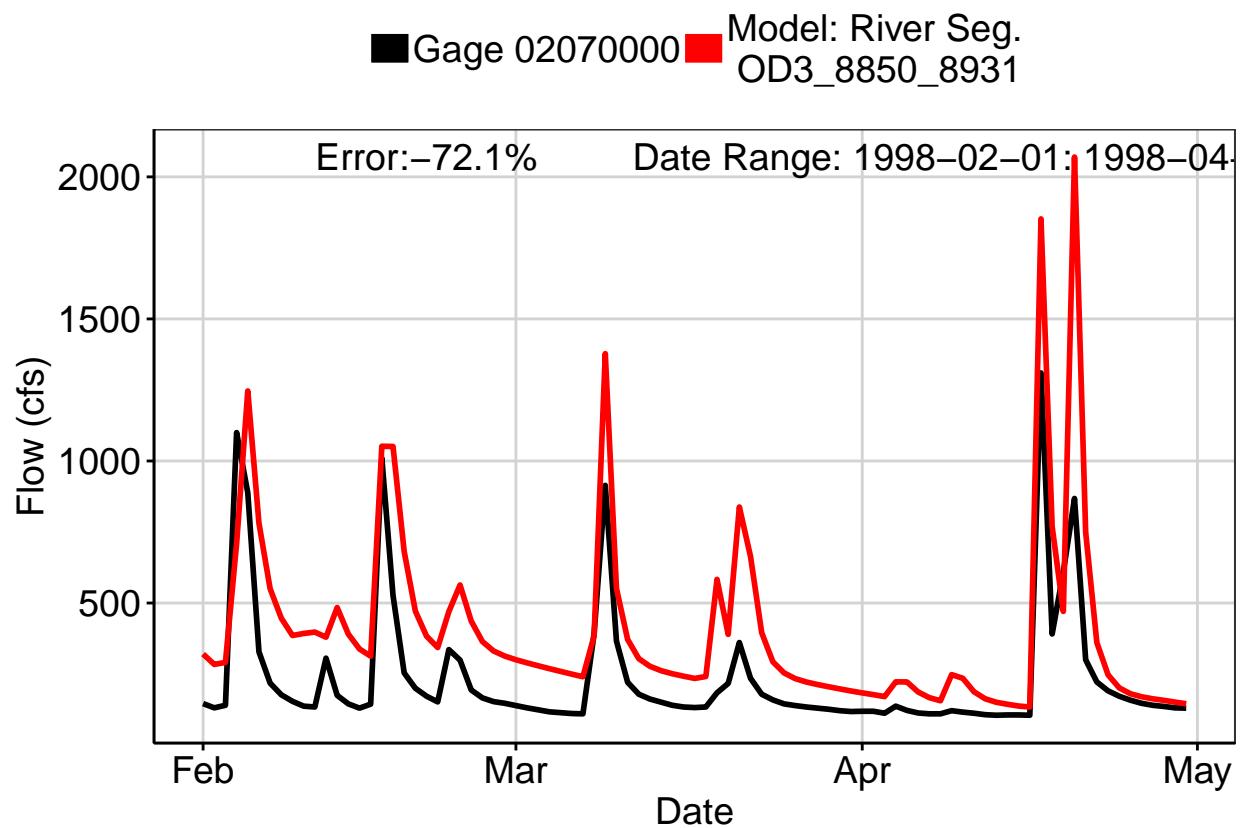


Fig. 8: Third Largest Error Segment

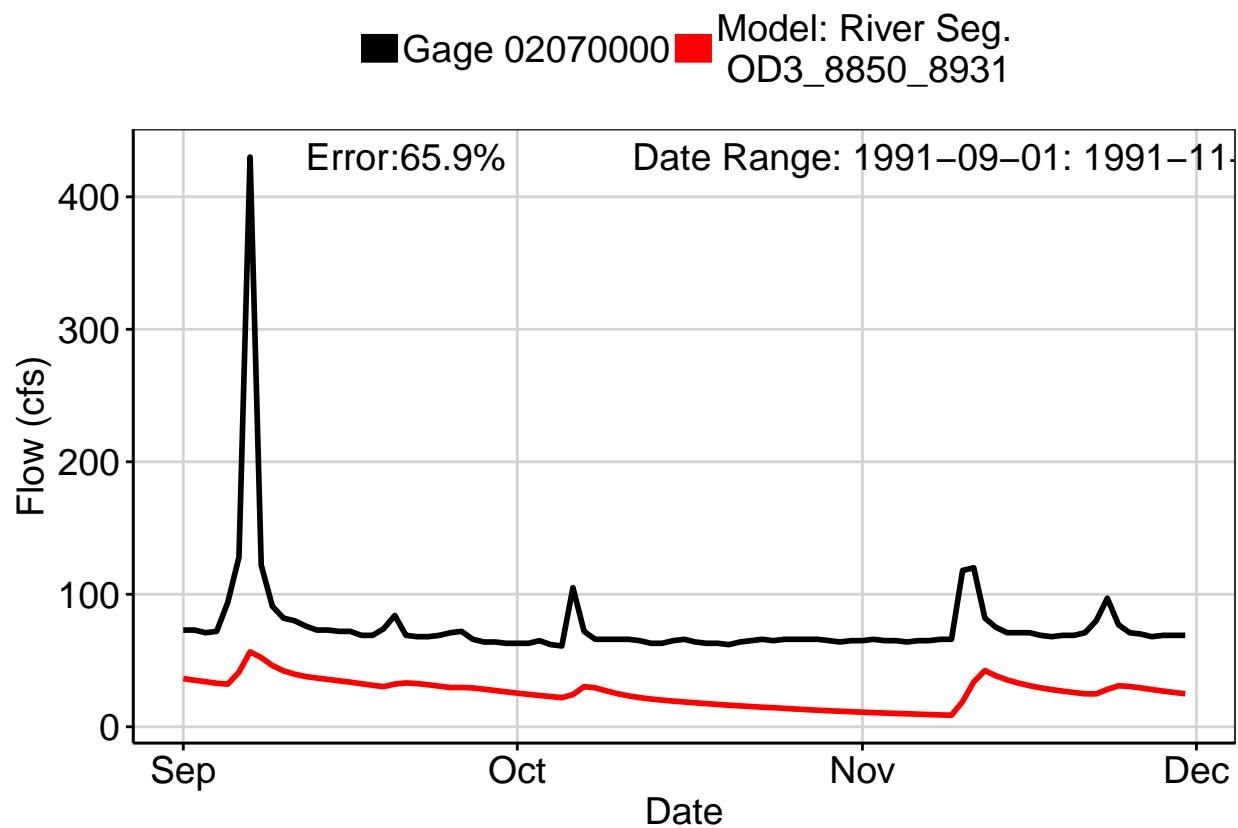
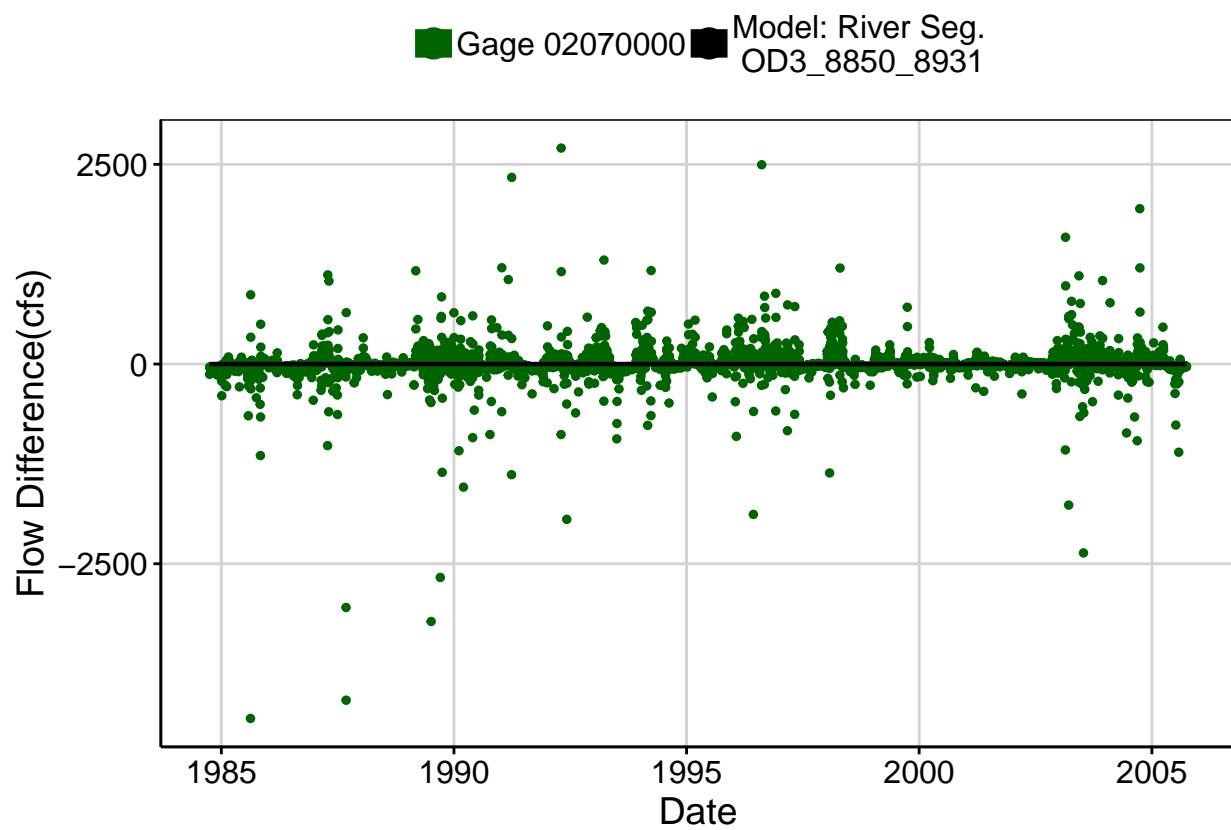
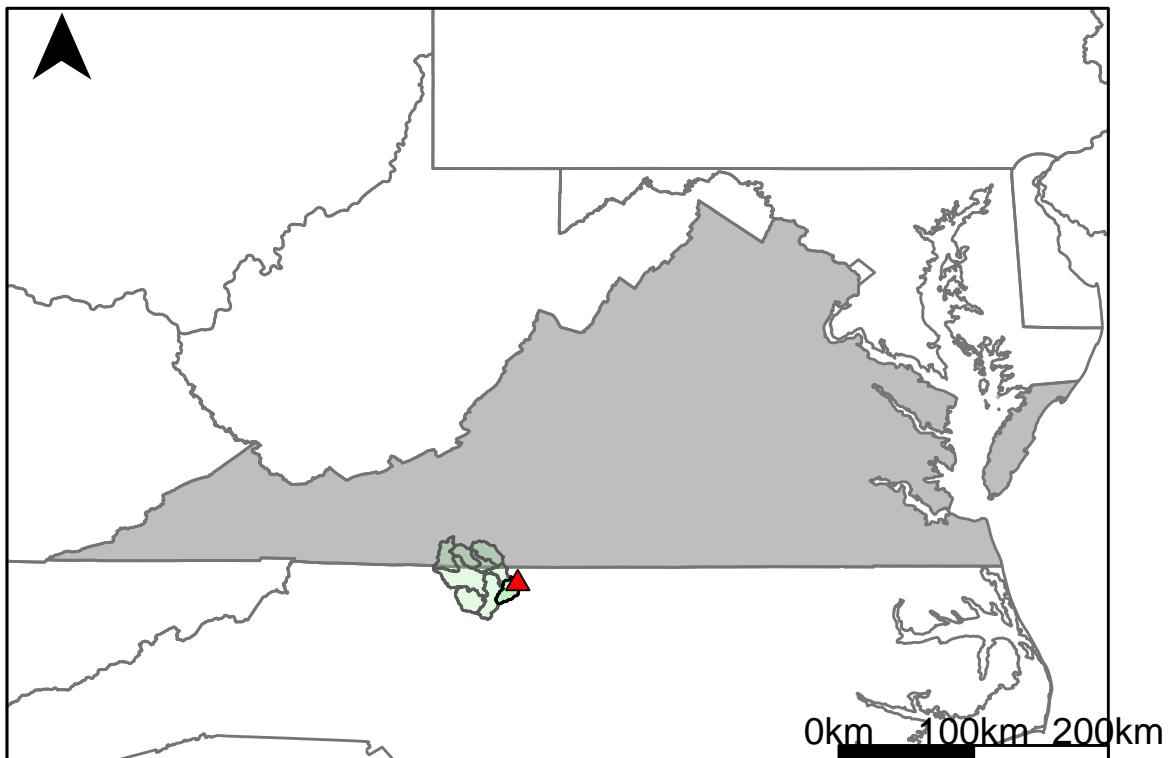


Fig. 9: Residuals Plot



## Appendix C.4: USGS Gage 02071000 vs. OD4\_9140\_8990



This river segment follows part of the flow of the Dan River, a tributary of the Roanoke River. The gage is located in Rockingham County, NC (Lat 36°24'45", Long 79°49'34") approximately 27 miles southwest of Danville, VA. Drainage area is 1053 sq. miles. This gage started taking data in 1939 and is still taking data. There are slight diurnal fluctuations and regulations at low flow stages caused by the Talbott and Townes reservoirs. The average daily discharge error between the model and gage data for the 20 year timespan was -1.72%, with 34.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	424	275	35.1
Feb. Low Flow	510	367	28
Mar. Low Flow	591	549	7.11
Apr. Low Flow	618	658	-6.47
May Low Flow	814	967	-18.8
Jun. Low Flow	880	952	-8.18
Jul. Low Flow	804	812	-1
Aug. Low Flow	715	699	2.24
Sep. Low Flow	632	558	11.7
Oct. Low Flow	488	448	8.2
Nov. Low Flow	391	387	1.02
Dec. Low Flow	338	311	7.99

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	1160	1180	-1.72
Jan. Mean Flow	1340	1390	-3.73
Feb. Mean Flow	1410	1570	-11.3
Mar. Mean Flow	1890	2150	-13.8
Apr. Mean Flow	1630	1780	-9.2
May Mean Flow	1220	1230	-0.82
Jun. Mean Flow	1070	1090	-1.87
Jul. Mean Flow	884	716	19
Aug. Mean Flow	827	778	5.93
Sep. Mean Flow	887	929	-4.74
Oct. Mean Flow	811	781	3.7
Nov. Mean Flow	895	819	8.49
Dec. Mean Flow	1050	1010	3.81

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	1020	778	23.7
Feb. High Flow	2070	2110	-1.93
Mar. High Flow	3190	2120	33.5
Apr. High Flow	3940	4000	-1.52
May High Flow	4230	2650	37.4
Jun. High Flow	6330	6460	-2.05
Jul. High Flow	2880	3540	-22.9
Aug. High Flow	2130	2600	-22.1
Sep. High Flow	1810	1310	27.6
Oct. High Flow	1520	941	38.1
Nov. High Flow	2060	790	61.7
Dec. High Flow	1300	767	41

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	63	93.4	-48.3
Med. 1 Day Min	297	242	18.5
Min. 3 Day Min	63.7	95.1	-49.3
Med. 3 Day Min	310	244	21.3
Min. 7 Day Min	65.3	99.1	-51.8
Med. 7 Day Min	340	256	24.7
Min. 30 Day Min	99.6	106	-6.43
Med. 30 Day Min	402	324	19.4
Min. 90 Day Min	156	186	-19.2
Med. 90 Day Min	586	435	25.8
7Q10	142	142	0
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	373	1180	-216
Mean Baseflow	709	743	-4.8

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	27800	30900	-11.2
Med. 1 Day Max	15600	13900	10.9
Max. 3 Day Max	18800	19600	-4.26
Med. 3 Day Max	9560	9490	0.73
Max. 7 Day Max	10100	10700	-5.94
Med. 7 Day Max	5590	5550	0.72
Max. 30 Day Max	5040	5720	-13.5
Med. 30 Day Max	2560	2800	-9.38
Max. 90 Day Max	3450	3920	-13.6
Med. 90 Day Max	1630	2030	-24.5

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	172	158	8.14
5% Non-Exceedance	296	231	22
50% Non-Exceedance	797	771	3.26
95% Non-Exceedance	2860	3130	-9.44
99% Non-Exceedance	7510	8260	-9.99
Sept. 10% Non-Exceedance	295	292	1.02

**Fig. 1: Hydrograph**

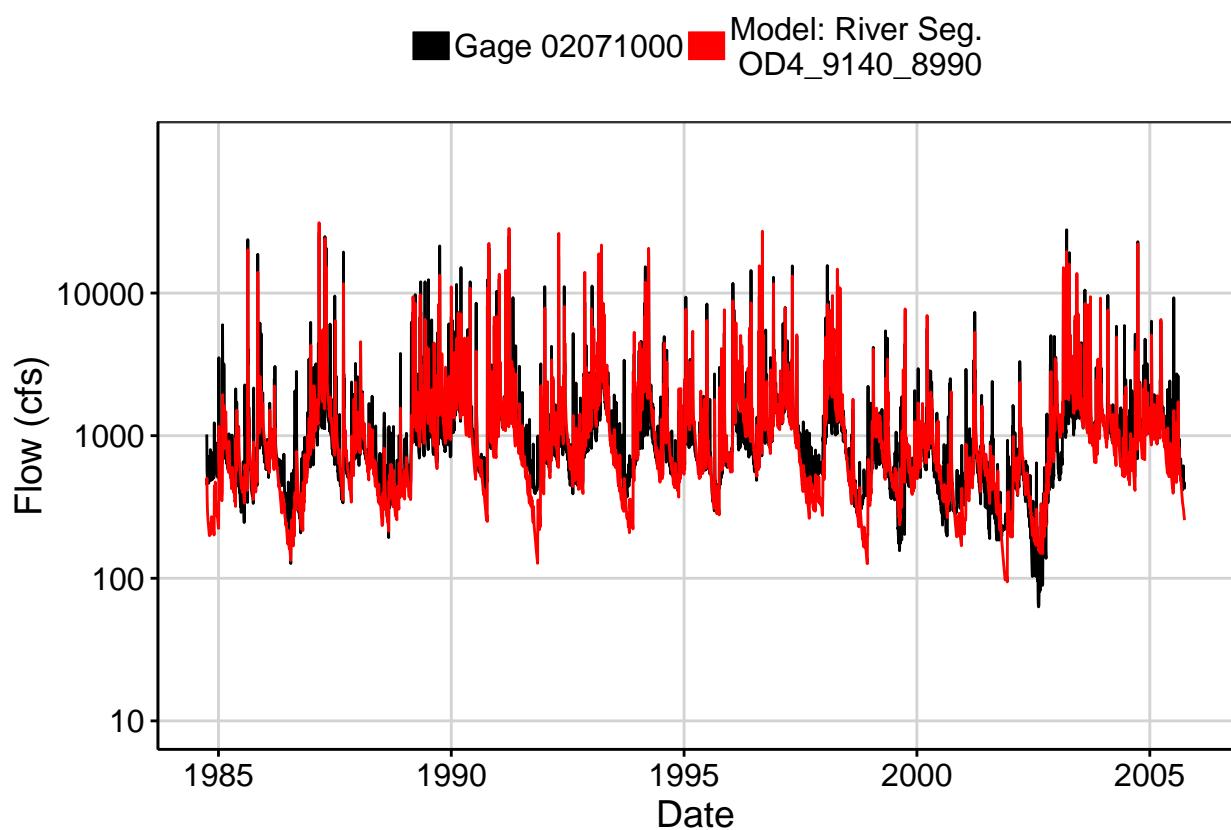


Fig. 2: Zoomed Hydrograph

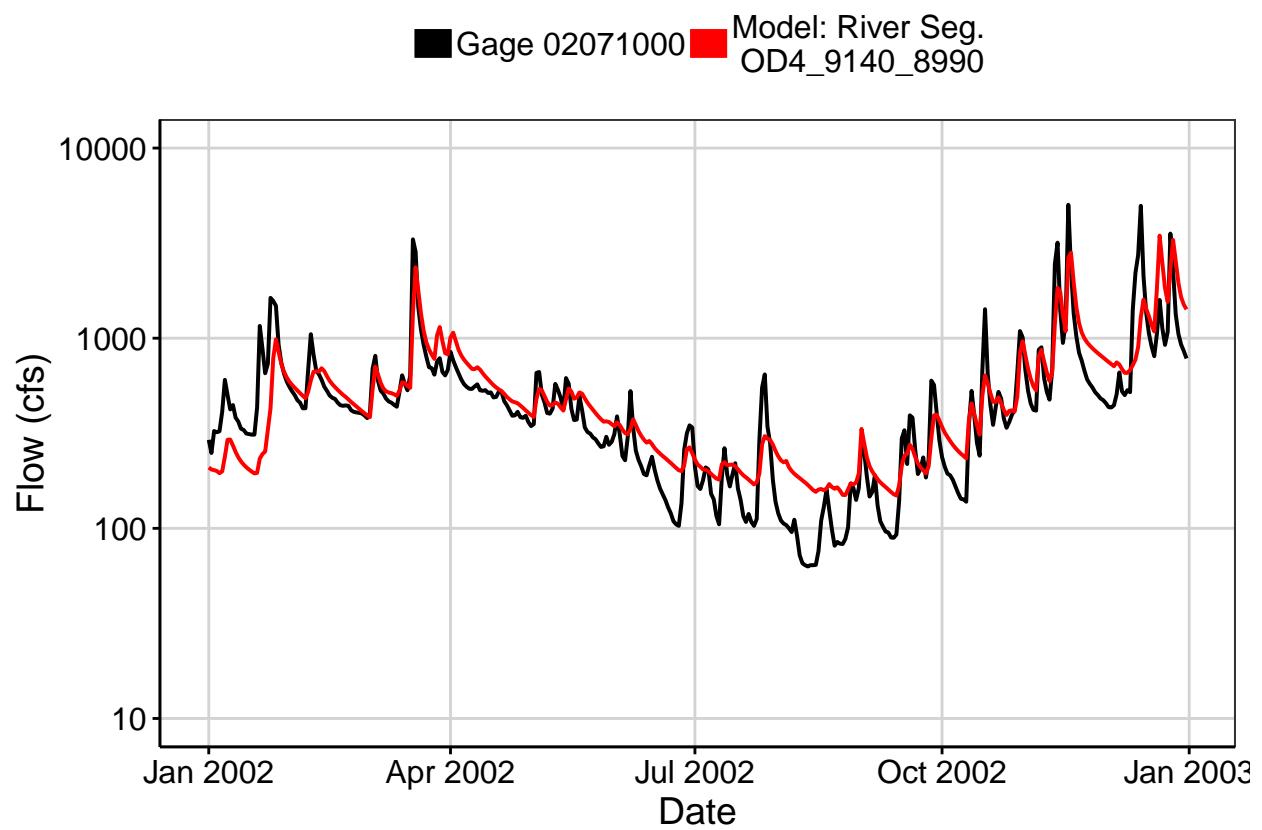


Fig. 3: Flow Exceedance

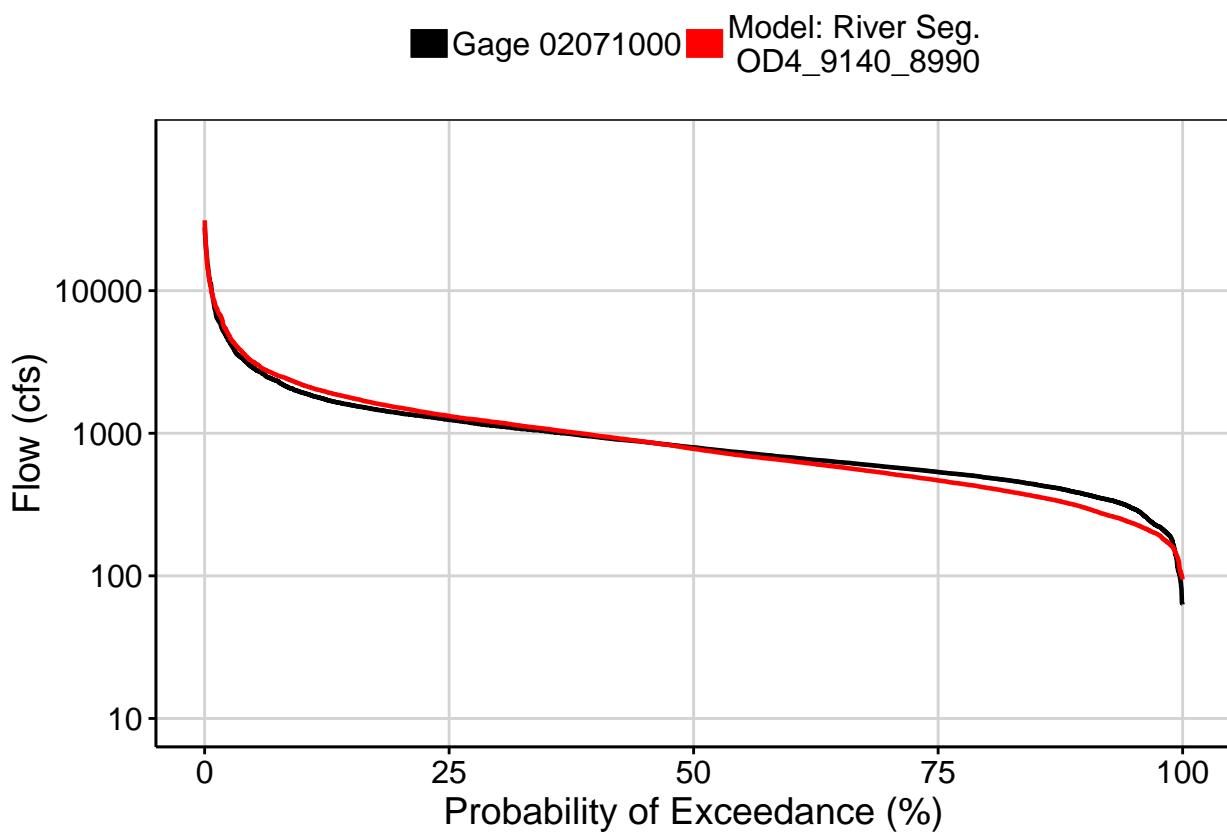
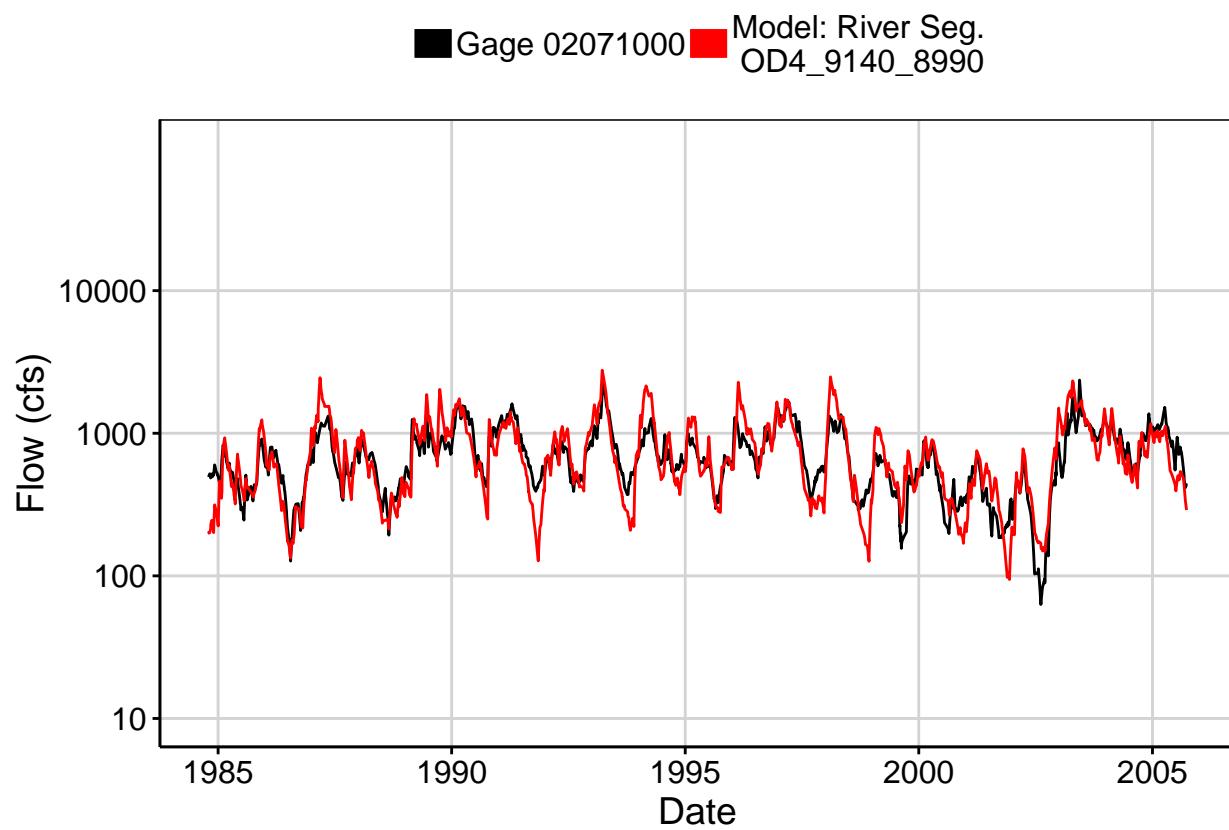


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

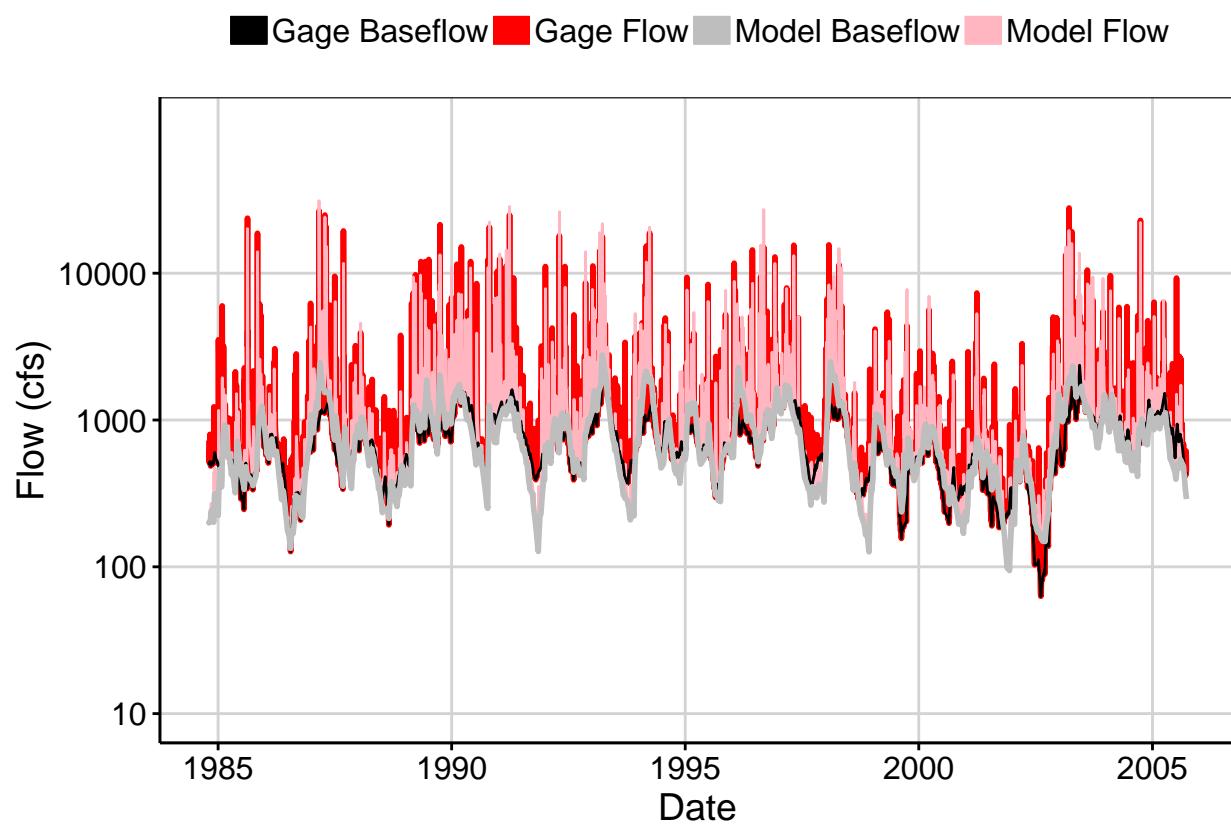


Fig. 6: Largest Error Segment

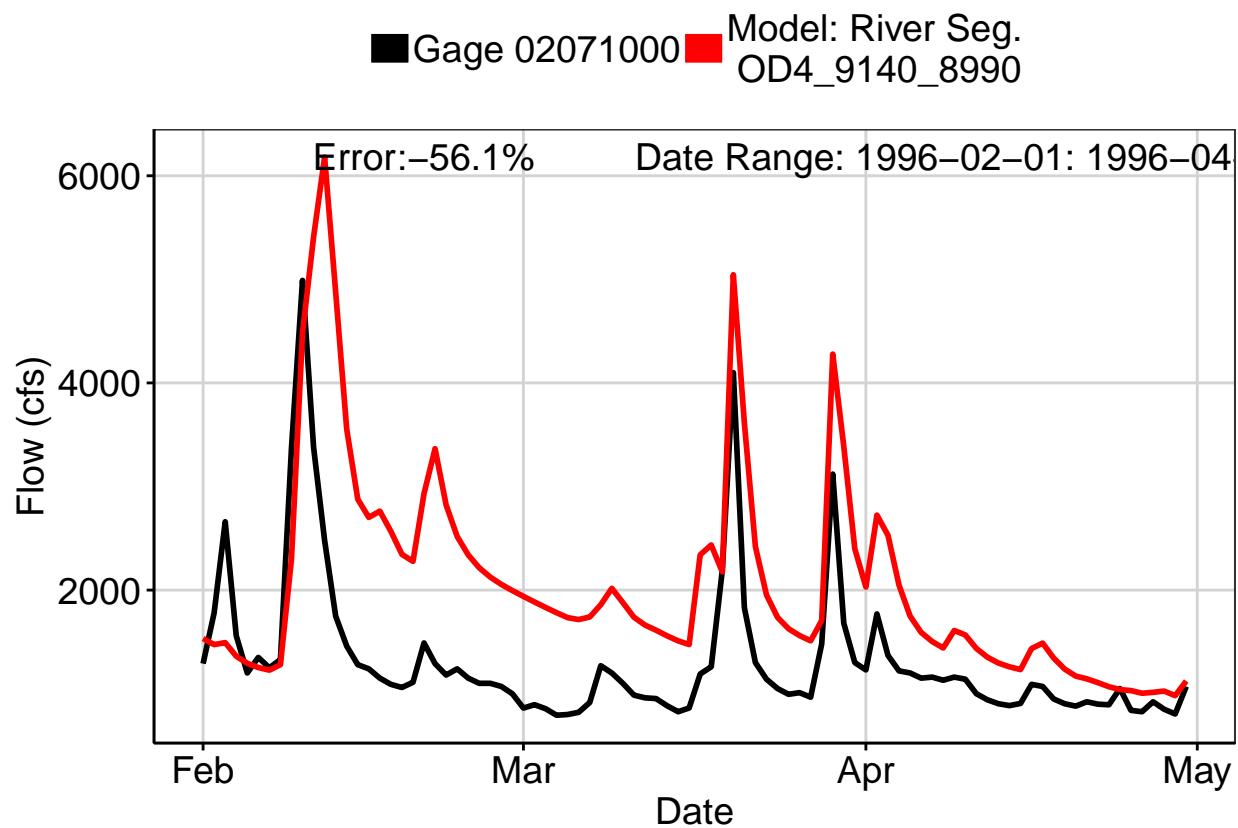


Fig. 7: Second Largest Error Segment

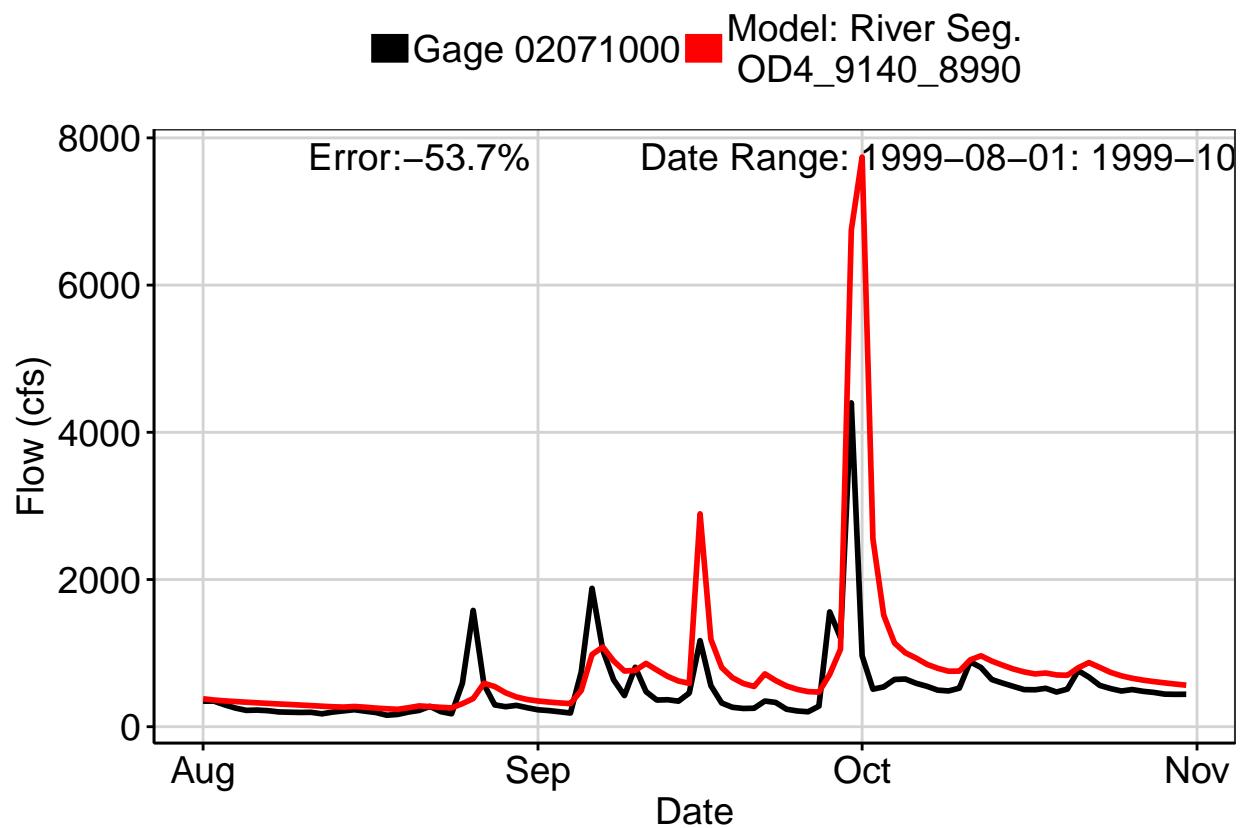


Fig. 8: Third Largest Error Segment

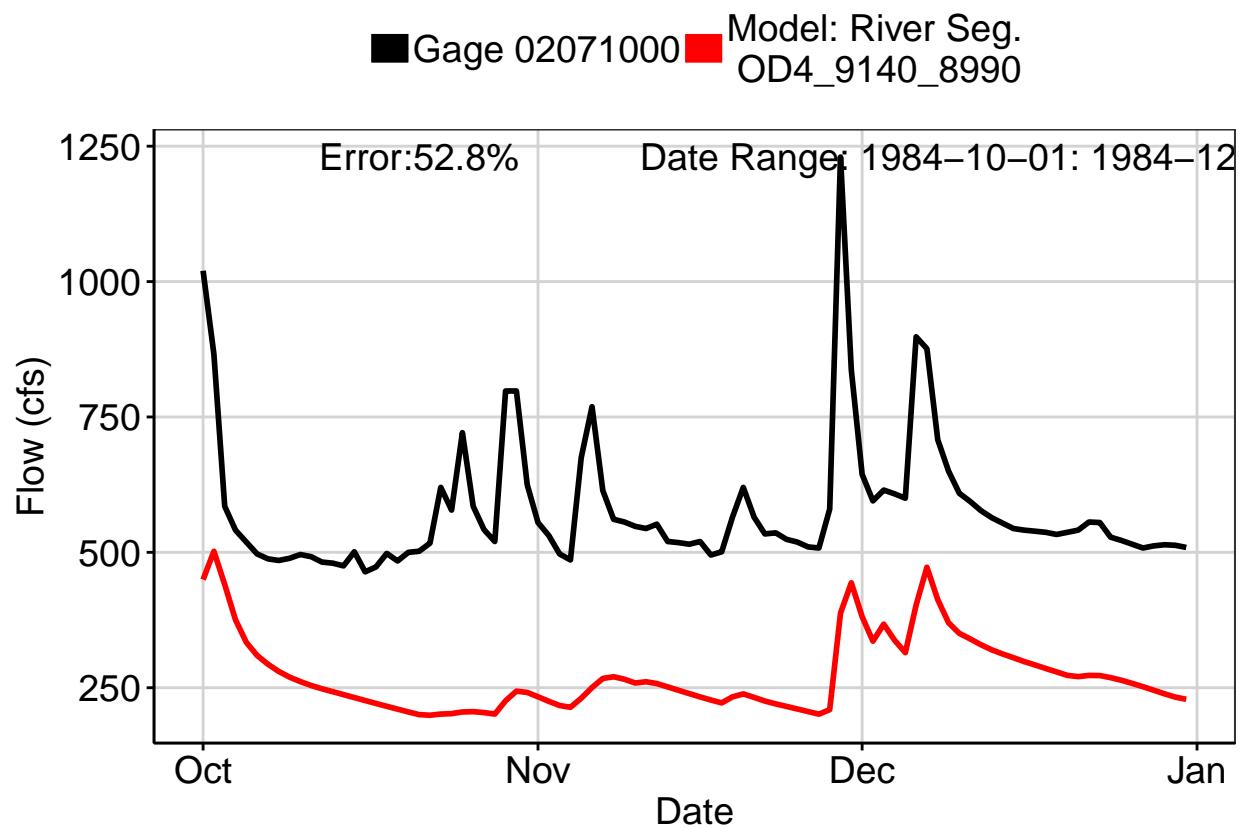
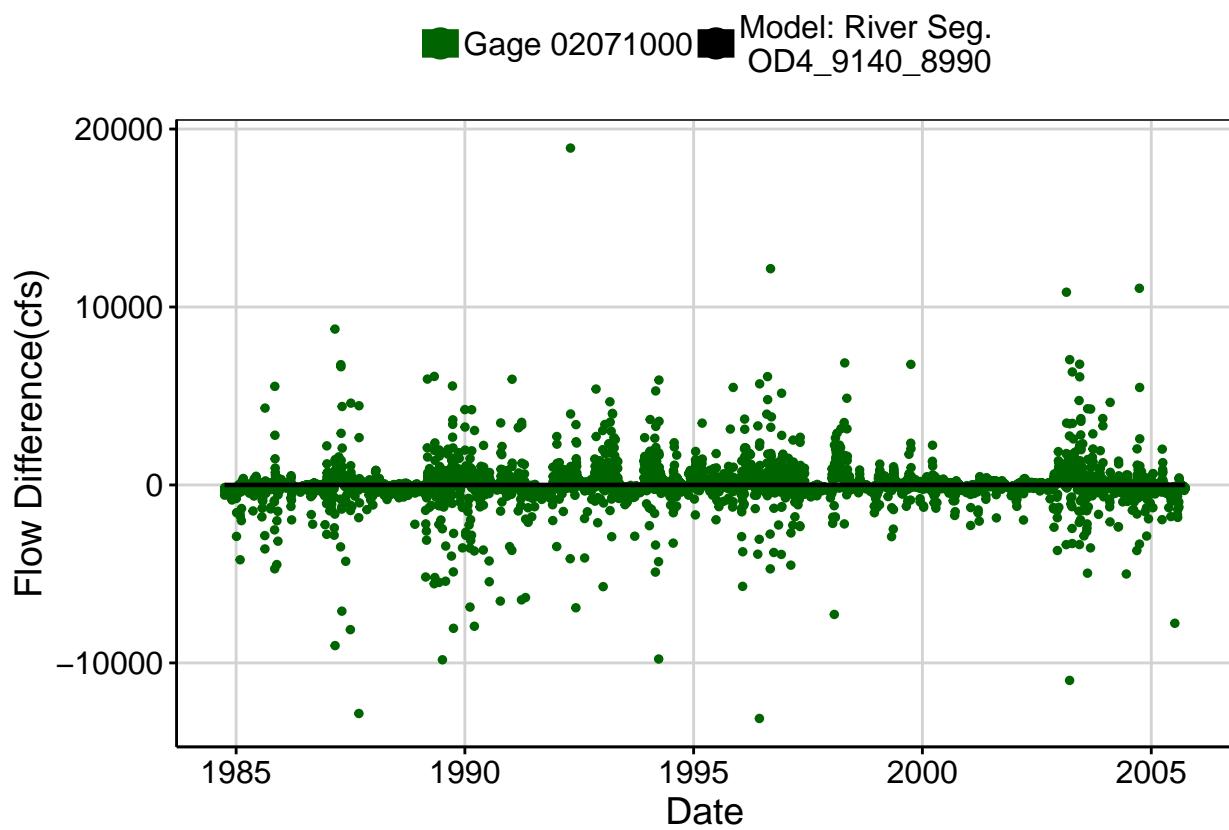
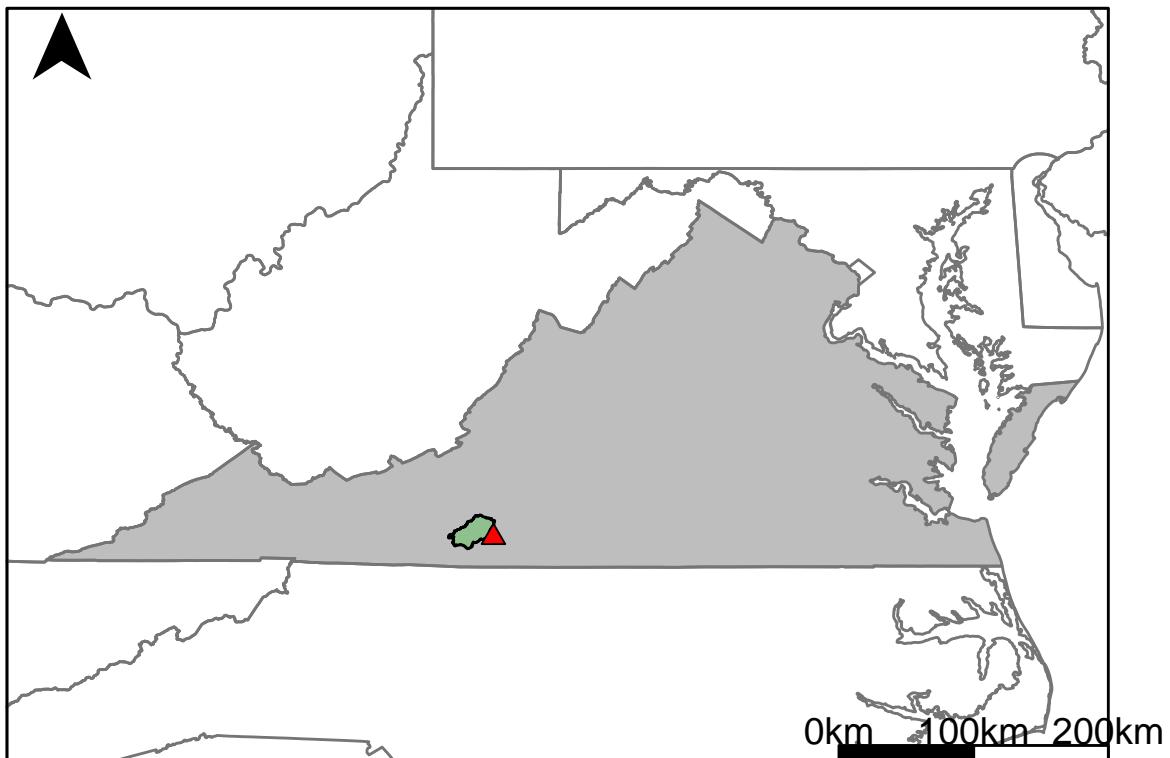


Fig. 9: Residuals Plot



## Appendix C.5: USGS Gage 02072000 vs. OD2\_8560\_8630



This river segment follows part of the flow of the Smith River, a tributary of the Dan River. The gage is located in Franklin County, VA (Lat 36°46'50", Long 80°01'30") approximately 10 miles northwest of Martinsville, VA. Drainage area is 215 sq. miles. This gage started taking data in 1946 and is still taking data. The Philpott Dam and Reservoir is located 900 ft upstream. The average daily discharge error between the model and gage data for the 20 year timespan was -5.71%, with 38.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	50	47.6	4.8
Feb. Low Flow	51	47.7	6.47
Mar. Low Flow	50	47.7	4.6
Apr. Low Flow	49	49.2	-0.41
May Low Flow	51	51.5	-0.98
Jun. Low Flow	49	51.9	-5.92
Jul. Low Flow	50	49.9	0.2
Aug. Low Flow	50	50.1	-0.2
Sep. Low Flow	50	49.6	0.8
Oct. Low Flow	51	49.3	3.33
Nov. Low Flow	50	48	4
Dec. Low Flow	49	47.6	2.86

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	280	296	-5.71
Jan. Mean Flow	292	267	8.56
Feb. Mean Flow	270	330	-22.2
Mar. Mean Flow	340	433	-27.4
Apr. Mean Flow	391	446	-14.1
May Mean Flow	301	340	-13
Jun. Mean Flow	305	311	-1.97
Jul. Mean Flow	259	244	5.79
Aug. Mean Flow	273	228	16.5
Sep. Mean Flow	269	239	11.2
Oct. Mean Flow	216	245	-13.4
Nov. Mean Flow	221	232	-4.98
Dec. Mean Flow	228	246	-7.89

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	248	214	13.7
Feb. High Flow	238	221	7.14
Mar. High Flow	263	267	-1.52
Apr. High Flow	612	466	23.9
May High Flow	468	530	-13.2
Jun. High Flow	632	687	-8.7
Jul. High Flow	673	686	-1.93
Aug. High Flow	728	559	23.2
Sep. High Flow	562	447	20.5
Oct. High Flow	417	296	29
Nov. High Flow	419	285	32
Dec. High Flow	412	261	36.7

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	38	45.2	-18.9
Med. 1 Day Min	46	45.8	0.44
Min. 3 Day Min	44	68.1	-54.8
Med. 3 Day Min	62	84.2	-35.8
Min. 7 Day Min	60.6	93.6	-54.5
Med. 7 Day Min	93.3	129	-38.3
Min. 30 Day Min	69.8	93.4	-33.8
Med. 30 Day Min	128	126	1.56
Min. 90 Day Min	72.5	102	-40.7
Med. 90 Day Min	143	155	-8.39
7Q10	67.7	102	-50.7
Year of 90-Day Min. Flow	2003	1985	100
Drought Year Mean	409	296	27.6
Mean Baseflow	57.5	54.4	5.39

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	5710	2620	54.1
Med. 1 Day Max	1370	1300	5.11
Max. 3 Day Max	4300	2010	53.3
Med. 3 Day Max	1270	1130	11
Max. 7 Day Max	2380	1650	30.7
Med. 7 Day Max	1100	752	31.6
Max. 30 Day Max	1200	1320	-10
Med. 30 Day Max	628	564	10.2
Max. 90 Day Max	839	908	-8.22
Med. 90 Day Max	438	492	-12.3

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	44	45.7	-3.86
5% Non-Exceedance	47	48.4	-2.98
50% Non-Exceedance	202	217	-7.43
95% Non-Exceedance	760	742	2.37
99% Non-Exceedance	1350	1310	2.96
Sept. 10% Non-Exceedance	49.9	49.7	0.4

**Fig. 1: Hydrograph**

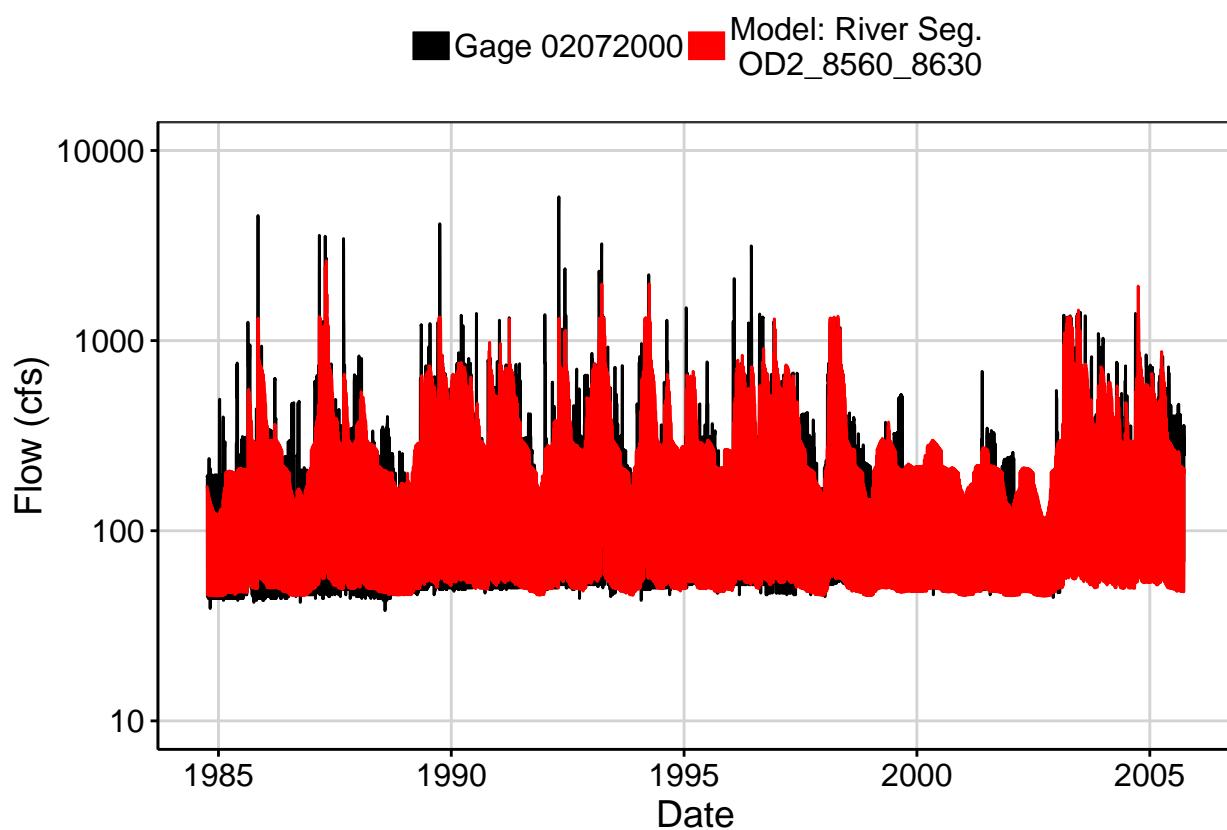


Fig. 2: Zoomed Hydrograph

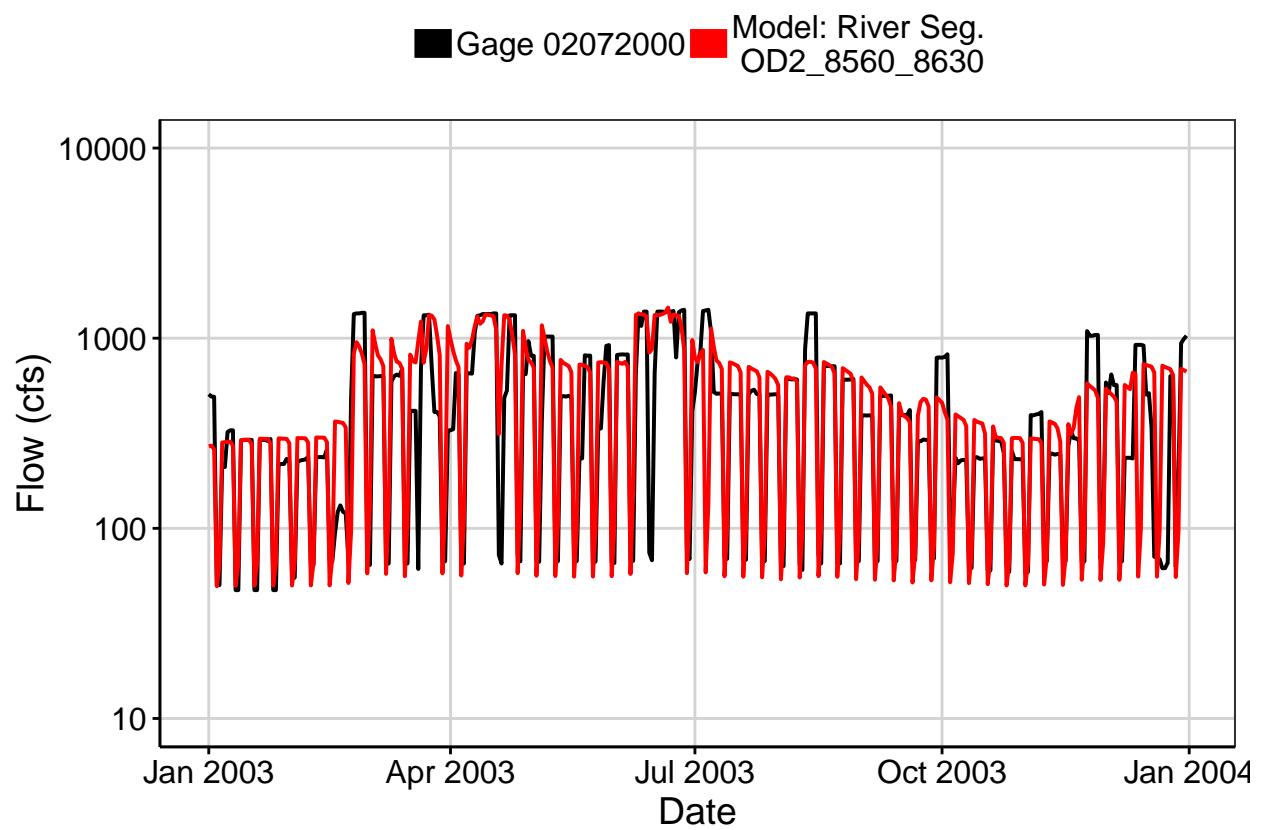


Fig. 3: Flow Exceedance

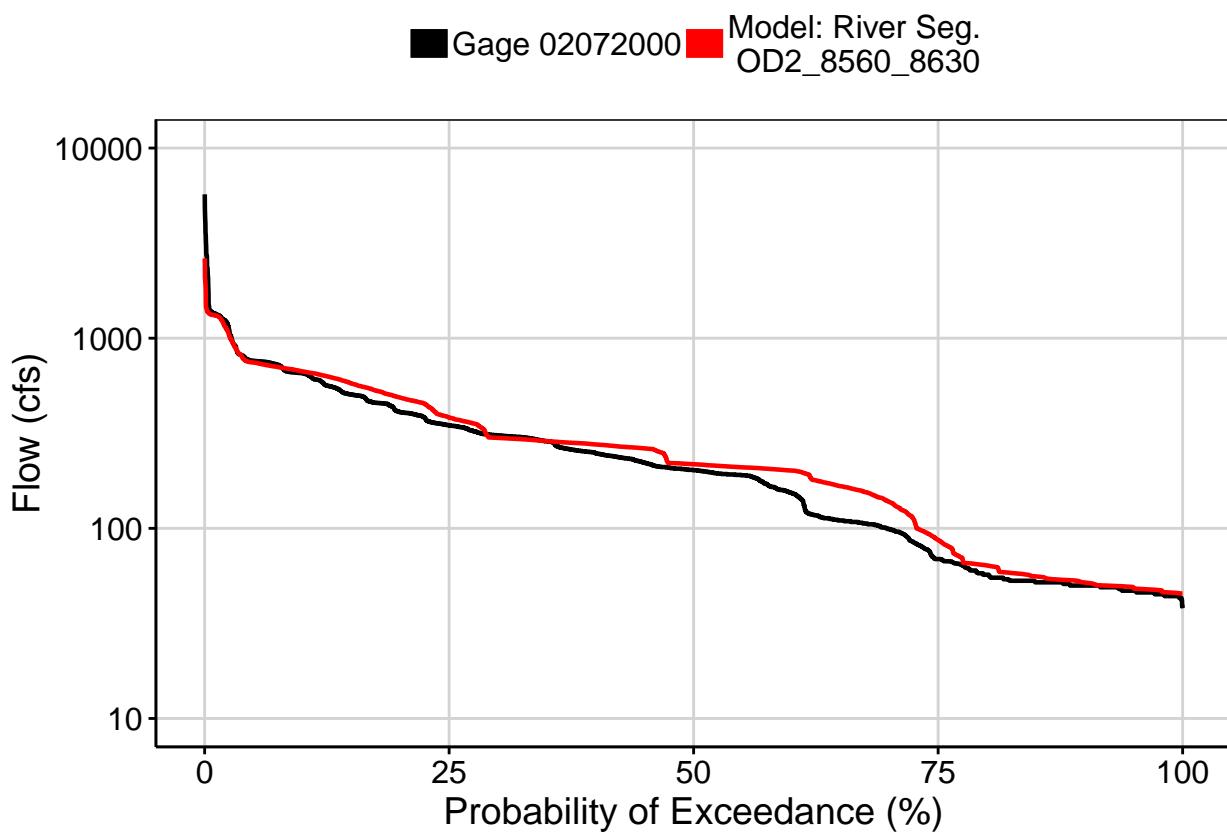


Fig. 4: Baseflow

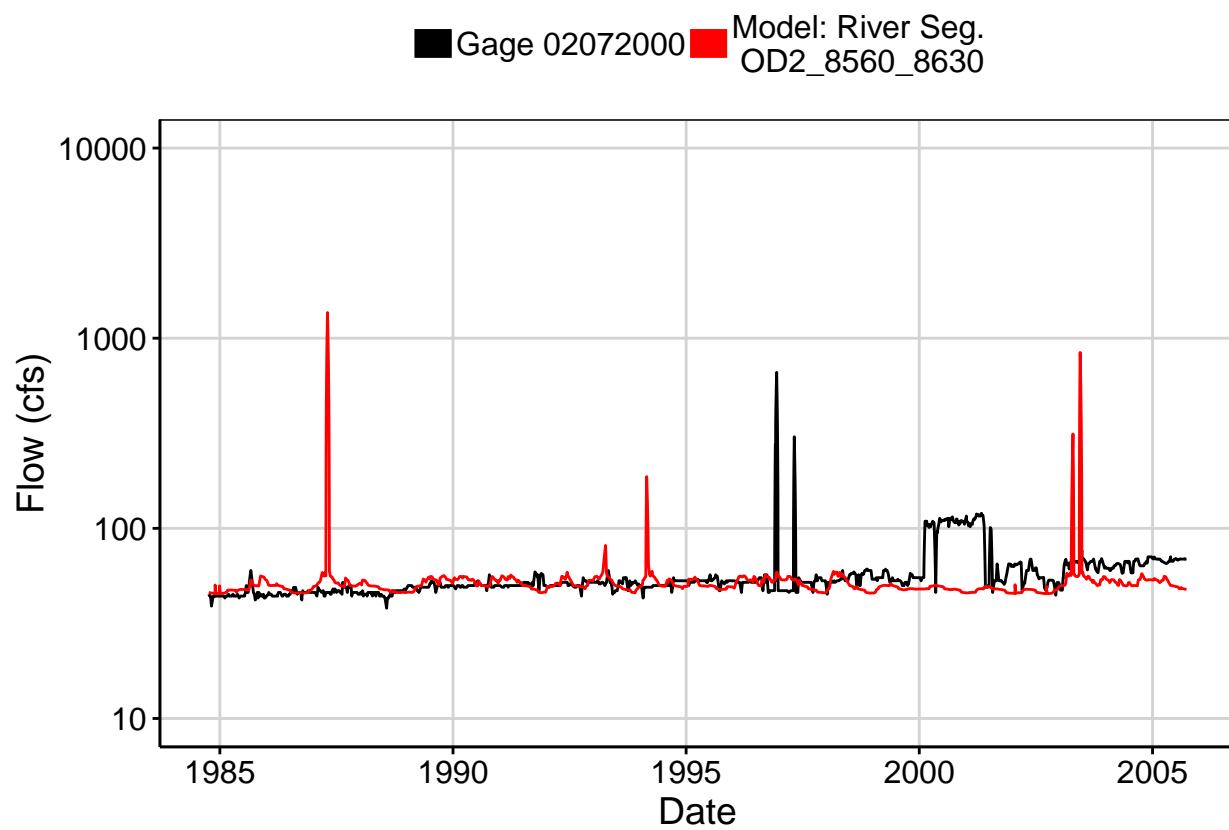


Fig. 5: Combined Baseflow

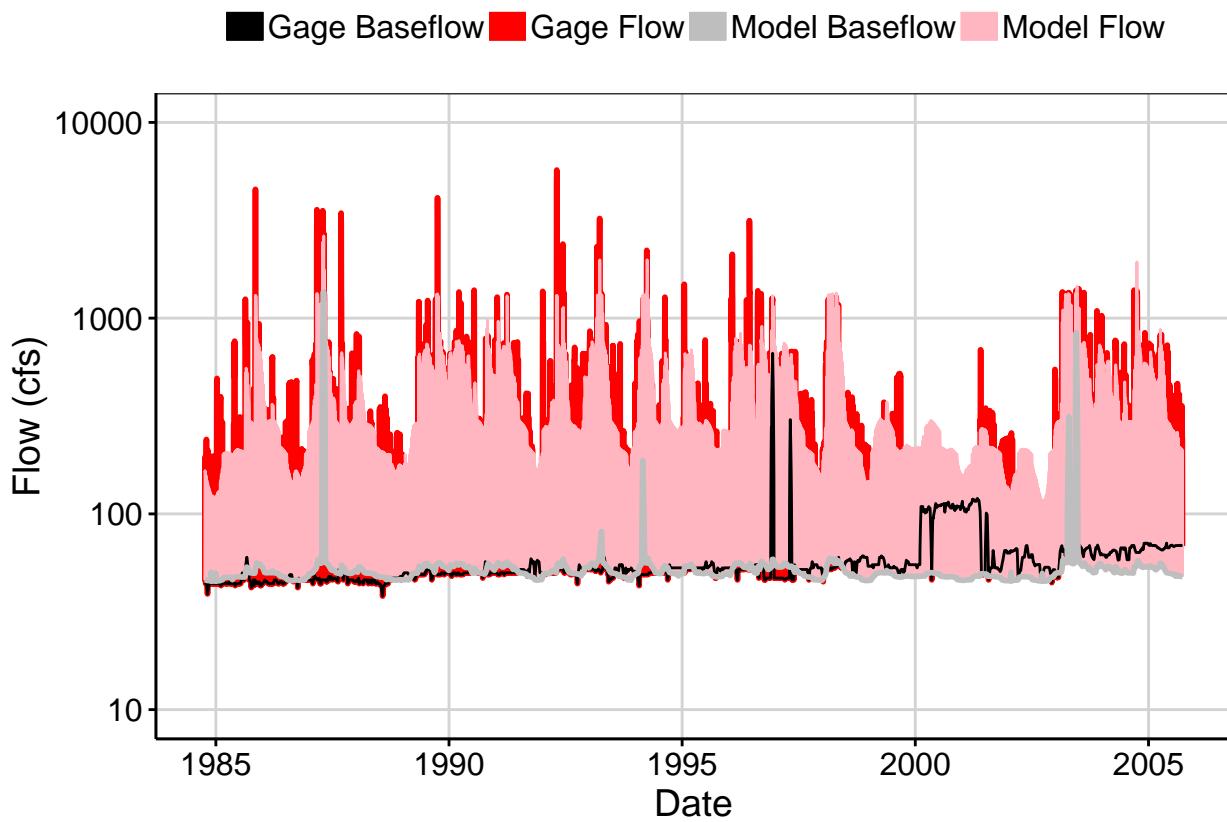


Fig. 6: Largest Error Segment

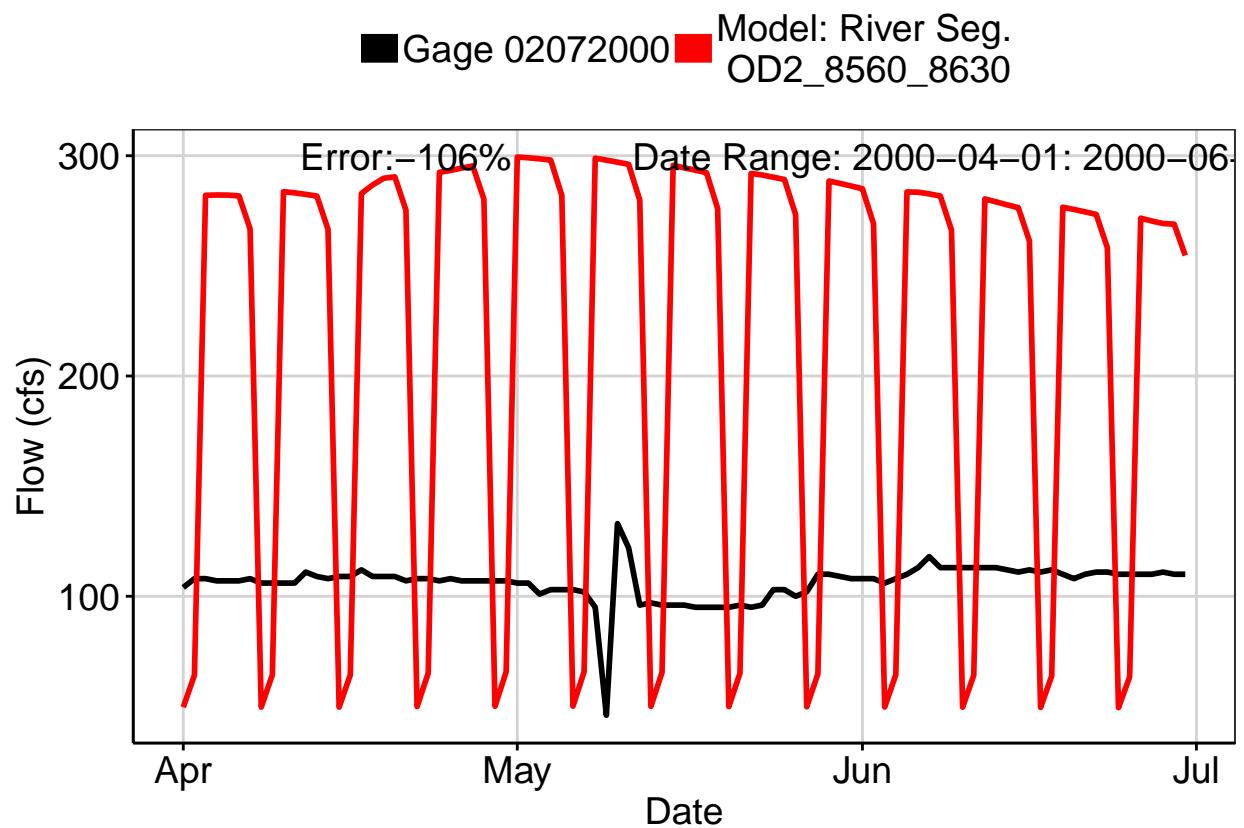


Fig. 7: Second Largest Error Segment

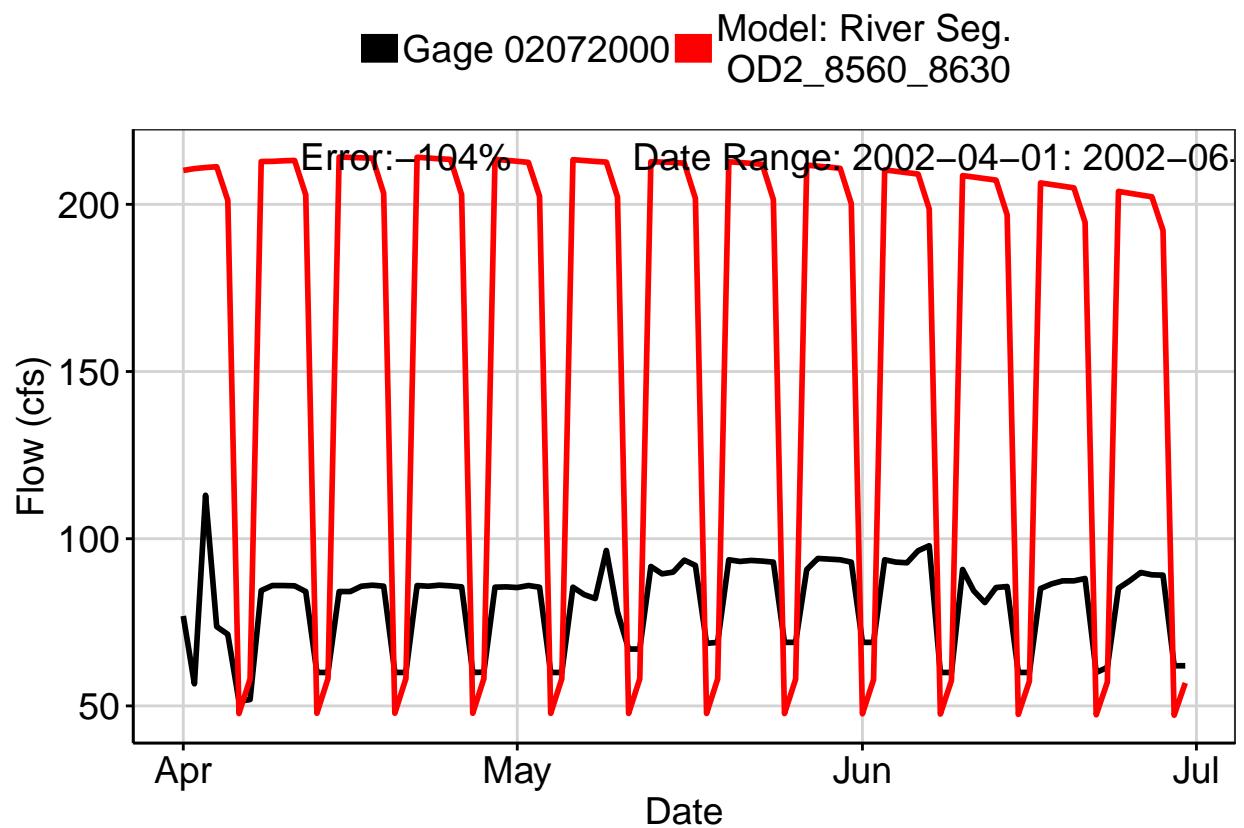


Fig. 8: Third Largest Error Segment

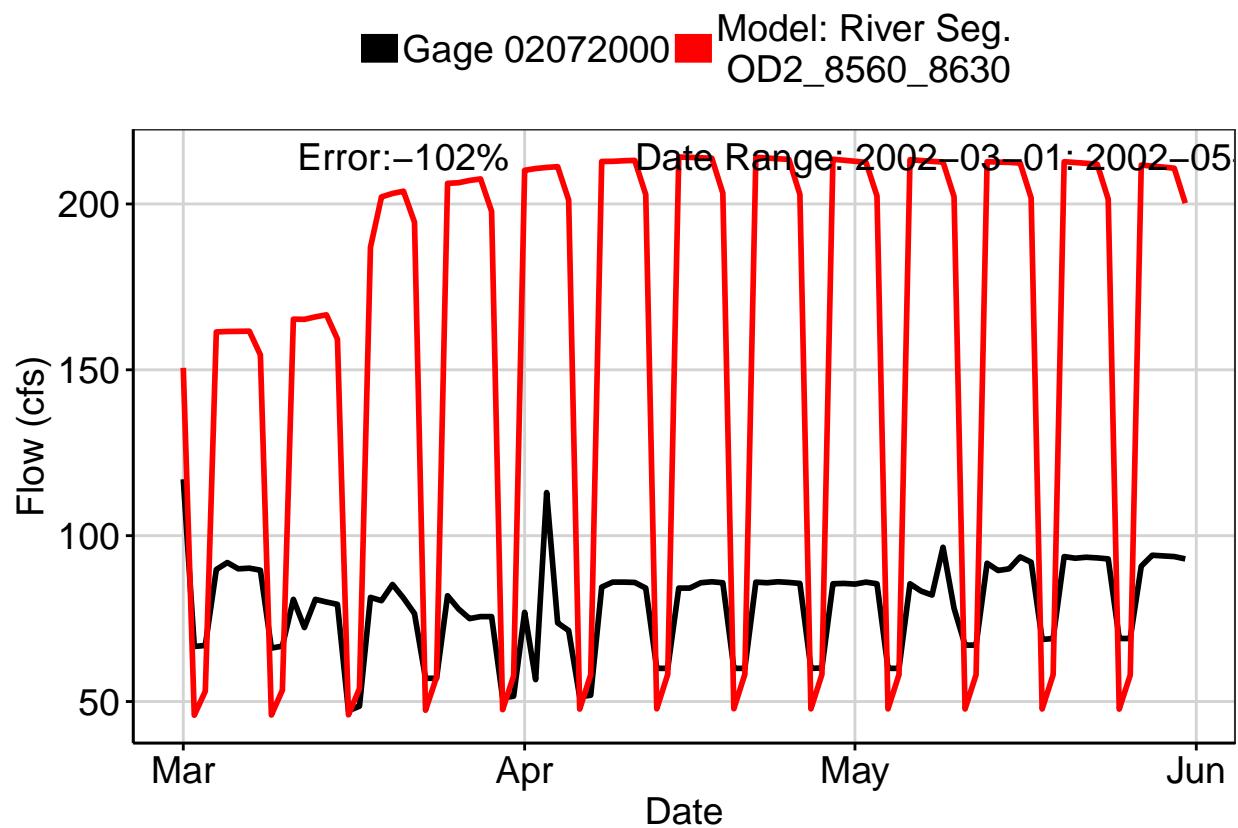
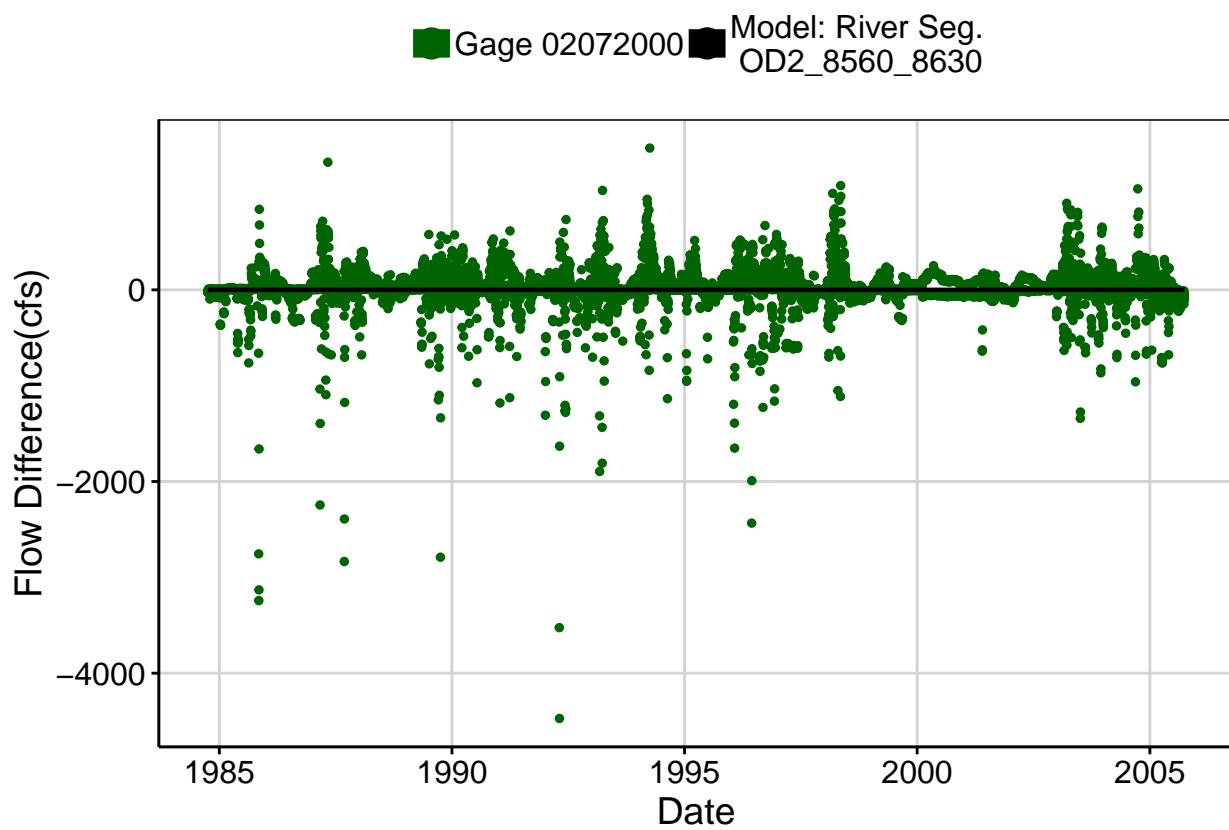
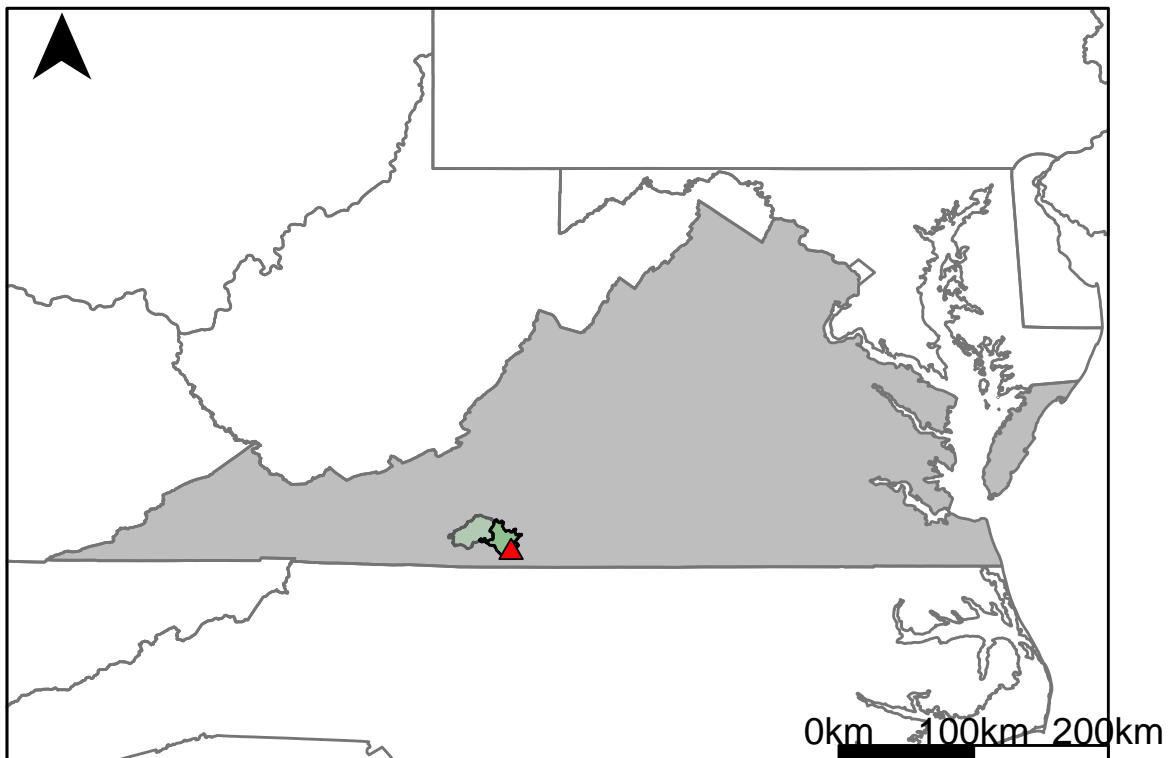


Fig. 9: Residuals Plot



## Appendix C.6: USGS Gage 02073000 vs. OD3\_8630\_8720



This river segment follows part of the flow of the Smith River, a tributary of the Dan River. The gage is located in Henry County, VA (Lat 36°39'40", Long 79°52'51") approximately 2 miles south of Martinsville, VA. Drainage area is 379 sq. miles. This gage started taking data in 1929 and is still taking data. The flow of this area has been regulated since August of 1950 by the Philpott Lake, approximately 20 miles upstream. Additional regulations have since been put in place since the addition of a power plant 1,000 ft upstream. The average daily discharge error between the model and gage data for the 20 year timespan was 13.7%, with 61.3% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	102	57.2	43.9
Feb. Low Flow	127	72.2	43.1
Mar. Low Flow	133	103	22.6
Apr. Low Flow	147	130	11.6
May Low Flow	155	202	-30.3
Jun. Low Flow	160	196	-22.5
Jul. Low Flow	179	121	32.4
Aug. Low Flow	152	104	31.6
Sep. Low Flow	195	68.2	65
Oct. Low Flow	143	55.5	61.2
Nov. Low Flow	116	59.6	48.6
Dec. Low Flow	123	61	50.4

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	526	454	13.7
Jan. Mean Flow	552	482	12.7
Feb. Mean Flow	525	595	-13.3
Mar. Mean Flow	665	773	-16.2
Apr. Mean Flow	685	685	0
May Mean Flow	561	483	13.9
Jun. Mean Flow	576	430	25.3
Jul. Mean Flow	506	295	41.7
Aug. Mean Flow	481	287	40.3
Sep. Mean Flow	529	362	31.6
Oct. Mean Flow	394	331	16
Nov. Mean Flow	409	348	14.9
Dec. Mean Flow	430	395	8.14

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	506	450	11.1
Feb. High Flow	667	926	-38.8
Mar. High Flow	906	964	-6.4
Apr. High Flow	1210	991	18.1
May High Flow	1080	895	17.1
Jun. High Flow	1400	2340	-67.1
Jul. High Flow	1460	1150	21.2
Aug. High Flow	1260	859	31.8
Sep. High Flow	1010	702	30.5
Oct. High Flow	945	475	49.7
Nov. High Flow	880	361	59
Dec. High Flow	884	283	68

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	54	22.5	58.3
Med. 1 Day Min	75.5	45.5	39.7
Min. 3 Day Min	69.4	37.1	46.5
Med. 3 Day Min	161	66.5	58.7
Min. 7 Day Min	82.5	60.3	26.9
Med. 7 Day Min	216	110	49.1
Min. 30 Day Min	94.9	68.7	27.6
Med. 30 Day Min	252	127	49.6
Min. 90 Day Min	110	83.3	24.3
Med. 90 Day Min	287	167	41.8
7Q10	127	75.2	40.8
Year of 90-Day Min. Flow	2002	1985	100
Drought Year Mean	187	454	-143
Mean Baseflow	179	145	19

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	11300	8480	25
Med. 1 Day Max	3760	4420	-17.6
Max. 3 Day Max	8320	5880	29.3
Med. 3 Day Max	2890	2800	3.11
Max. 7 Day Max	4890	3720	23.9
Med. 7 Day Max	2010	1880	6.47
Max. 30 Day Max	2220	2280	-2.7
Med. 30 Day Max	1160	1050	9.48
Max. 90 Day Max	1550	1510	2.58
Med. 90 Day Max	816	790	3.19

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	83.8	45.7	45.5
5% Non-Exceedance	130	72.8	44
50% Non-Exceedance	378	292	22.8
95% Non-Exceedance	1360	1250	8.09
99% Non-Exceedance	2620	2470	5.73
Sept. 10% Non-Exceedance	80.7	80.5	0.25

**Fig. 1: Hydrograph**

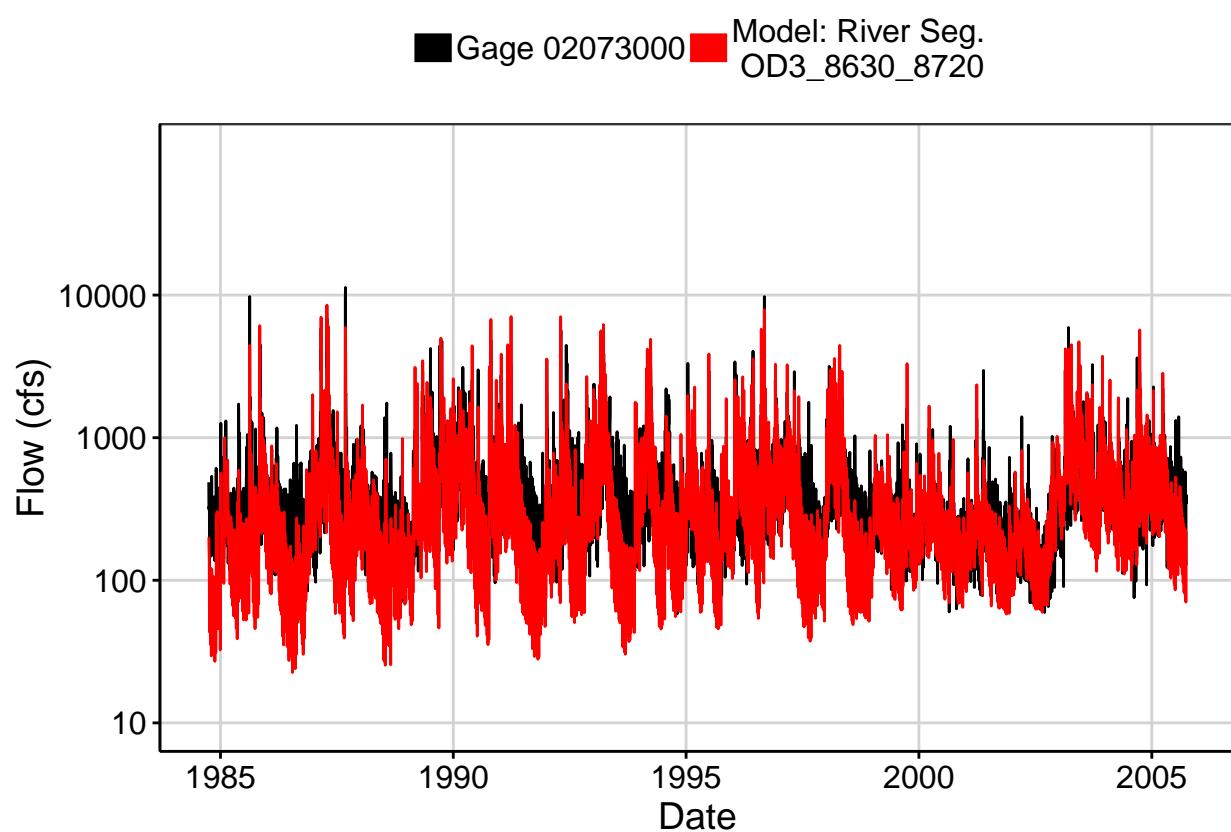


Fig. 2: Zoomed Hydrograph

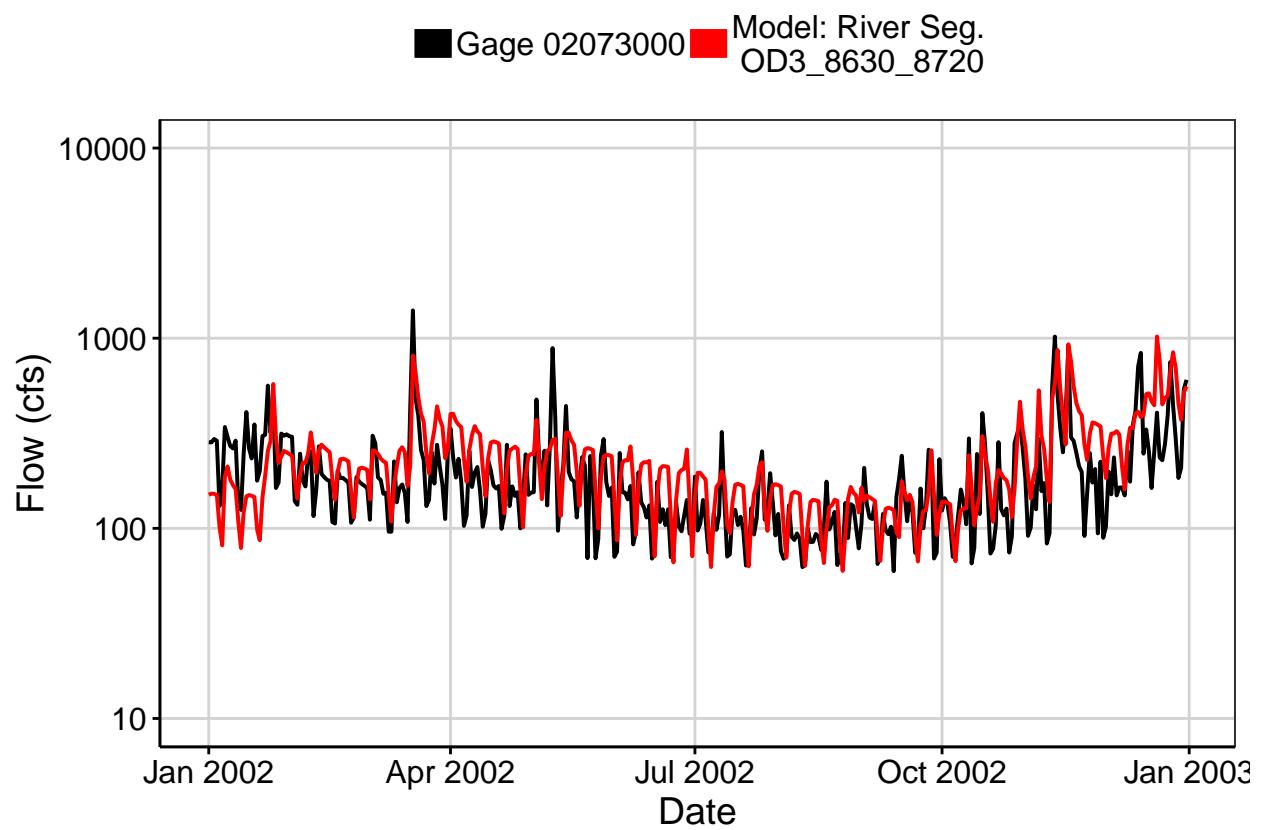


Fig. 3: Flow Exceedance

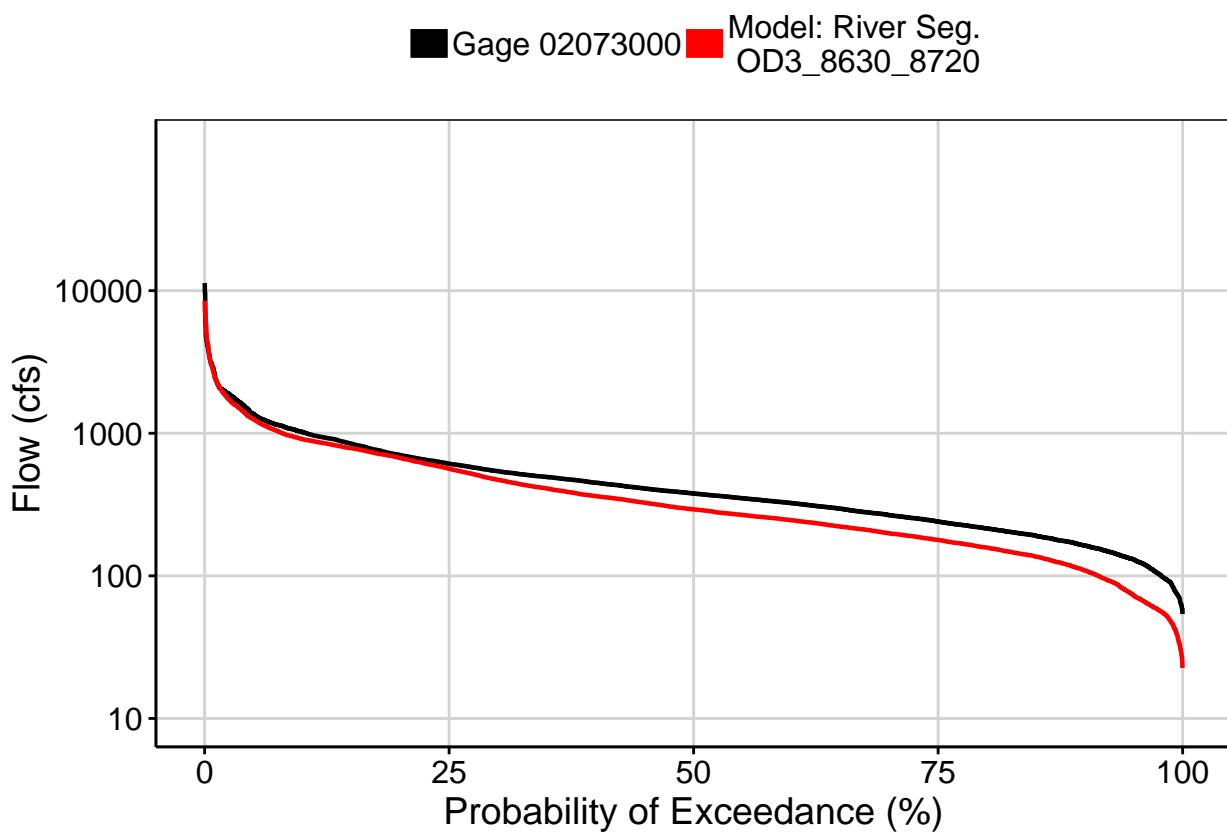
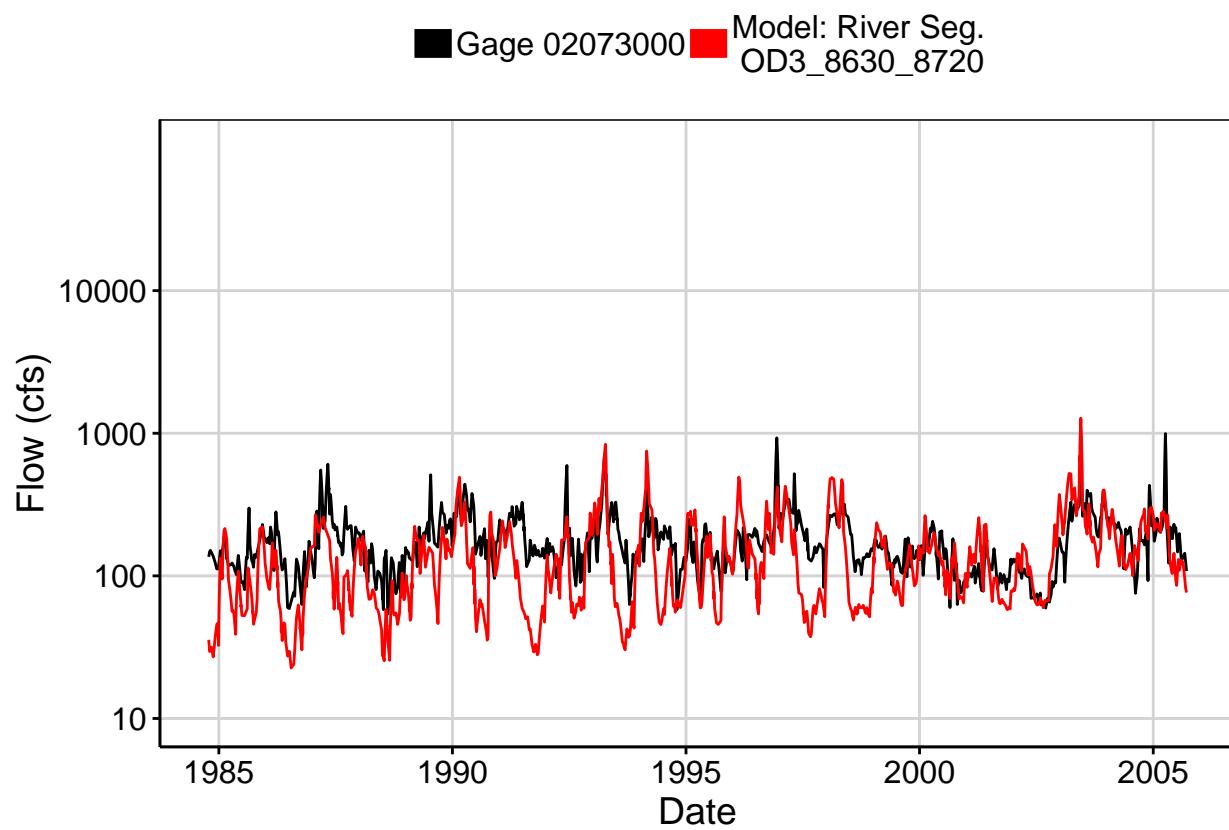


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

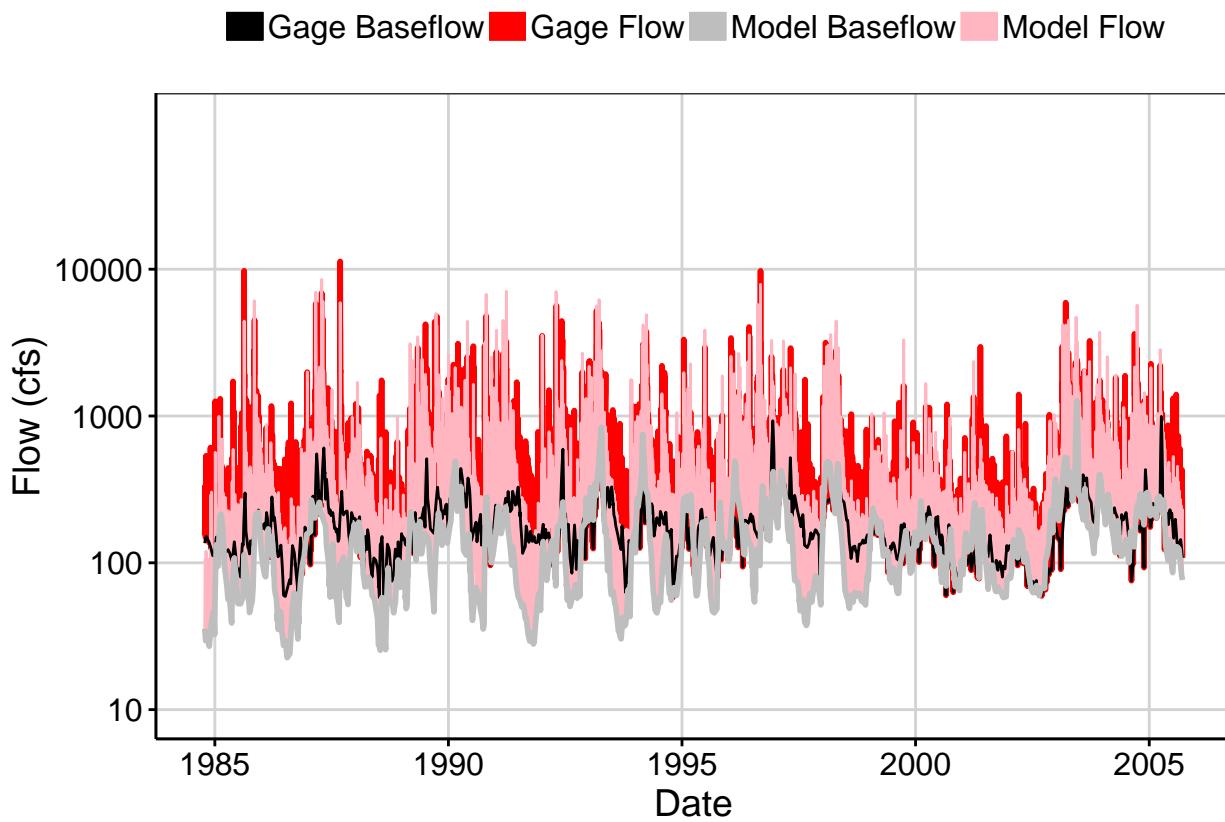


Fig. 6: Largest Error Segment

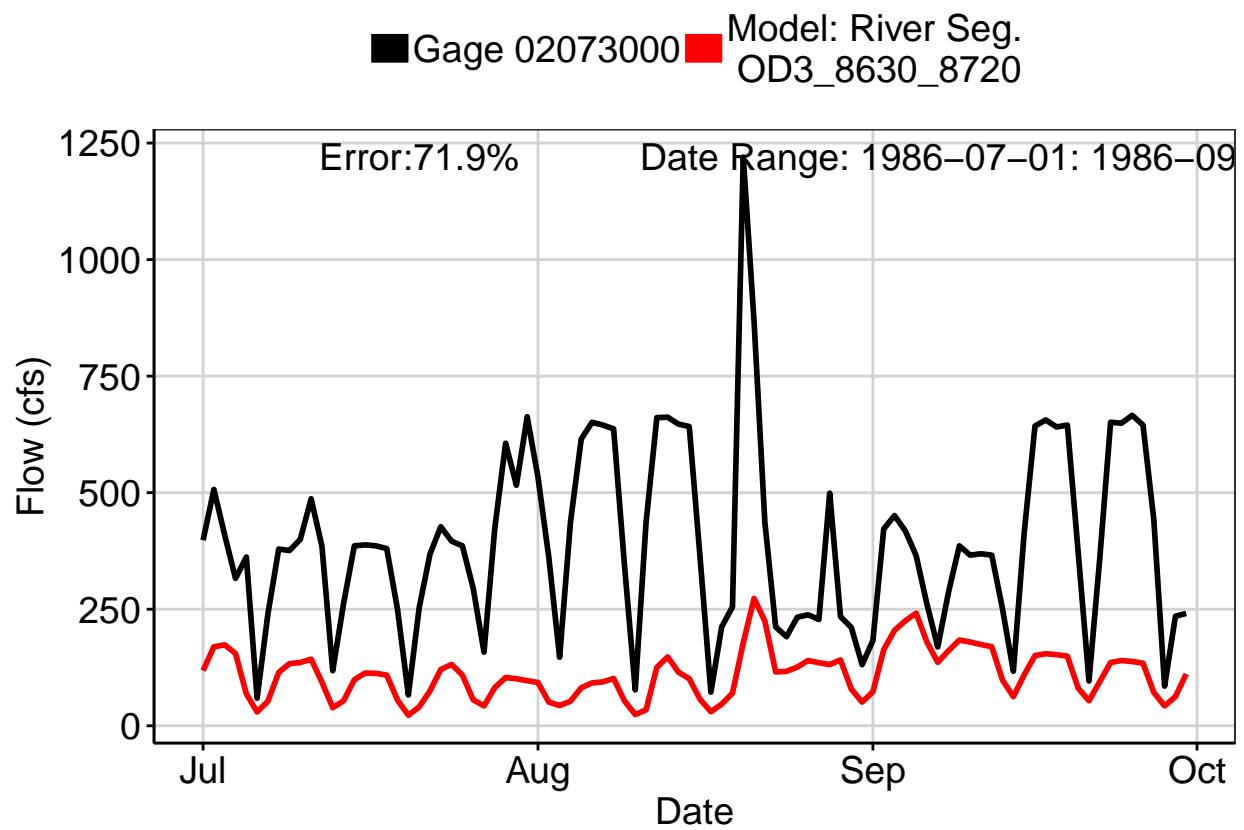


Fig. 7: Second Largest Error Segment

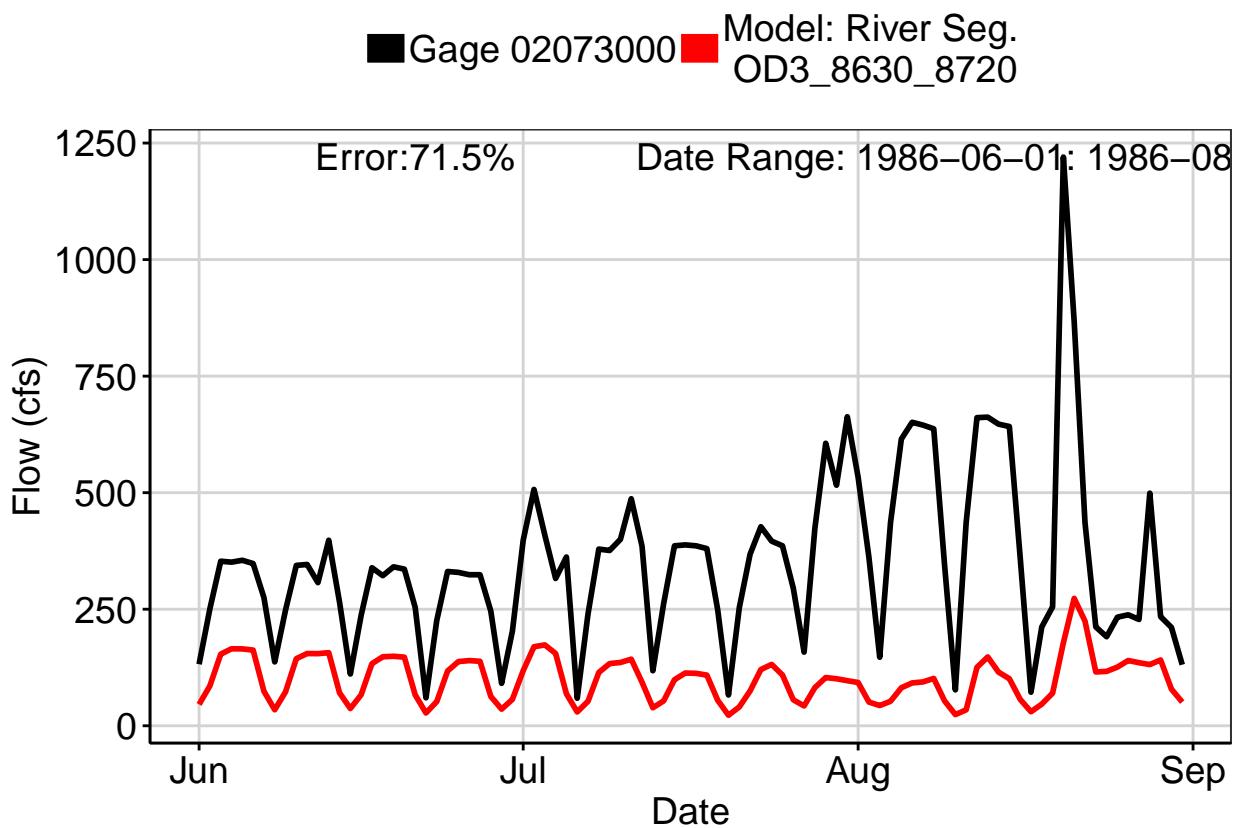


Fig. 8: Third Largest Error Segment

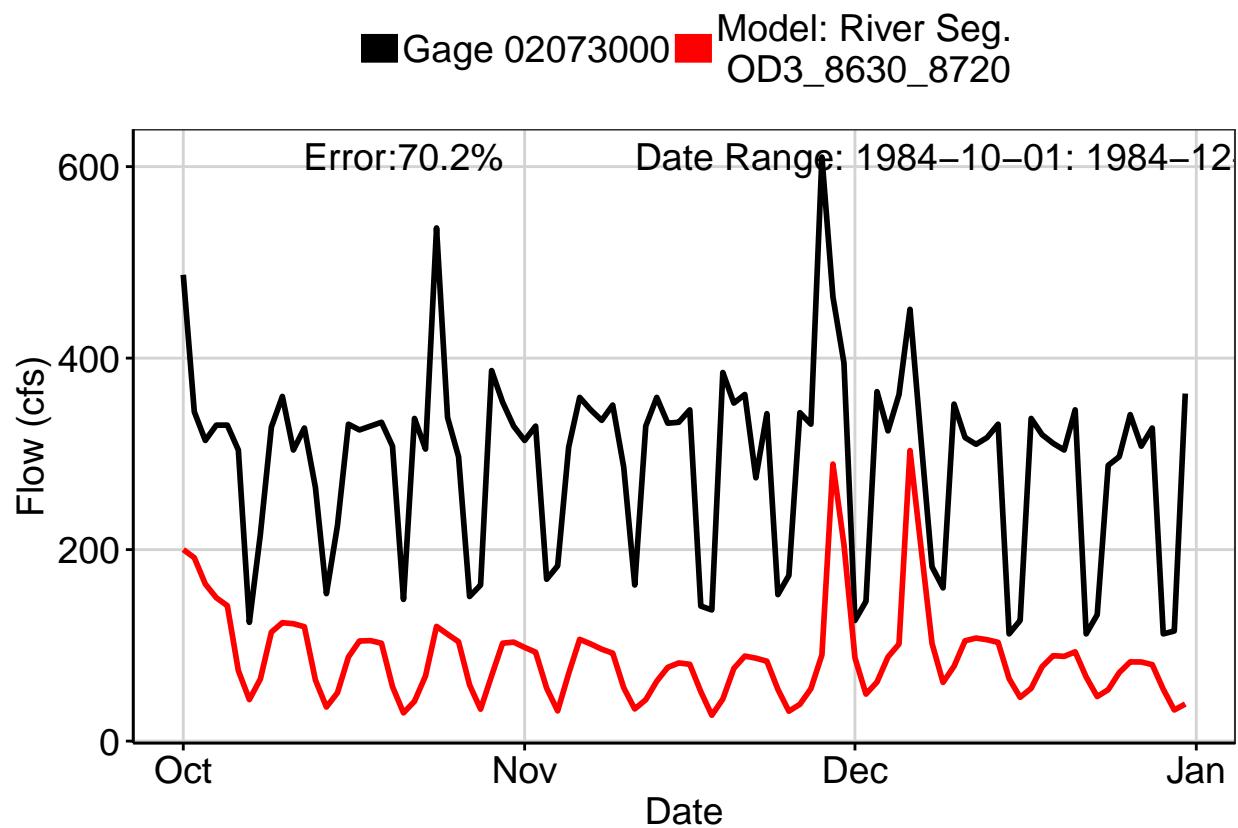
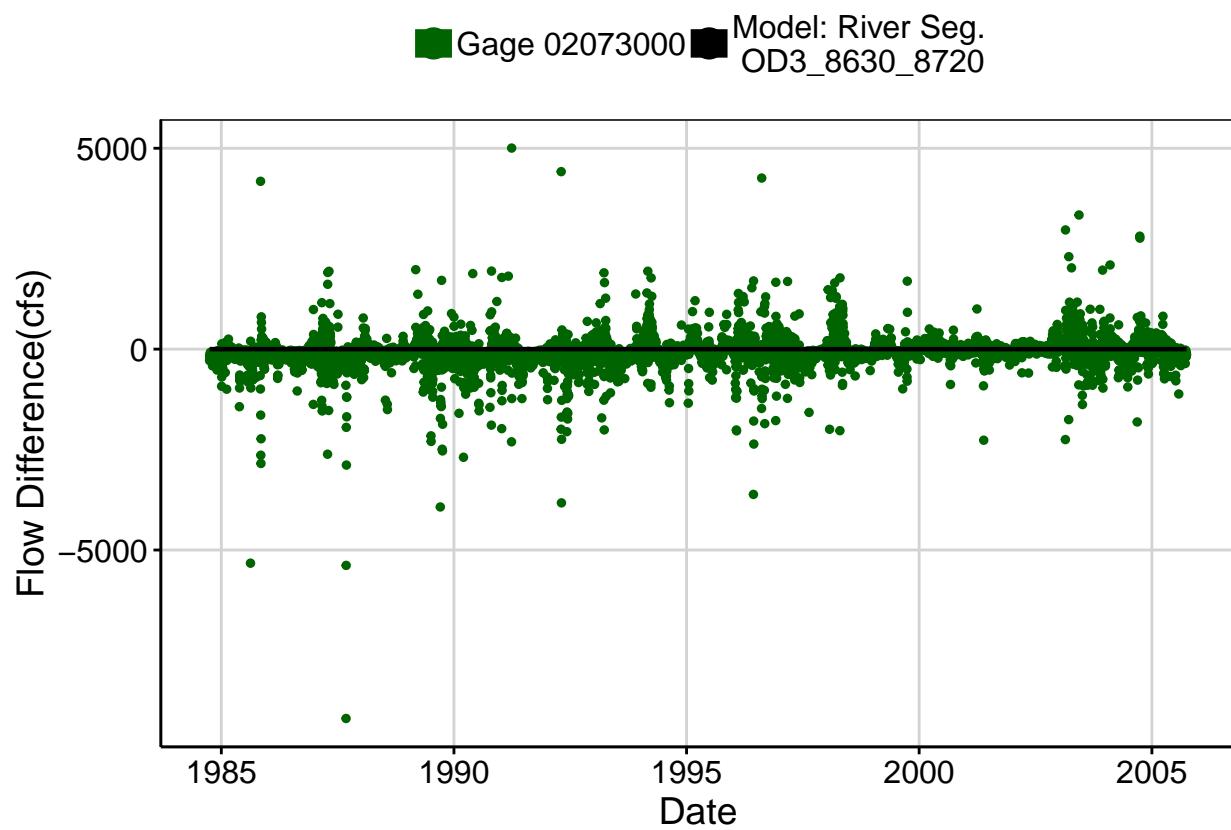
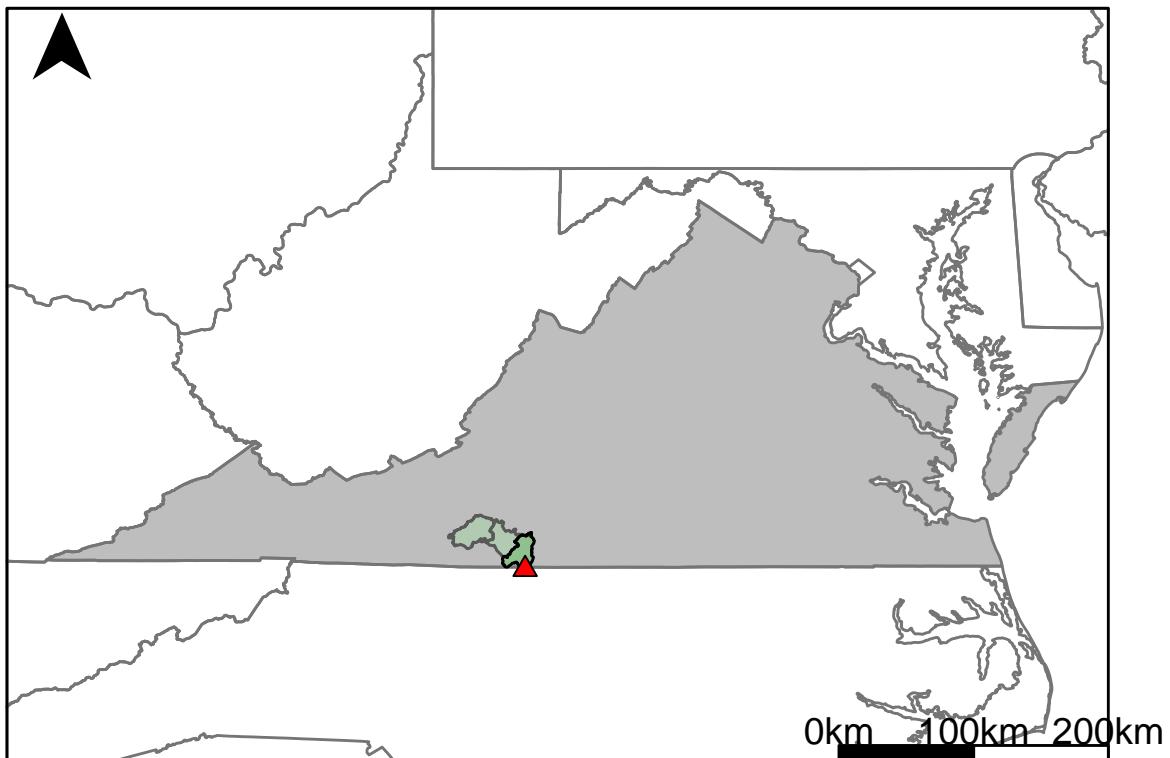


Fig. 9: Residuals Plot



## Appendix C.7: USGS Gage 02074000 vs. OD3\_8720\_8900



This river segment follows part of the flow of the Smith River, a tributary of the Dan River. The gage is located in Rockingham County, NC (Lat 36°31'32", Long 79°45'56") approximately 13 miles southeast of Martinsville, VA. Drainage area is 538 sq. miles. This gage started taking data in 1939 and is still taking data. This area is regulated by the Philpott Reservoir as well as a power plant in Martinsville, VA. The average daily discharge error between the model and gage data for the 20 year timespan was 4.7%, with 48.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	196	104	46.9
Feb. Low Flow	200	155	22.5
Mar. Low Flow	214	247	-15.4
Apr. Low Flow	220	300	-36.4
May Low Flow	270	417	-54.4
Jun. Low Flow	242	428	-76.9
Jul. Low Flow	347	276	20.5
Aug. Low Flow	288	232	19.4
Sep. Low Flow	245	174	29
Oct. Low Flow	204	132	35.3
Nov. Low Flow	187	109	41.7
Dec. Low Flow	183	120	34.4

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	702	669	4.7
Jan. Mean Flow	761	758	0.39
Feb. Mean Flow	747	924	-23.7
Mar. Mean Flow	961	1180	-22.8
Apr. Mean Flow	935	985	-5.35
May Mean Flow	762	683	10.4
Jun. Mean Flow	745	604	18.9
Jul. Mean Flow	616	394	36
Aug. Mean Flow	583	398	31.7
Sep. Mean Flow	657	537	18.3
Oct. Mean Flow	522	471	9.77
Nov. Mean Flow	550	507	7.82
Dec. Mean Flow	590	603	-2.2

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	563	605	-7.46
Feb. High Flow	1110	1700	-53.2
Mar. High Flow	1330	1330	0
Apr. High Flow	1570	1660	-5.73
May High Flow	1720	1380	19.8
Jun. High Flow	2180	4240	-94.5
Jul. High Flow	1760	1800	-2.27
Aug. High Flow	1600	1380	13.8
Sep. High Flow	1440	807	44
Oct. High Flow	1440	610	57.6
Nov. High Flow	1020	444	56.5
Dec. High Flow	928	408	56

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	72.8	57.3	21.3
Med. 1 Day Min	124	81.6	34.2
Min. 3 Day Min	86	63.5	26.2
Med. 3 Day Min	181	92.7	48.8
Min. 7 Day Min	99.8	77.8	22
Med. 7 Day Min	259	129	50.2
Min. 30 Day Min	125	96	23.2
Med. 30 Day Min	306	151	50.7
Min. 90 Day Min	137	121	11.7
Med. 90 Day Min	375	211	43.7
7Q10	150	88.2	41.2
Year of 90-Day Min. Flow	2002	1986	100
Drought Year Mean	254	669	-163
Mean Baseflow	298	308	-3.36

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	15300	15900	-3.92
Med. 1 Day Max	6350	8000	-26
Max. 3 Day Max	8230	10200	-23.9
Med. 3 Day Max	4090	4620	-13
Max. 7 Day Max	5500	6030	-9.64
Med. 7 Day Max	2840	2910	-2.46
Max. 30 Day Max	3050	3330	-9.18
Med. 30 Day Max	1520	1570	-3.29
Max. 90 Day Max	2050	2220	-8.29
Med. 90 Day Max	1150	1120	2.61

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	115	80.8	29.7
5% Non-Exceedance	185	118	36.2
50% Non-Exceedance	496	413	16.7
95% Non-Exceedance	1770	1850	-4.52
99% Non-Exceedance	3980	4340	-9.05
Sept. 10% Non-Exceedance	124	128	-3.23

**Fig. 1: Hydrograph**

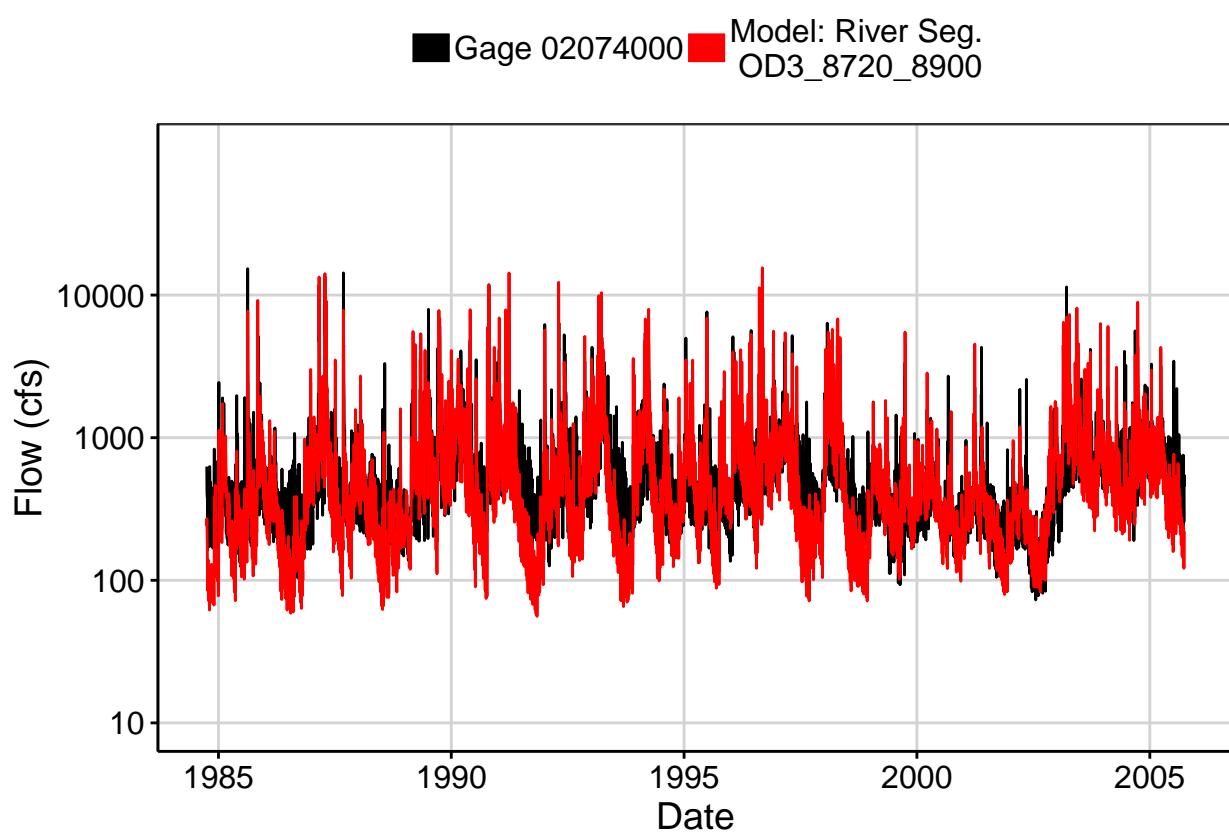


Fig. 2: Zoomed Hydrograph

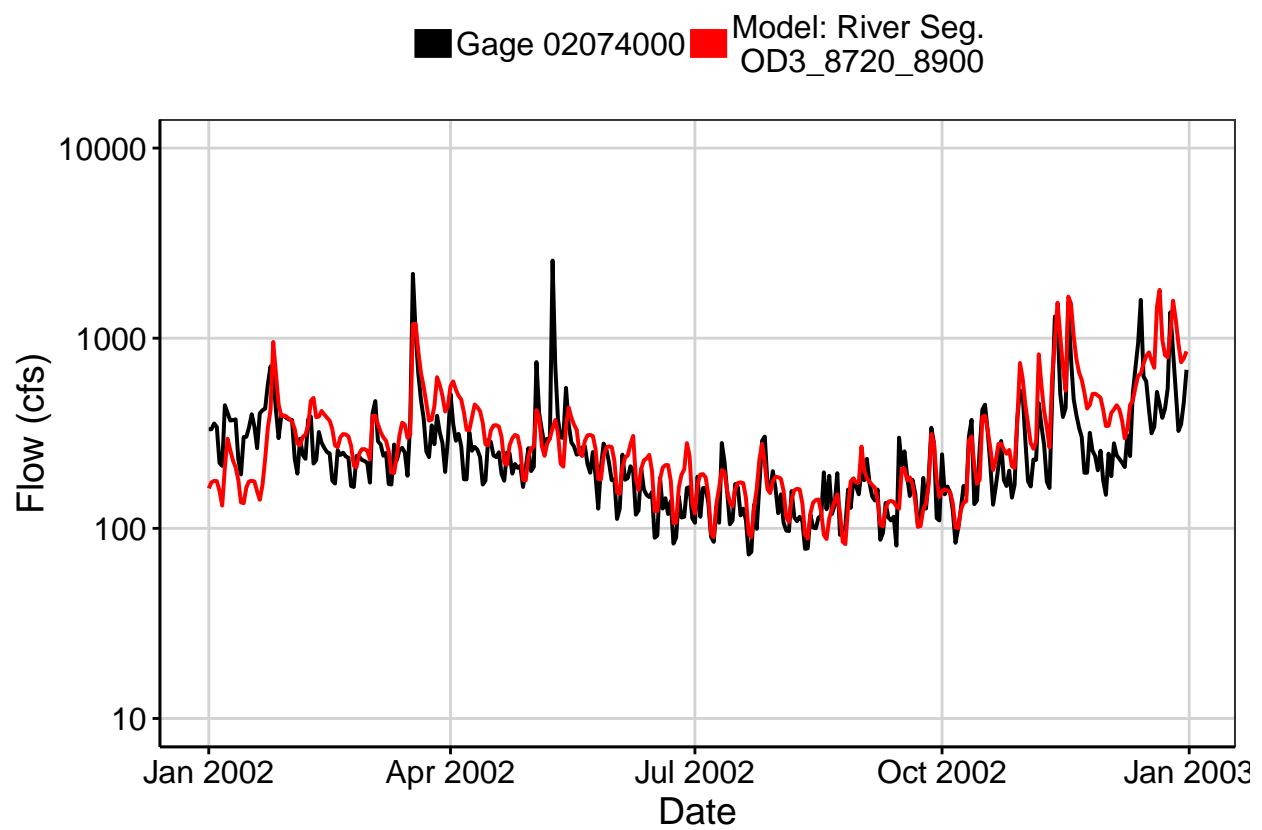


Fig. 3: Flow Exceedance

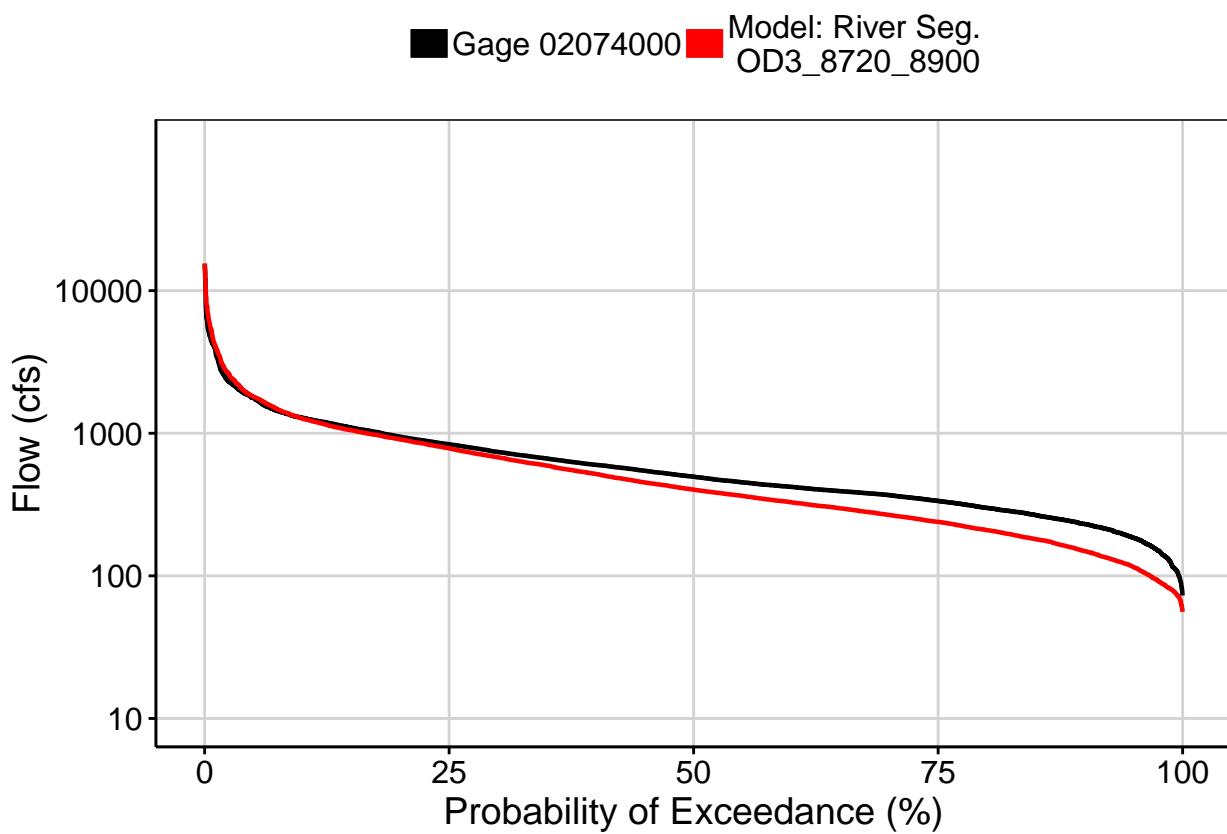
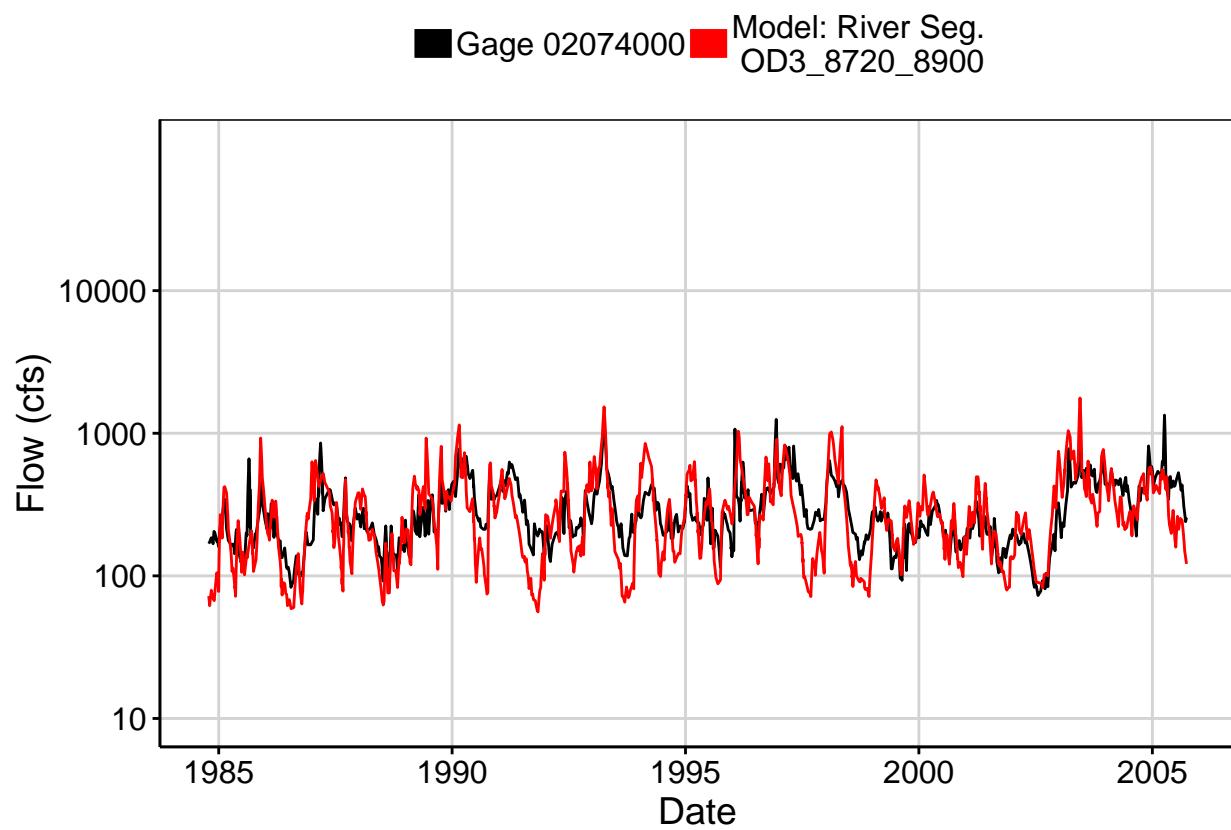


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

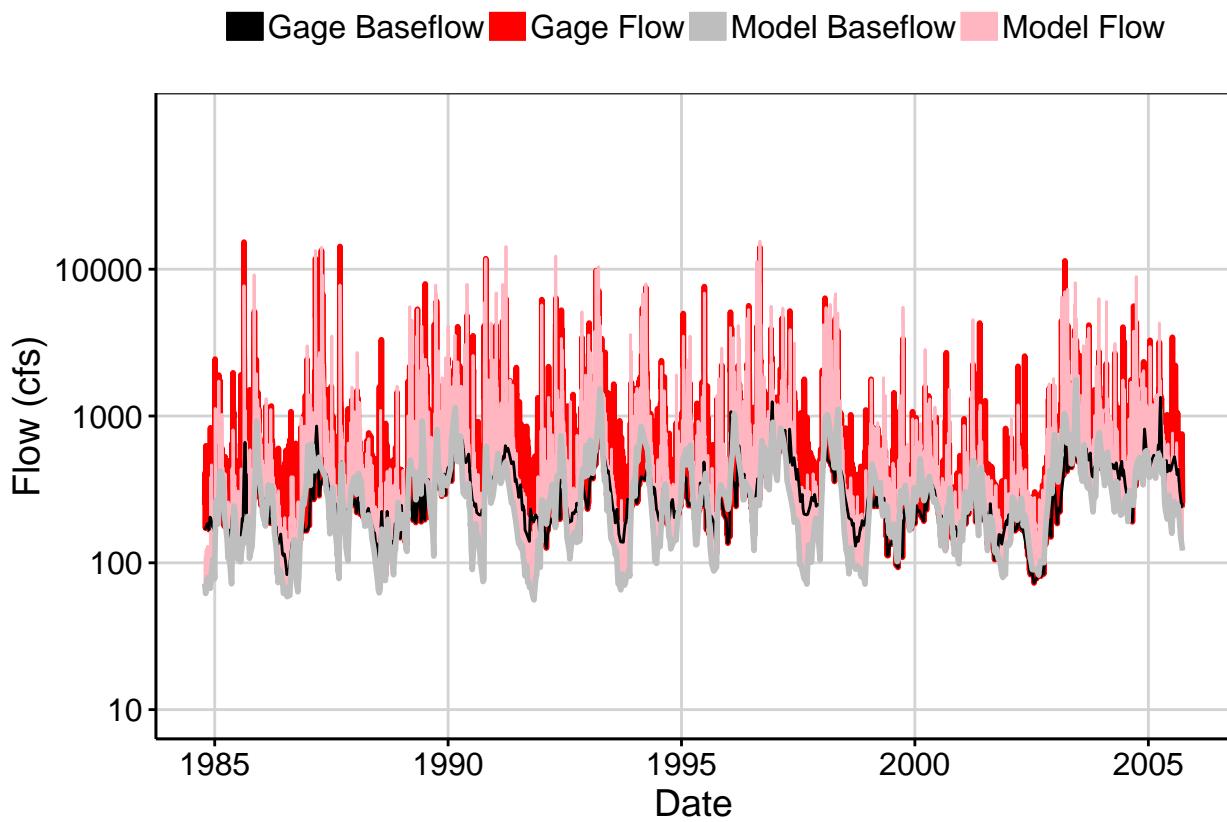


Fig. 6: Largest Error Segment

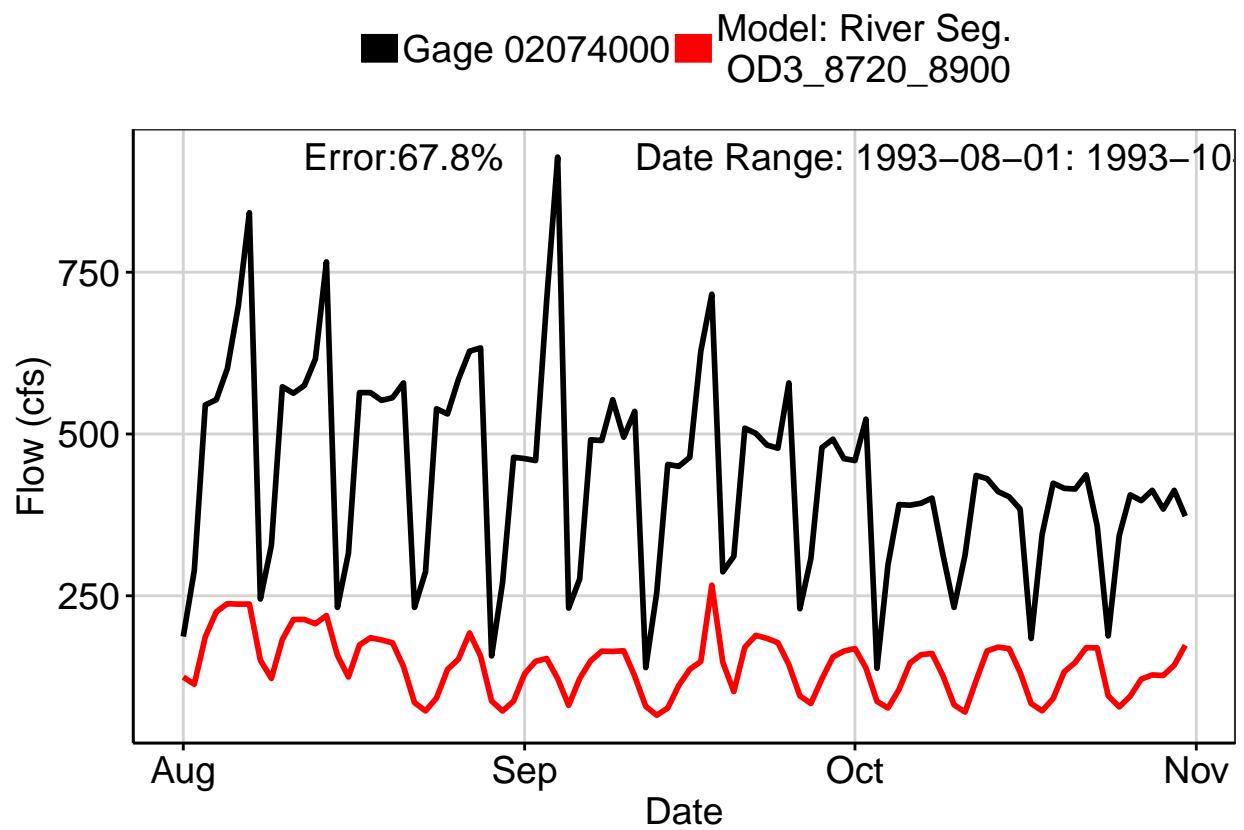


Fig. 7: Second Largest Error Segment

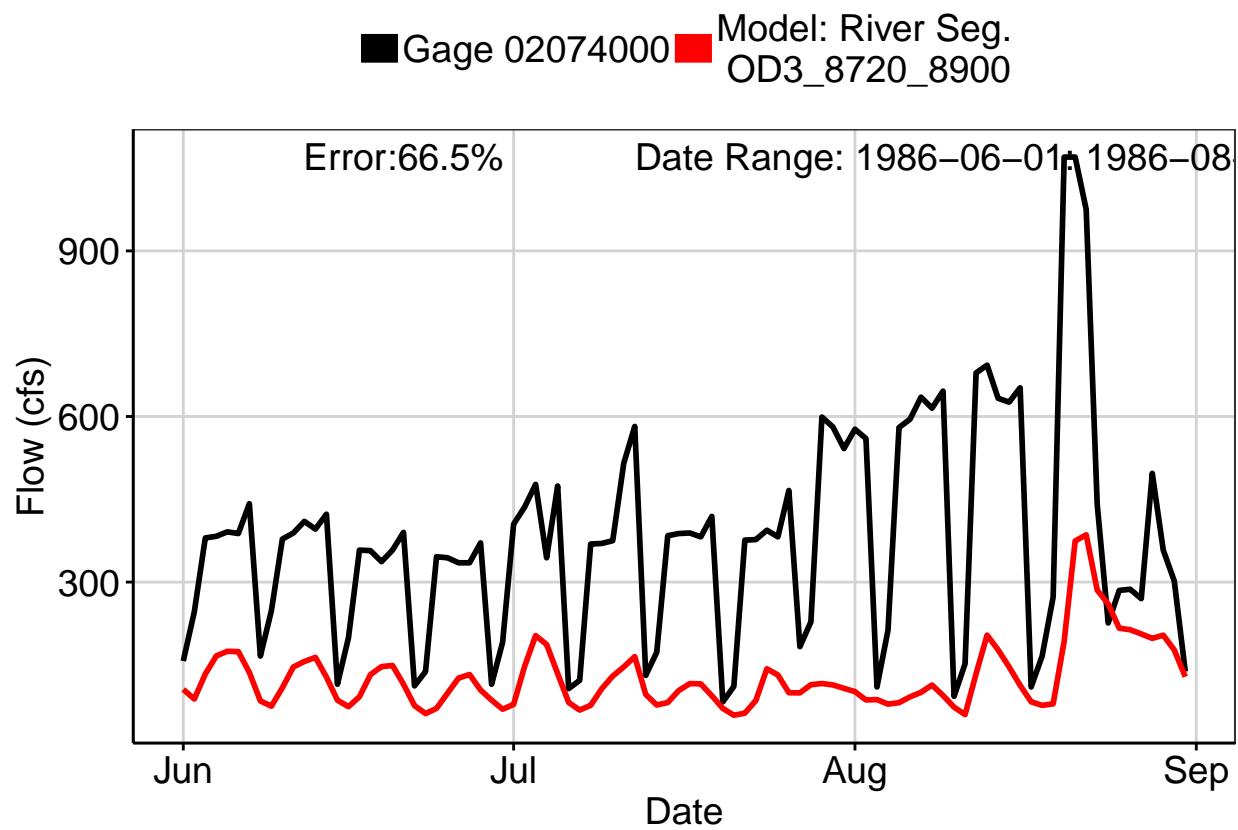


Fig. 8: Third Largest Error Segment

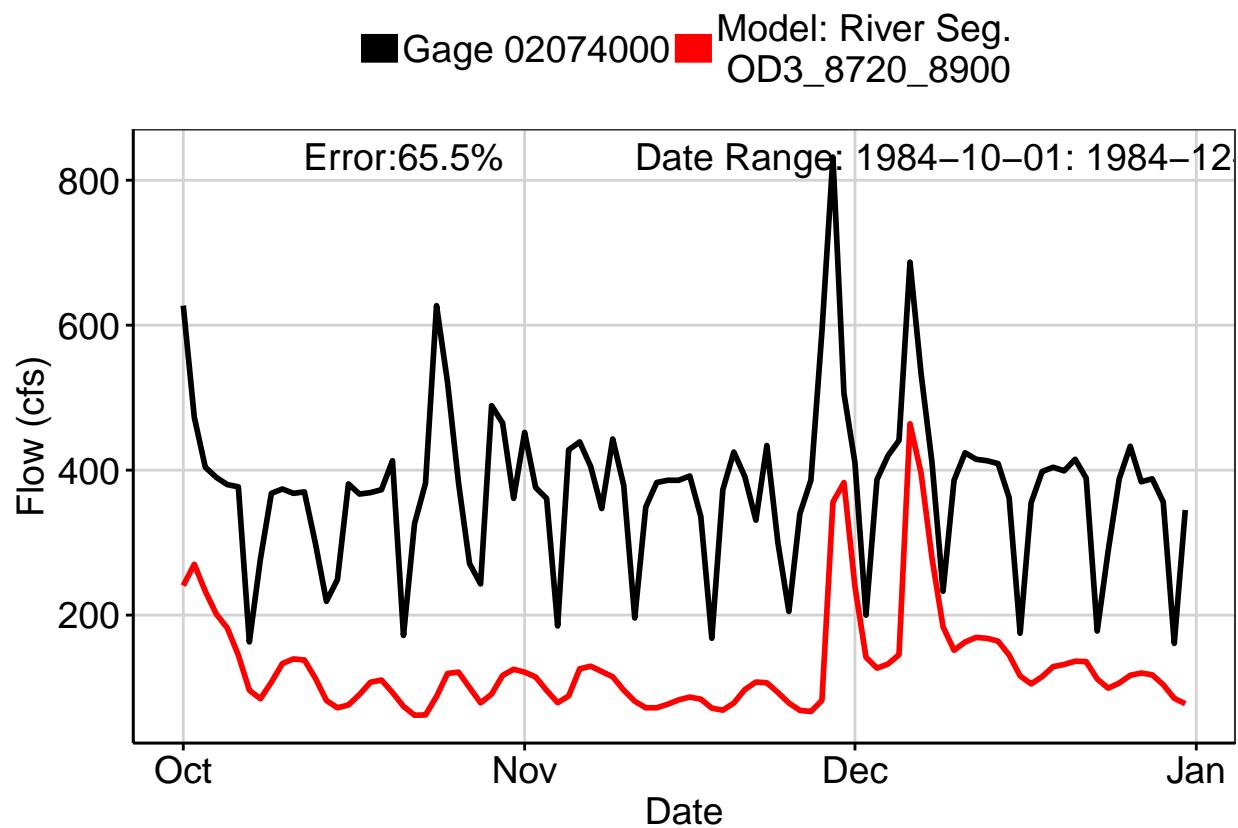
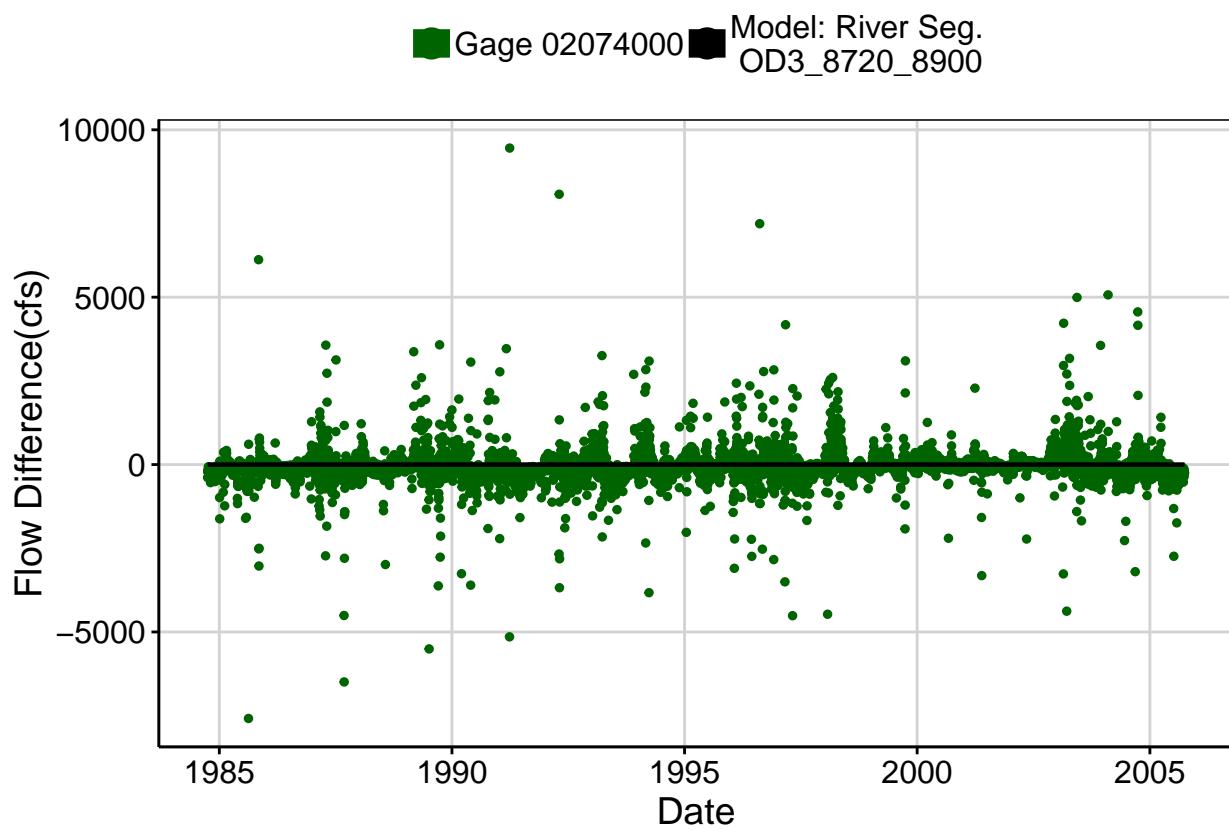
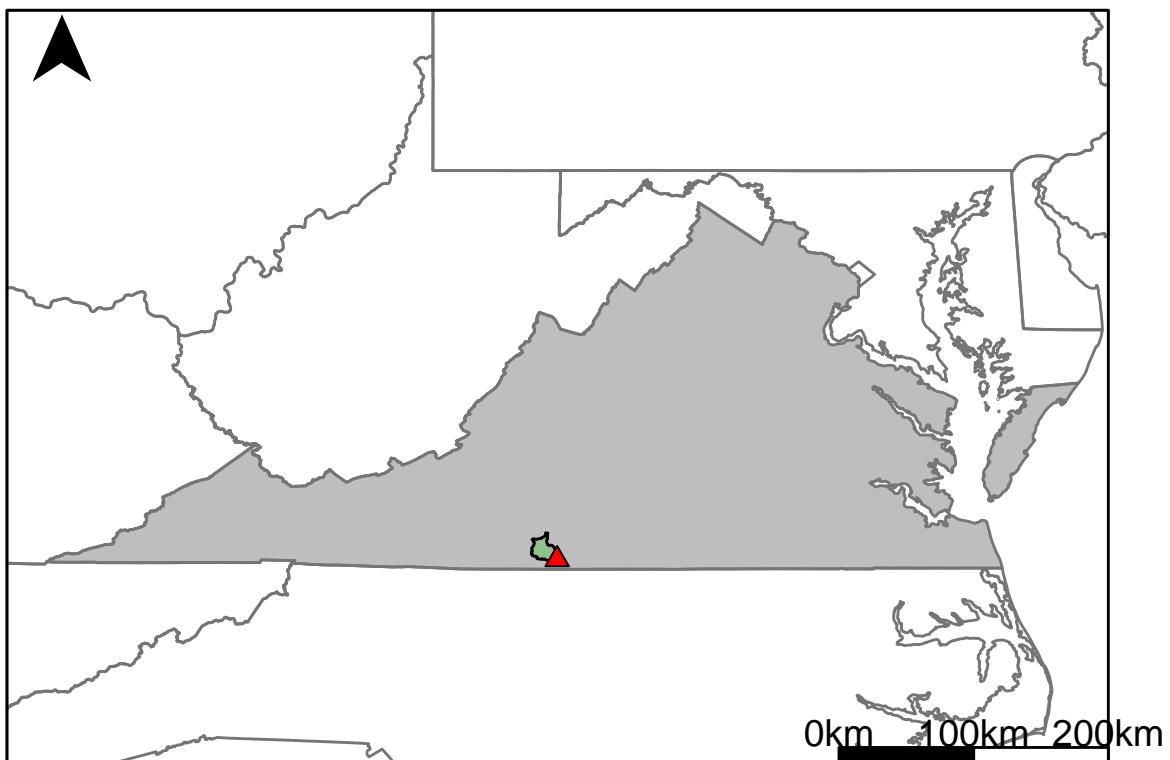


Fig. 9: Residuals Plot



## Appendix C.8: USGS Gage 02074500 vs. OD2\_8670\_8890



This river segment follows part of the flow of the Sandy River, a tributary of the Dan River. The gage is located in Pittsylvania County, VA (Lat 36°37'10", Long 79°30'16") approximately 6 miles northwest of Danville, VA. Drainage area is 111 sq. miles. This gage started taking data in 1929 and is still taking data. There is a diurnal fluctuation at low flow caused by Stony Mill, a small mill upstream. The average daily discharge error between the model and gage data for the 20 year timespan was 3.39%, with 54.6% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	42	16.4	61
Feb. Low Flow	50	25	50
Mar. Low Flow	55	36.8	33.1
Apr. Low Flow	59	59.6	-1.02
May Low Flow	72	97.5	-35.4
Jun. Low Flow	88	99.2	-12.7
Jul. Low Flow	76.3	68.2	10.6
Aug. Low Flow	64.6	47.7	26.2
Sep. Low Flow	52	34.4	33.8
Oct. Low Flow	39	22.4	42.6
Nov. Low Flow	36	19.4	46.1
Dec. Low Flow	36	14.6	59.4

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	118	114	3.39
Jan. Mean Flow	149	144	3.36
Feb. Mean Flow	146	178	-21.9
Mar. Mean Flow	193	234	-21.2
Apr. Mean Flow	156	170	-8.97
May Mean Flow	116	111	4.31
Jun. Mean Flow	103	94.2	8.54
Jul. Mean Flow	79.1	49.3	37.7
Aug. Mean Flow	86.1	51.4	40.3
Sep. Mean Flow	114	95	16.7
Oct. Mean Flow	83.9	72.4	13.7
Nov. Mean Flow	90.1	78.6	12.8
Dec. Mean Flow	107	98.8	7.66

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	112	68.1	39.2
Feb. High Flow	200	283	-41.5
Mar. High Flow	255	300	-17.6
Apr. High Flow	533	444	16.7
May High Flow	518	380	26.6
Jun. High Flow	630	1030	-63.5
Jul. High Flow	280	309	-10.4
Aug. High Flow	236	184	22
Sep. High Flow	165	171	-3.64
Oct. High Flow	192	90.5	52.9
Nov. High Flow	156	59.2	62.1
Dec. High Flow	134	63.9	52.3

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	6.4	2.88	55
Med. 1 Day Min	33	9.47	71.3
Min. 3 Day Min	6.56	2.95	55
Med. 3 Day Min	33.3	9.83	70.5
Min. 7 Day Min	7.82	3.1	60.4
Med. 7 Day Min	34.1	10.5	69.2
Min. 30 Day Min	10.6	3.75	64.6
Med. 30 Day Min	41.7	15.3	63.3
Min. 90 Day Min	16.6	8.24	50.4
Med. 90 Day Min	59	27.1	54.1
7Q10	14.6	4.63	68.3
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	44.8	114	-154
Mean Baseflow	64.5	60.6	6.05

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	8340	8390	-0.6
Med. 1 Day Max	2660	2230	16.2
Max. 3 Day Max	4770	5160	-8.18
Med. 3 Day Max	1380	1170	15.2
Max. 7 Day Max	2780	2630	5.4
Med. 7 Day Max	662	610	7.85
Max. 30 Day Max	836	797	4.67
Med. 30 Day Max	282	315	-11.7
Max. 90 Day Max	364	445	-22.3
Med. 90 Day Max	188	211	-12.2

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	17	4.98	70.7
5% Non-Exceedance	29	10.8	62.8
50% Non-Exceedance	73.8	61.3	16.9
95% Non-Exceedance	274	315	-15
99% Non-Exceedance	974	1060	-8.83
Sept. 10% Non-Exceedance	10.2	10.3	-0.98

**Fig. 1: Hydrograph**

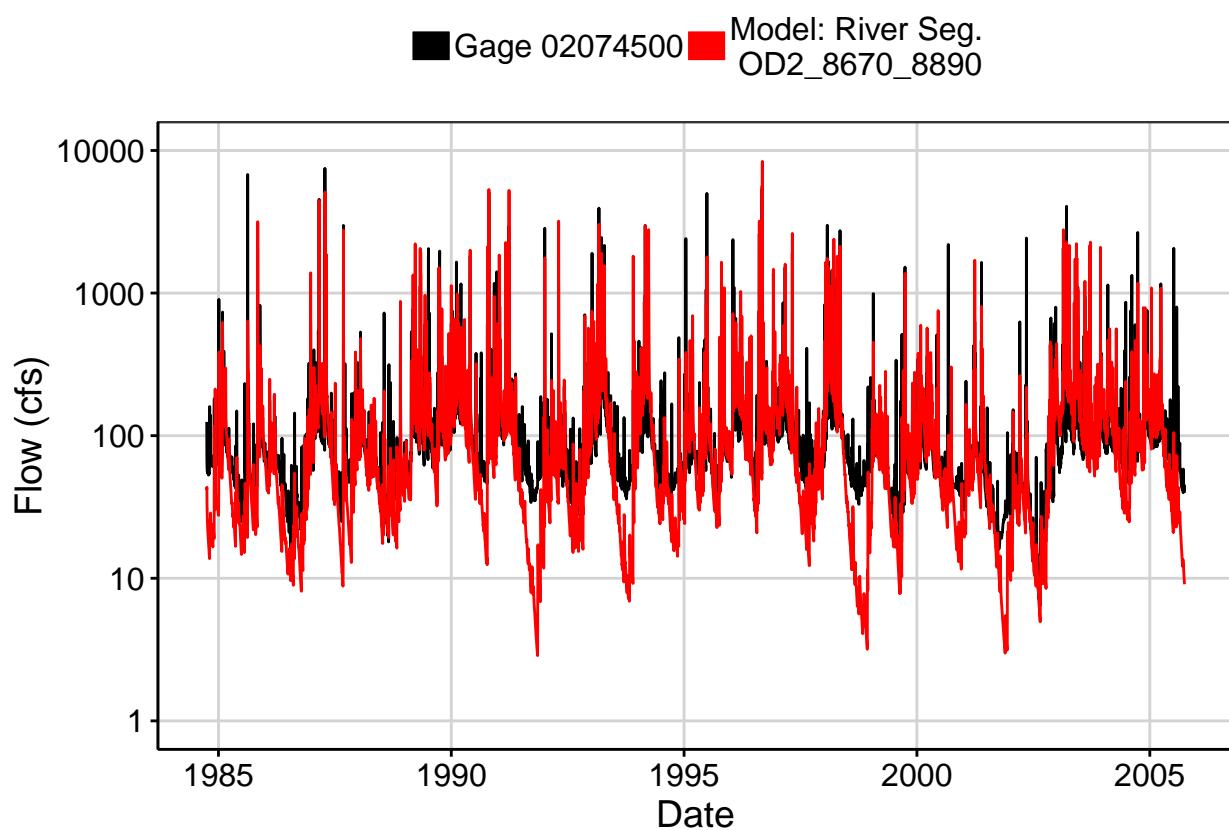


Fig. 2: Zoomed Hydrograph

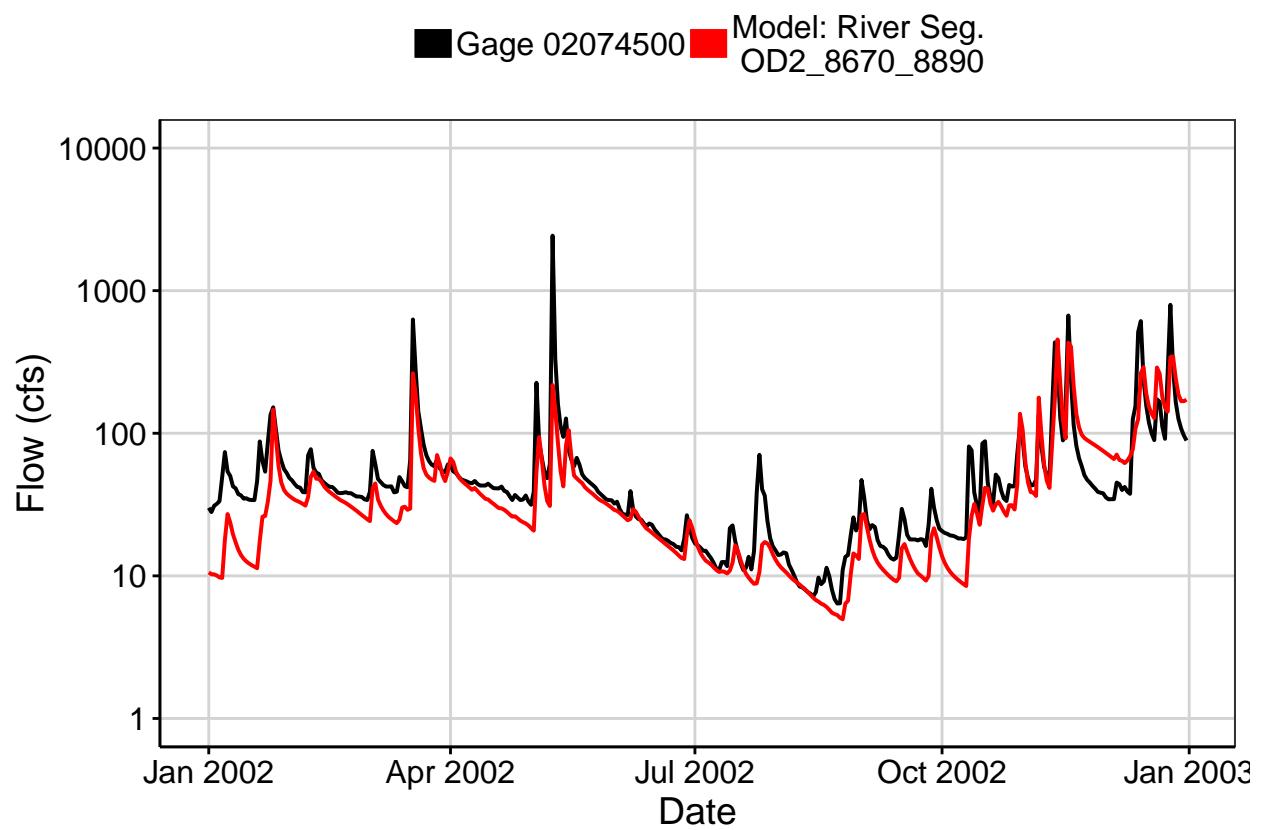


Fig. 3: Flow Exceedance

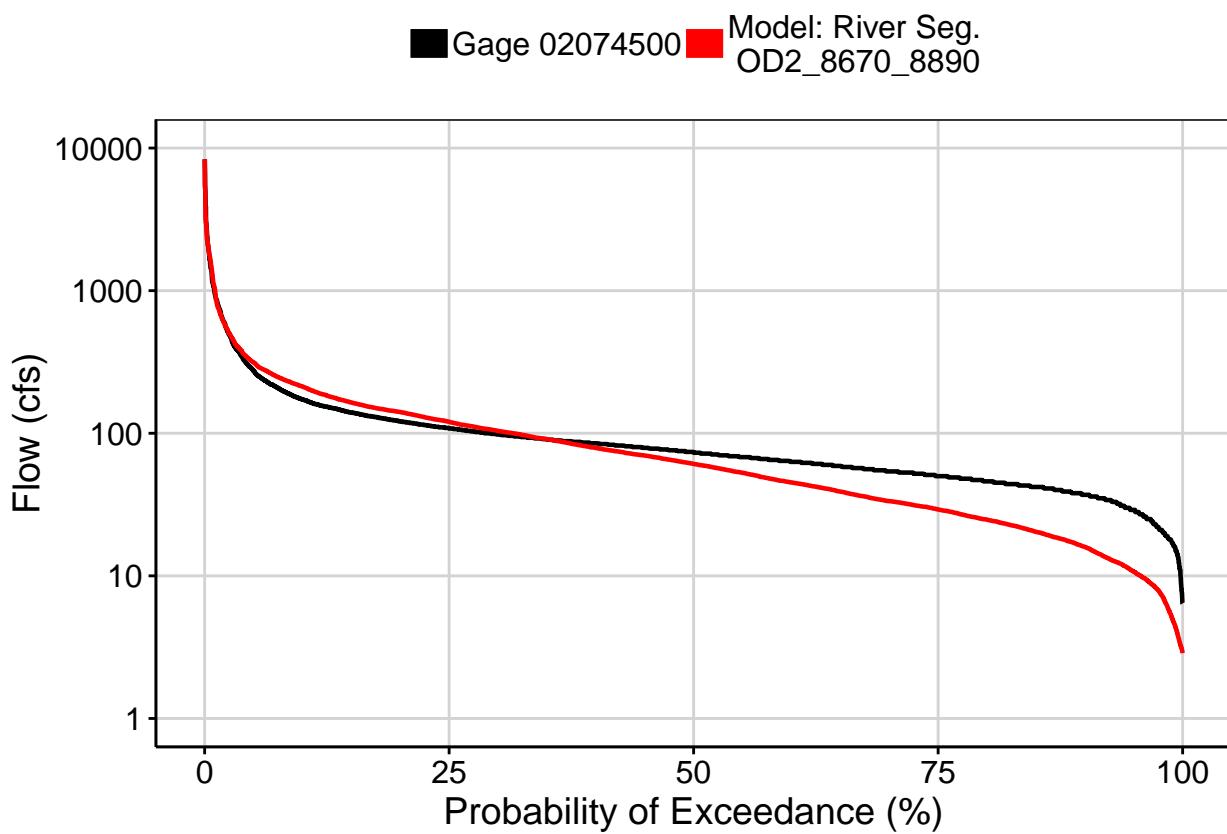


Fig. 4: Baseflow

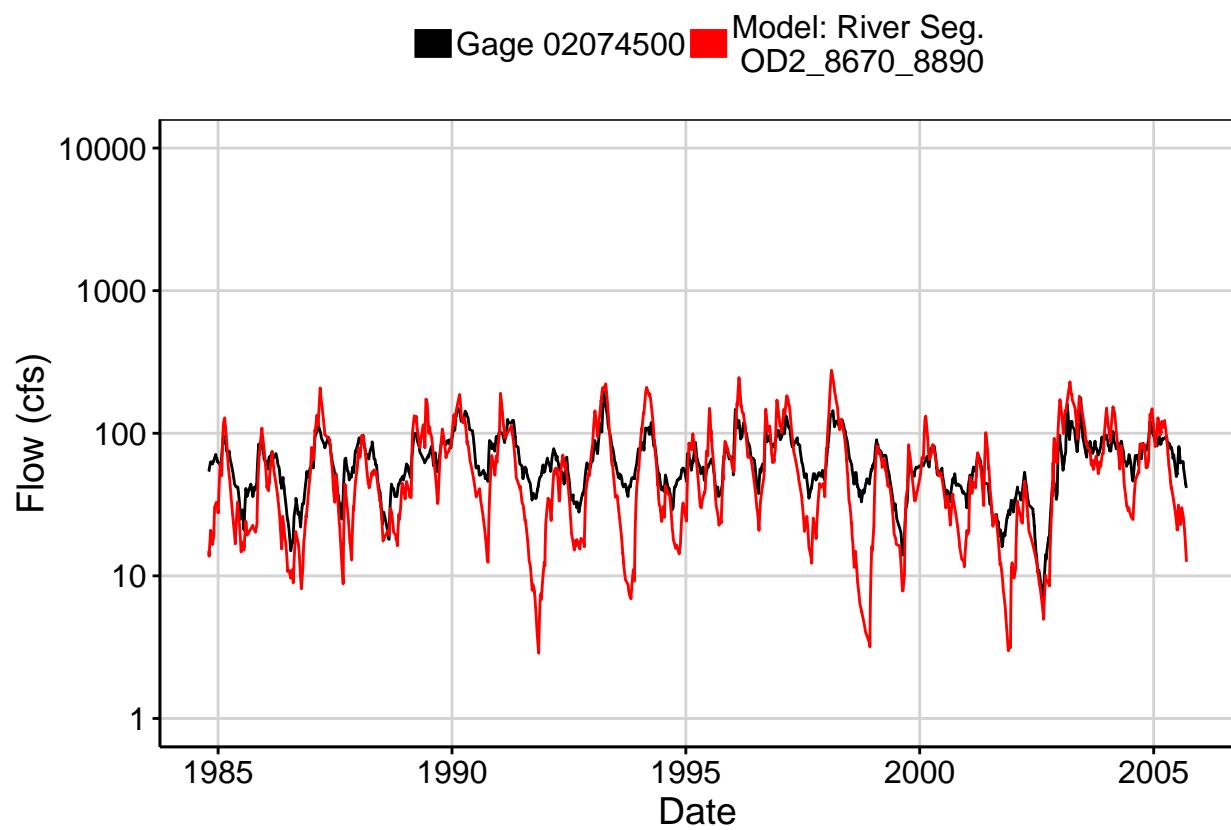


Fig. 5: Combined Baseflow

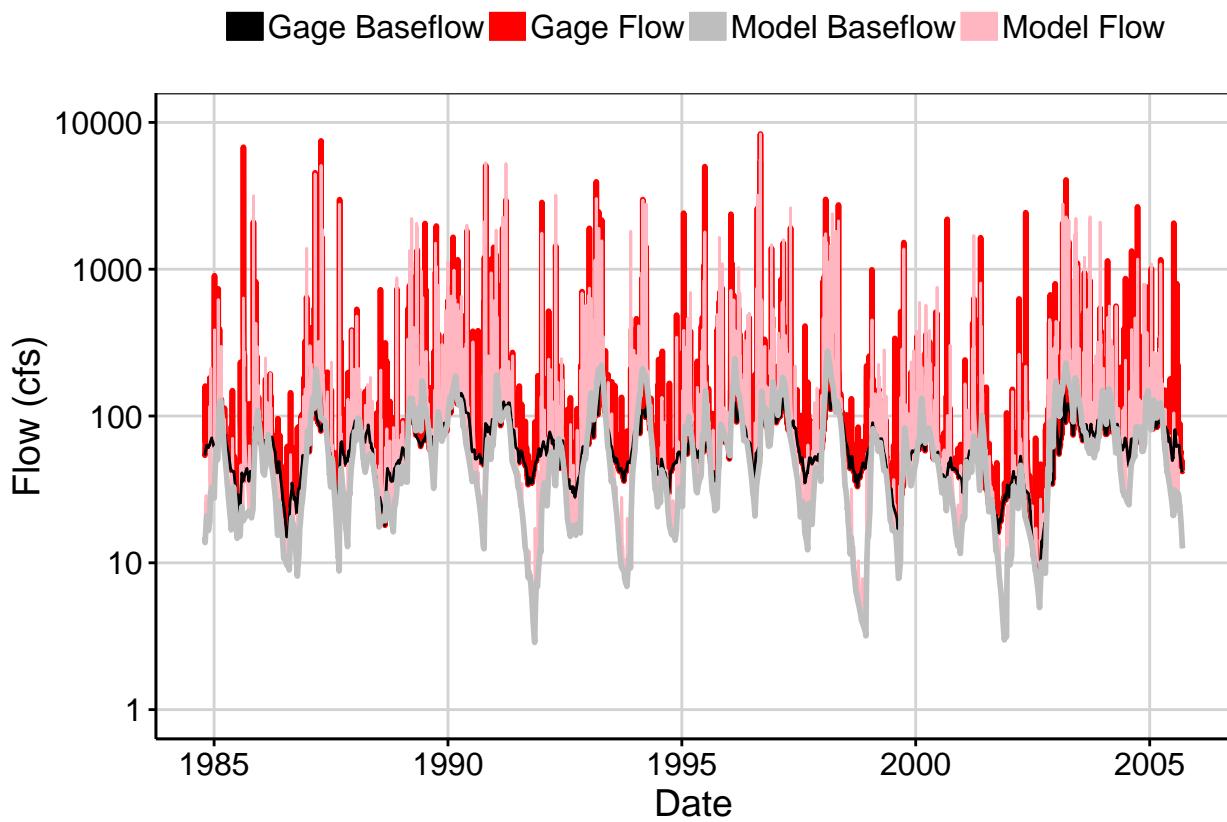


Fig. 6: Largest Error Segment

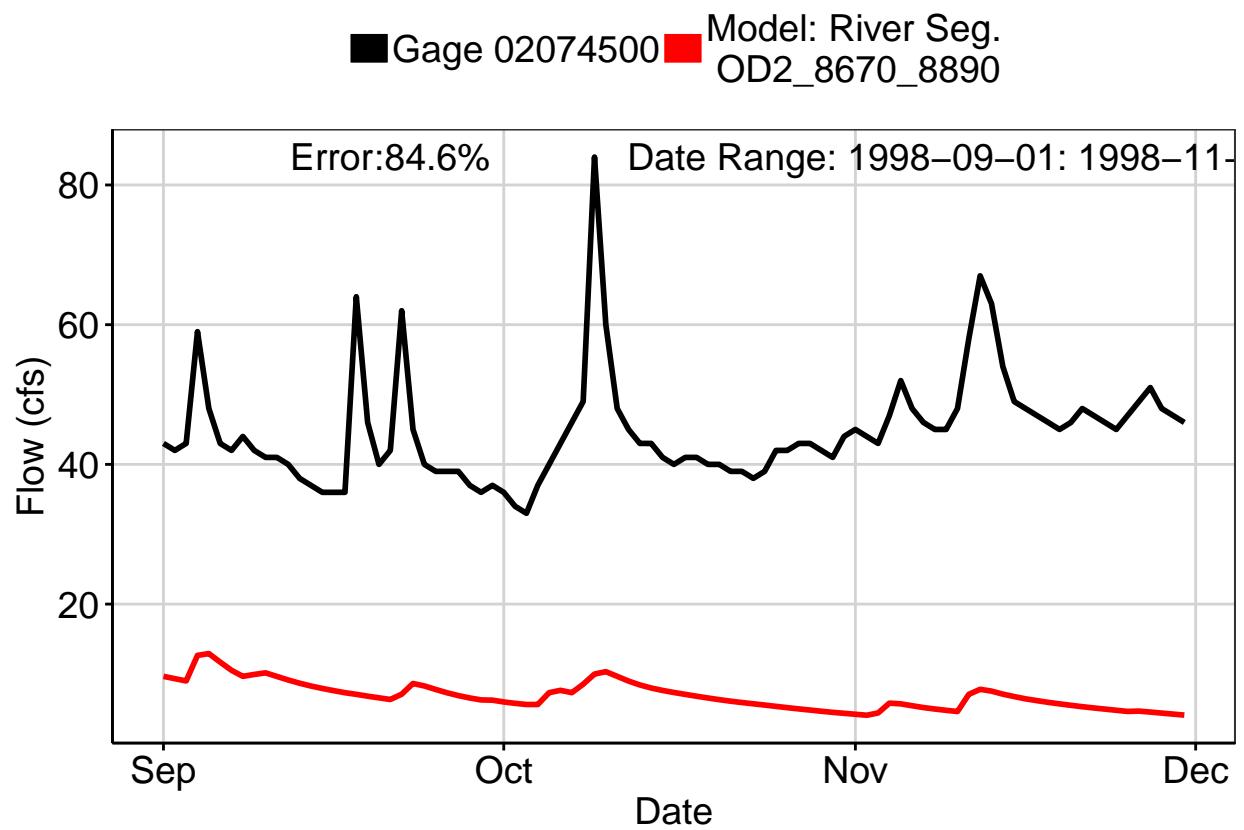


Fig. 7: Second Largest Error Segment

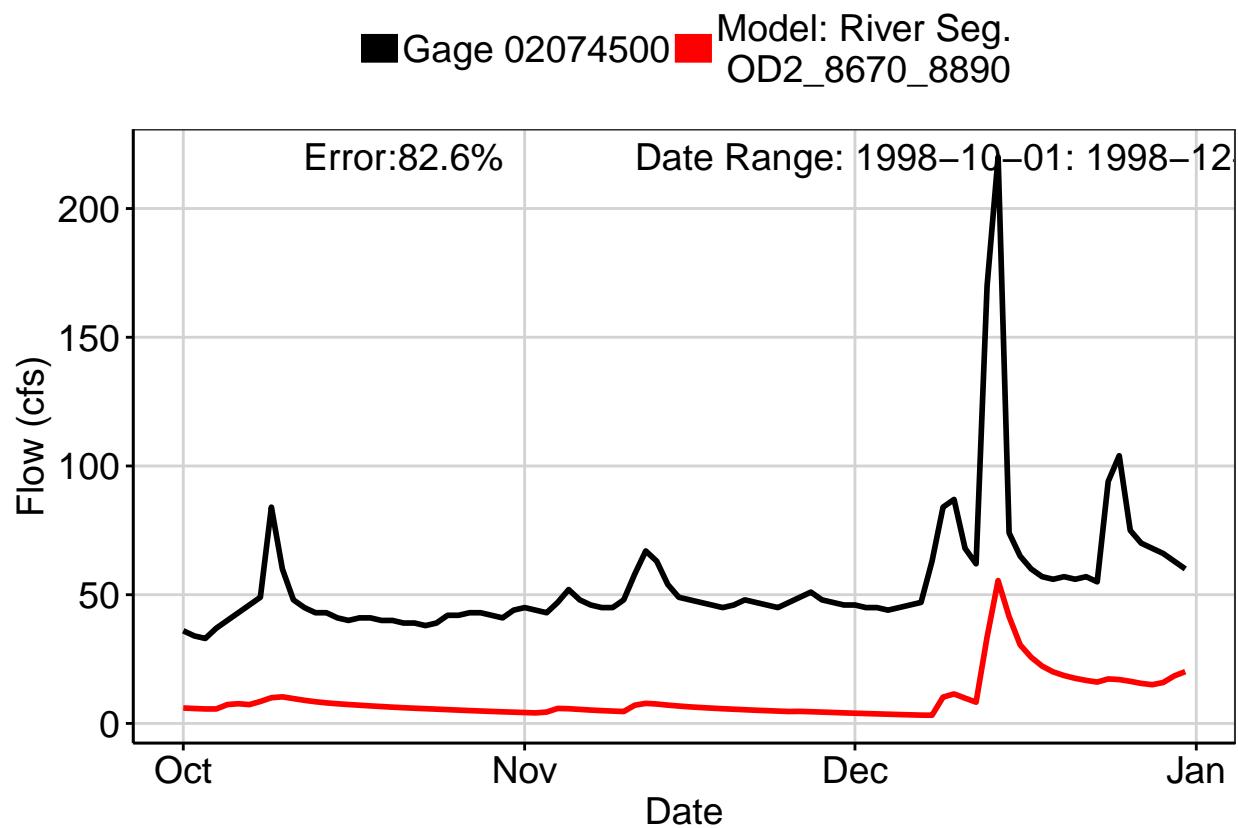


Fig. 8: Third Largest Error Segment

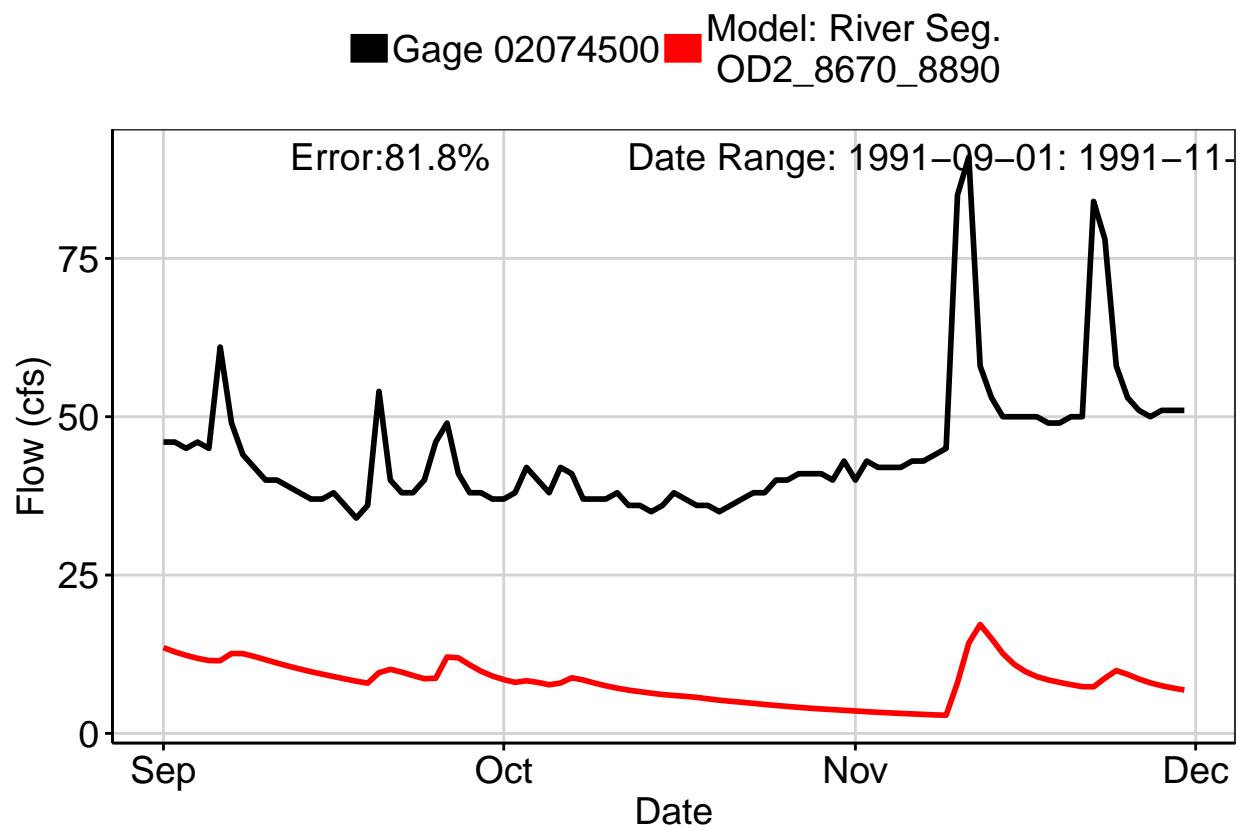
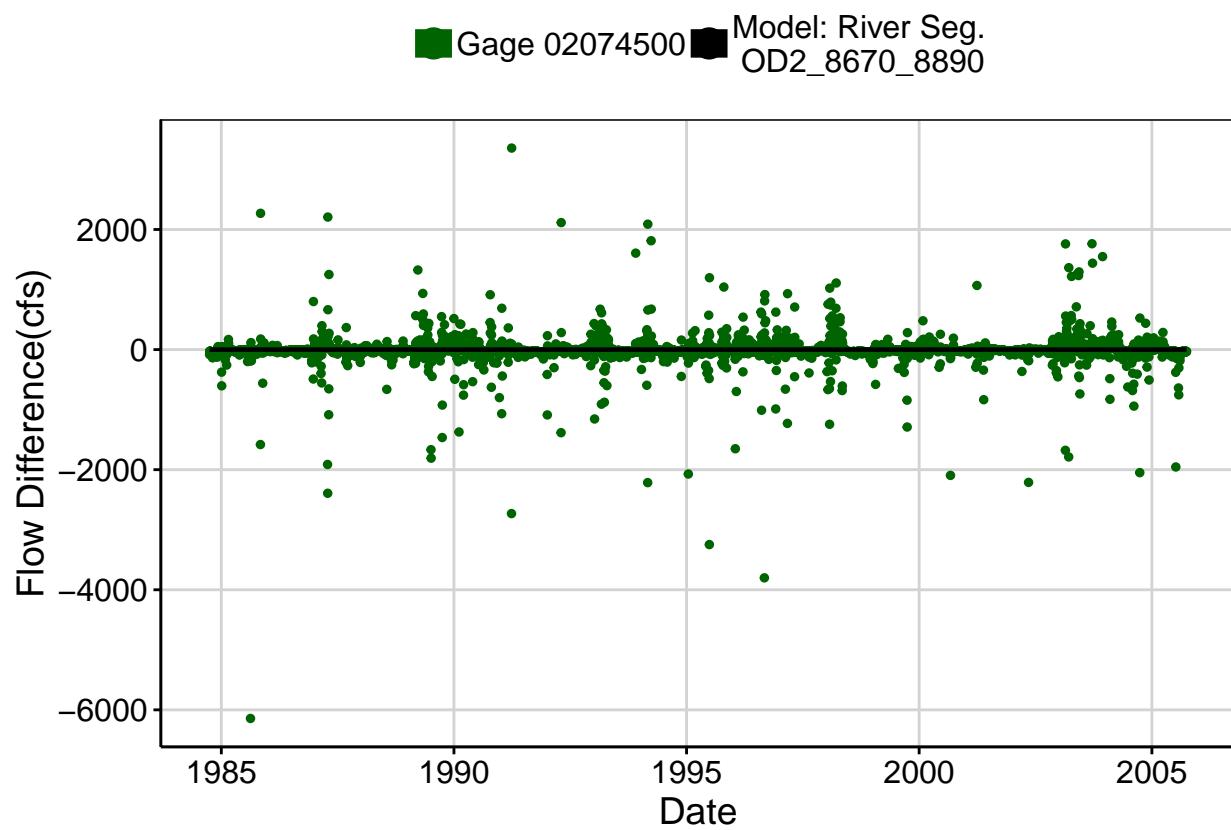
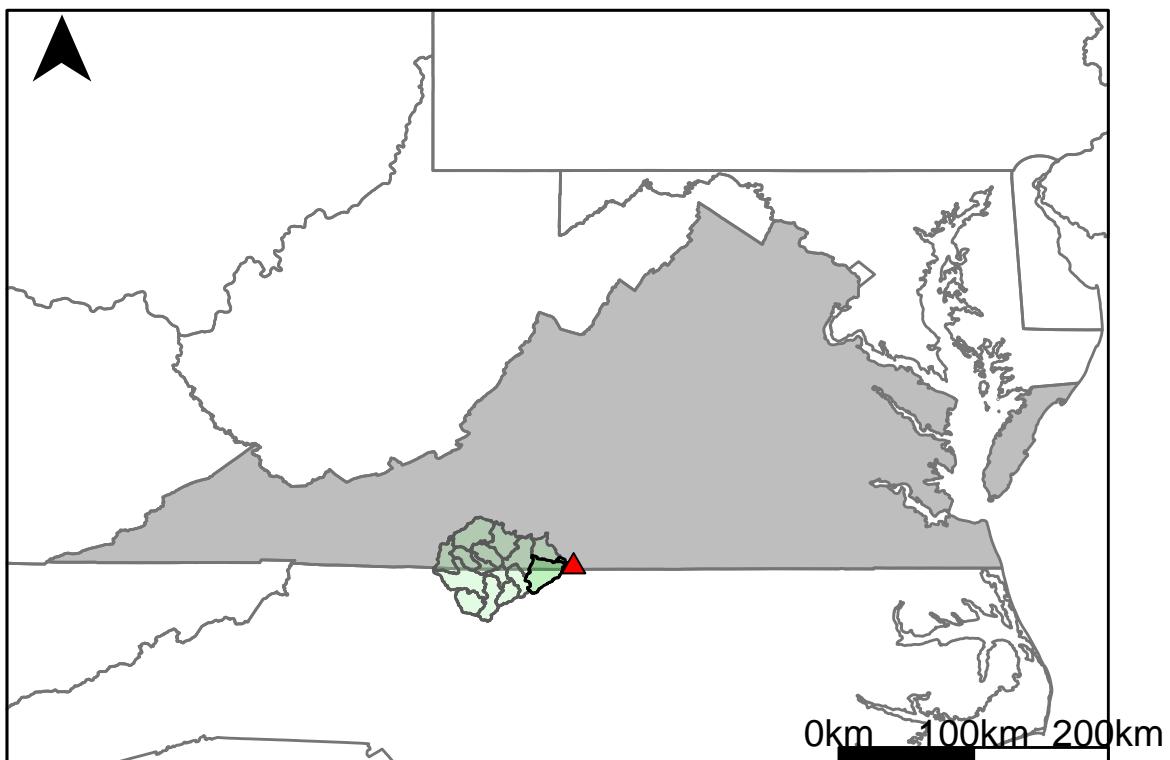


Fig. 9: Residuals Plot



## Appendix C.9: USGS Gage 02075045 vs. OD5\_8900\_8770+OD5\_8890\_8770



This river segment follows part of the flow of the Dan River. The gage is located in Pittsylvania County, VA (Lat 36°33'45", Long 79°22'12") approximately 2 miles southeast of Danville, VA. Drainage area is 2116 sq. miles. This gage started taking data in 1995 and is still taking data. There are a number of dams and mills located in Danville that are expected to regulate the flow of this area, especially during low flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 2.78%, with 34.3% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	612	429	29.9
Feb. Low Flow	840	589	29.9
Mar. Low Flow	731	915	-25.2
Apr. Low Flow	1040	1010	2.88
May Low Flow	1500	1610	-7.33
Jun. Low Flow	1460	1820	-24.7
Jul. Low Flow	1470	1380	6.12
Aug. Low Flow	1210	1070	11.6
Sep. Low Flow	1100	946	14
Oct. Low Flow	653	727	-11.3
Nov. Low Flow	569	536	5.8
Dec. Low Flow	506	503	0.59

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	2160	2100	2.78
Jan. Mean Flow	2480	2430	2.02
Feb. Mean Flow	2710	2840	-4.8
Mar. Mean Flow	3010	3860	-28.2
Apr. Mean Flow	3010	3210	-6.64
May Mean Flow	2330	2200	5.58
Jun. Mean Flow	2180	1910	12.4
Jul. Mean Flow	1430	1220	14.7
Aug. Mean Flow	1610	1280	20.5
Sep. Mean Flow	2370	1640	30.8
Oct. Mean Flow	1380	1430	-3.62
Nov. Mean Flow	1520	1450	4.61
Dec. Mean Flow	1990	1790	10.1

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	2270	1400	38.3
Feb. High Flow	3200	4230	-32.2
Mar. High Flow	4290	3750	12.6
Apr. High Flow	5360	6190	-15.5
May High Flow	6640	4320	34.9
Jun. High Flow	9740	10400	-6.78
Jul. High Flow	5980	5240	12.4
Aug. High Flow	6740	3560	47.2
Sep. High Flow	4360	2260	48.2
Oct. High Flow	2540	1550	39
Nov. High Flow	2920	1220	58.2
Dec. High Flow	3800	1230	67.6

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	104	186	-78.8
Med. 1 Day Min	360	353	1.94
Min. 3 Day Min	109	191	-75.2
Med. 3 Day Min	472	377	20.1
Min. 7 Day Min	126	201	-59.5
Med. 7 Day Min	635	425	33.1
Min. 30 Day Min	224	216	3.57
Med. 30 Day Min	783	516	34.1
Min. 90 Day Min	336	337	-0.3
Med. 90 Day Min	1110	762	31.4
7Q10	290	236	18.6
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	731	2100	-187
Mean Baseflow	1270	1250	1.57

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	41500	52400	-26.3
Med. 1 Day Max	20800	19300	7.21
Max. 3 Day Max	34500	36100	-4.64
Med. 3 Day Max	14600	15400	-5.48
Max. 7 Day Max	24500	20900	14.7
Med. 7 Day Max	7410	9670	-30.5
Max. 30 Day Max	9250	10400	-12.4
Med. 30 Day Max	3950	4690	-18.7
Max. 90 Day Max	6300	7100	-12.7
Med. 90 Day Max	2860	3400	-18.9

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	221	247	-11.8
5% Non-Exceedance	490	371	24.3
50% Non-Exceedance	1560	1330	14.7
95% Non-Exceedance	5320	5870	-10.3
99% Non-Exceedance	14600	14600	0
Sept. 10% Non-Exceedance	454	456	-0.44

**Fig. 1: Hydrograph**

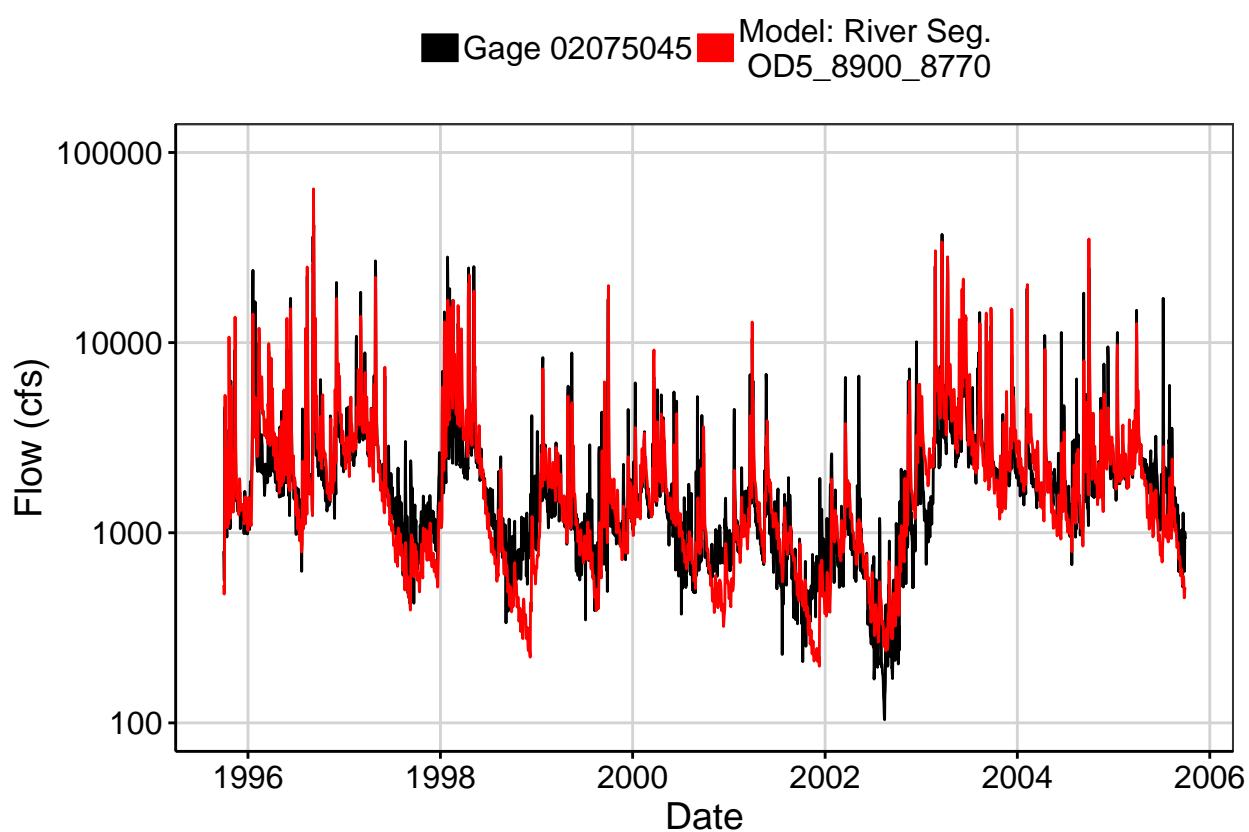


Fig. 2: Zoomed Hydrograph

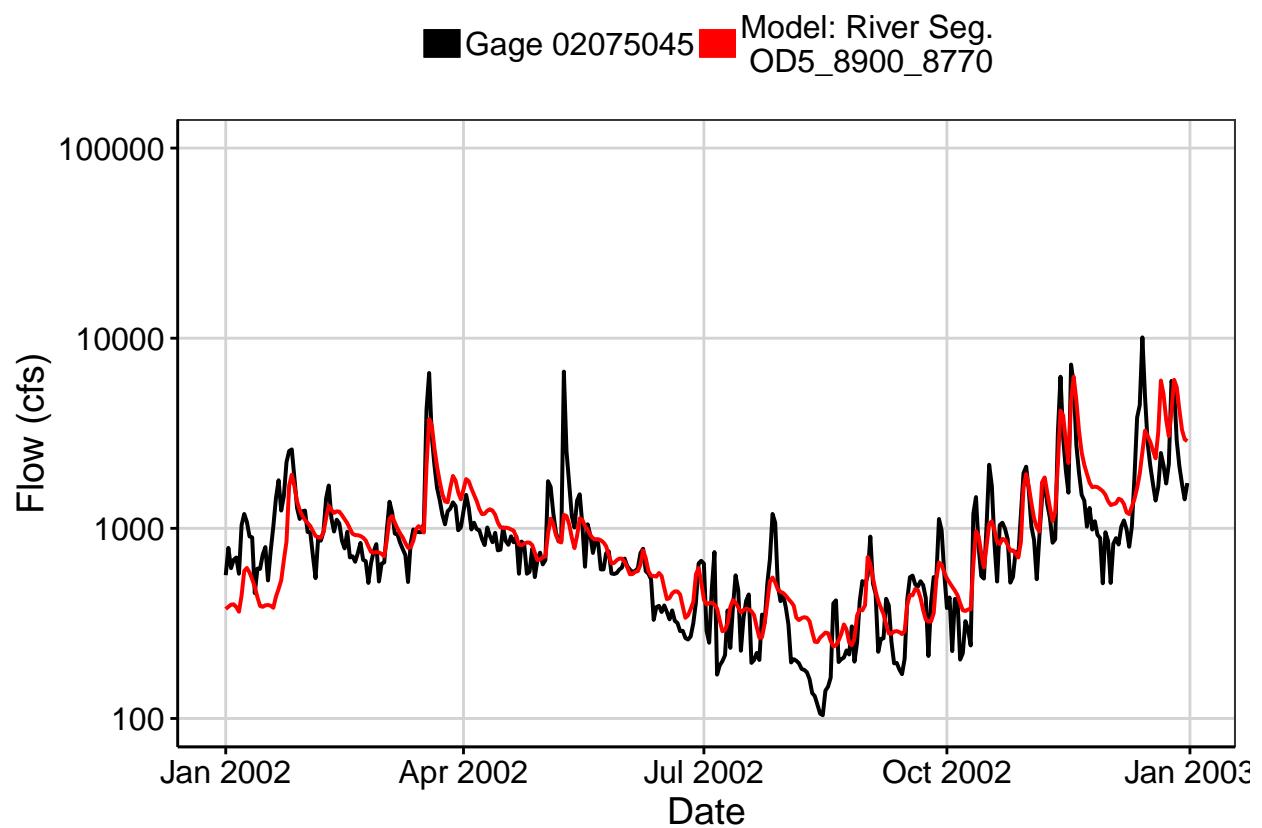


Fig. 3: Flow Exceedance

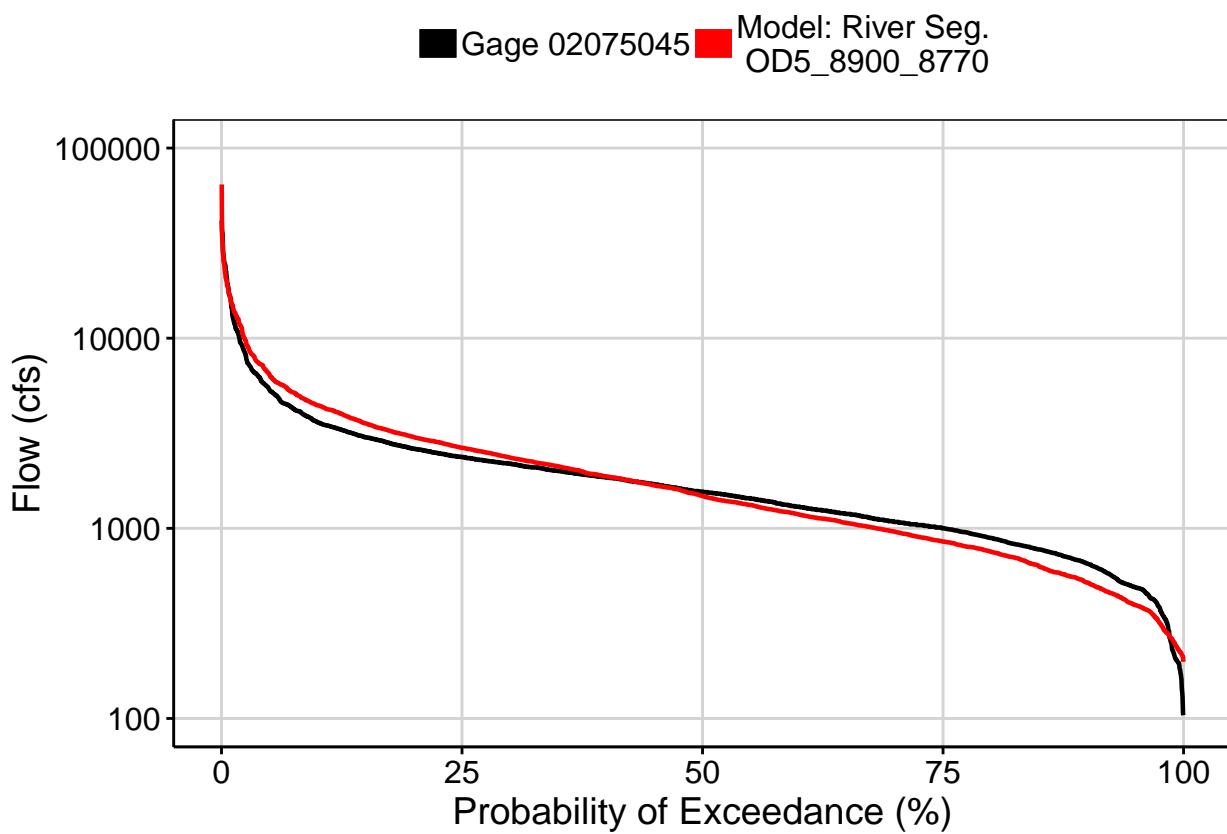
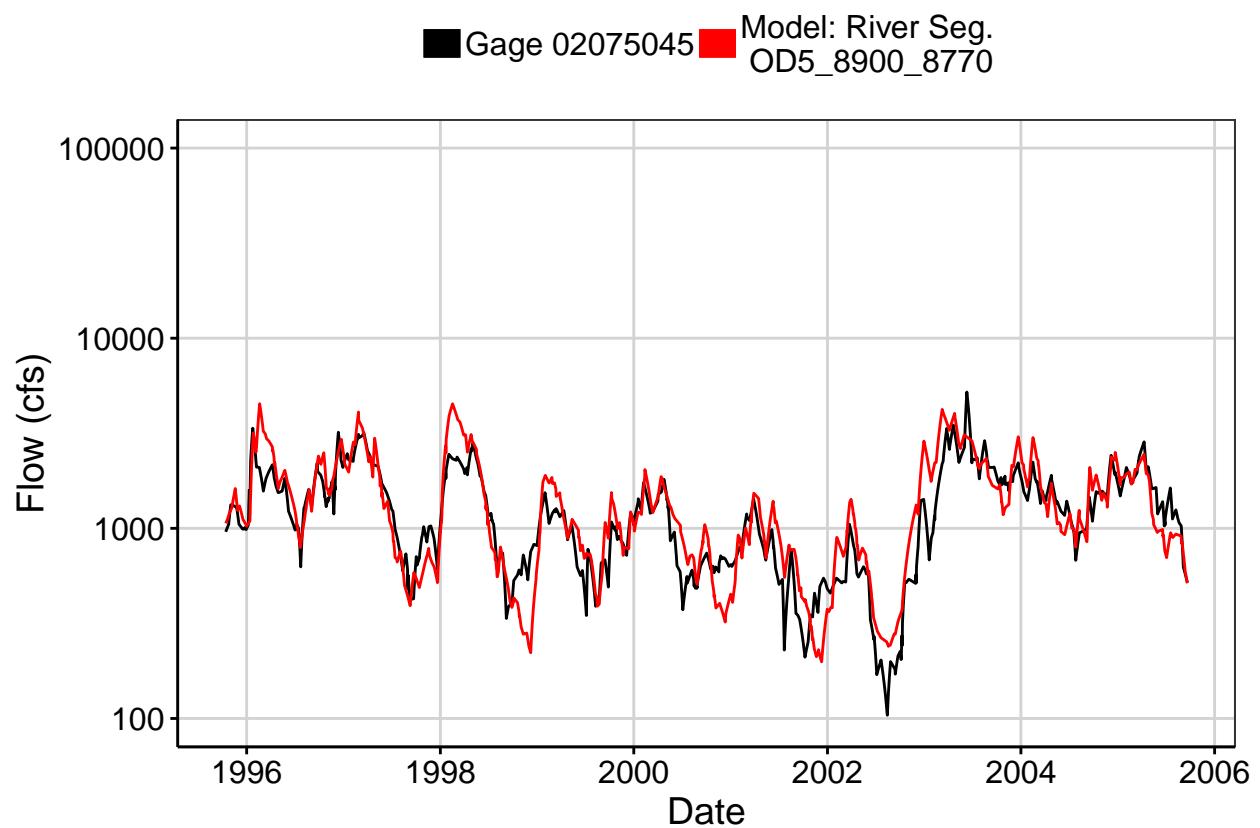


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

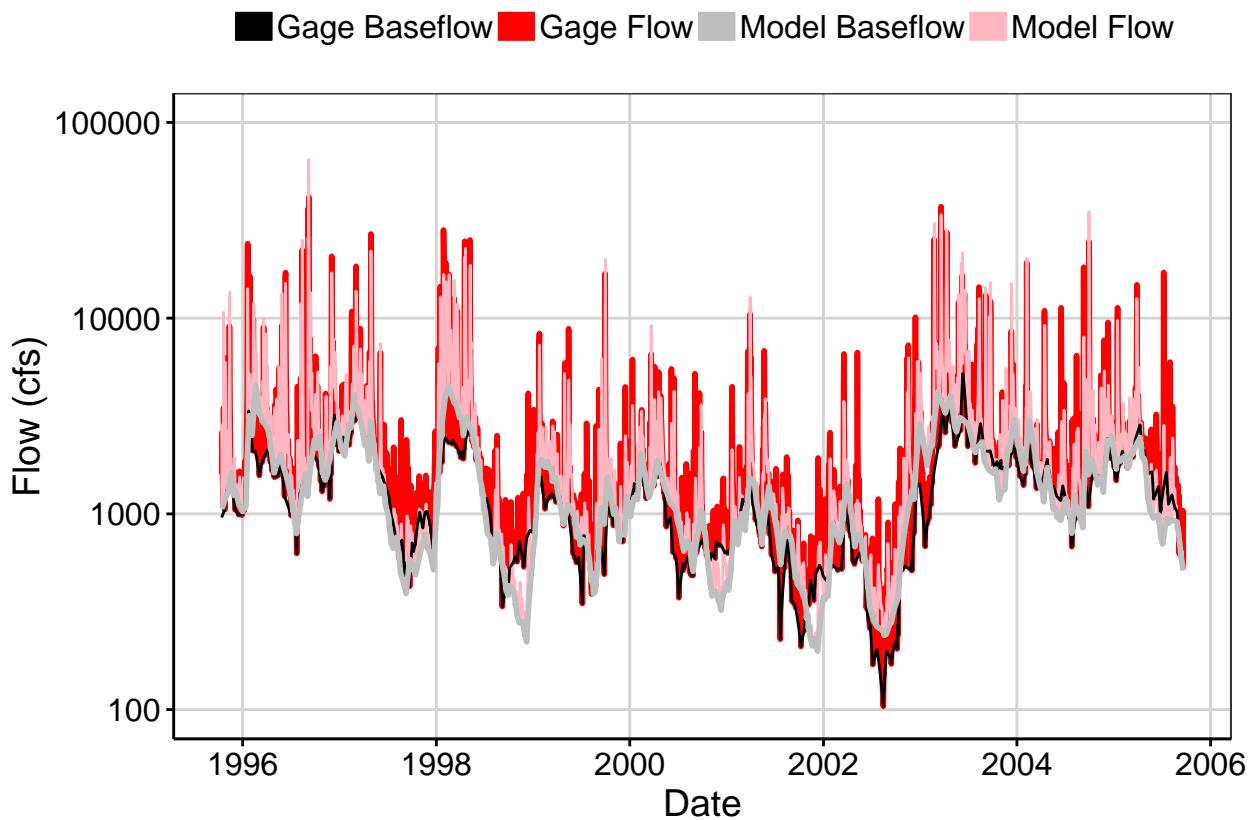


Fig. 6: Largest Error Segment

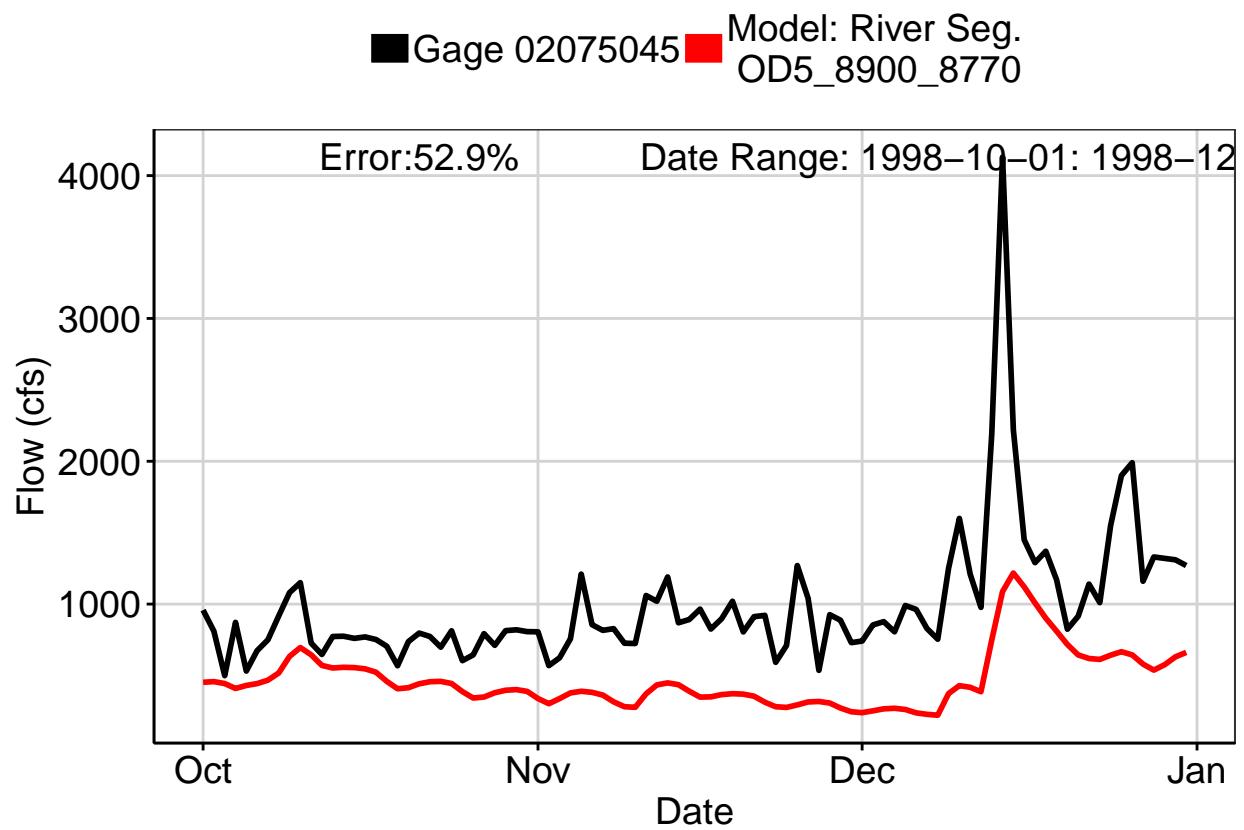


Fig. 7: Second Largest Error Segment

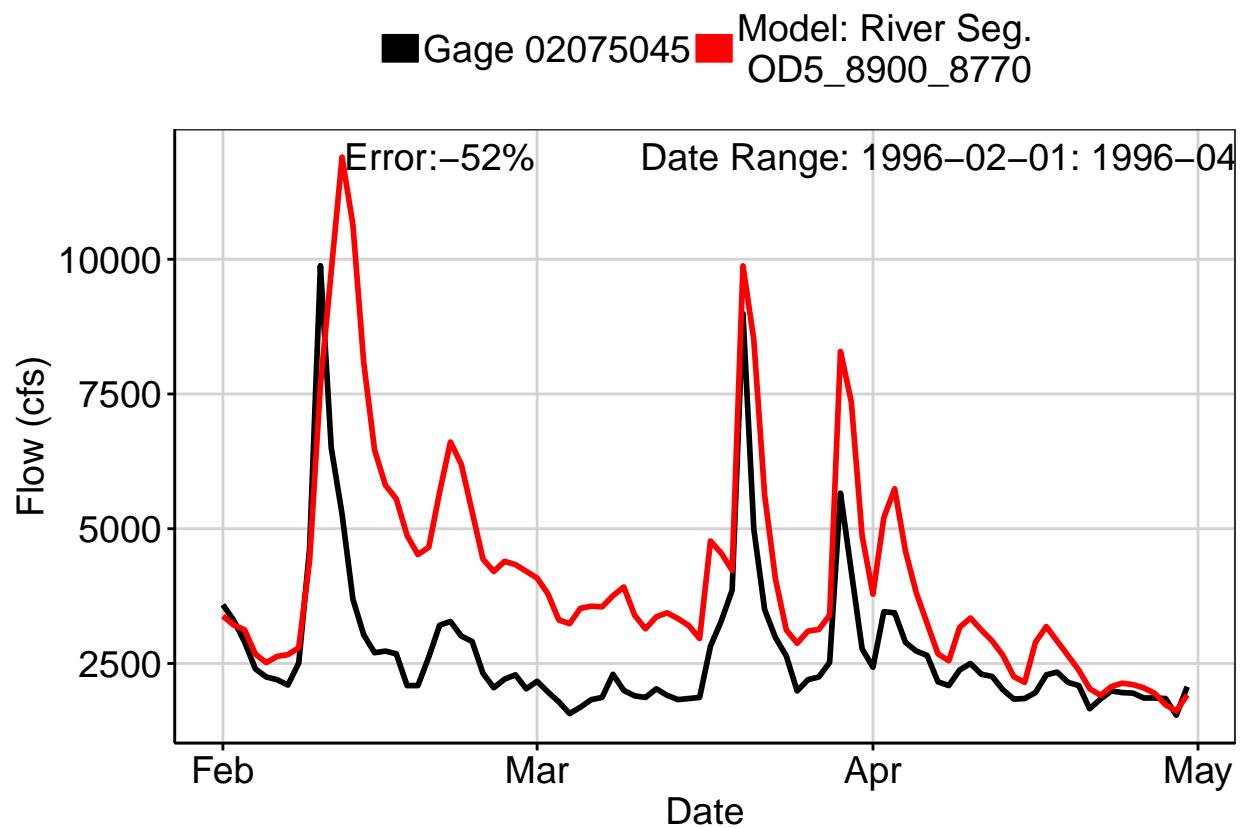


Fig. 8: Third Largest Error Segment

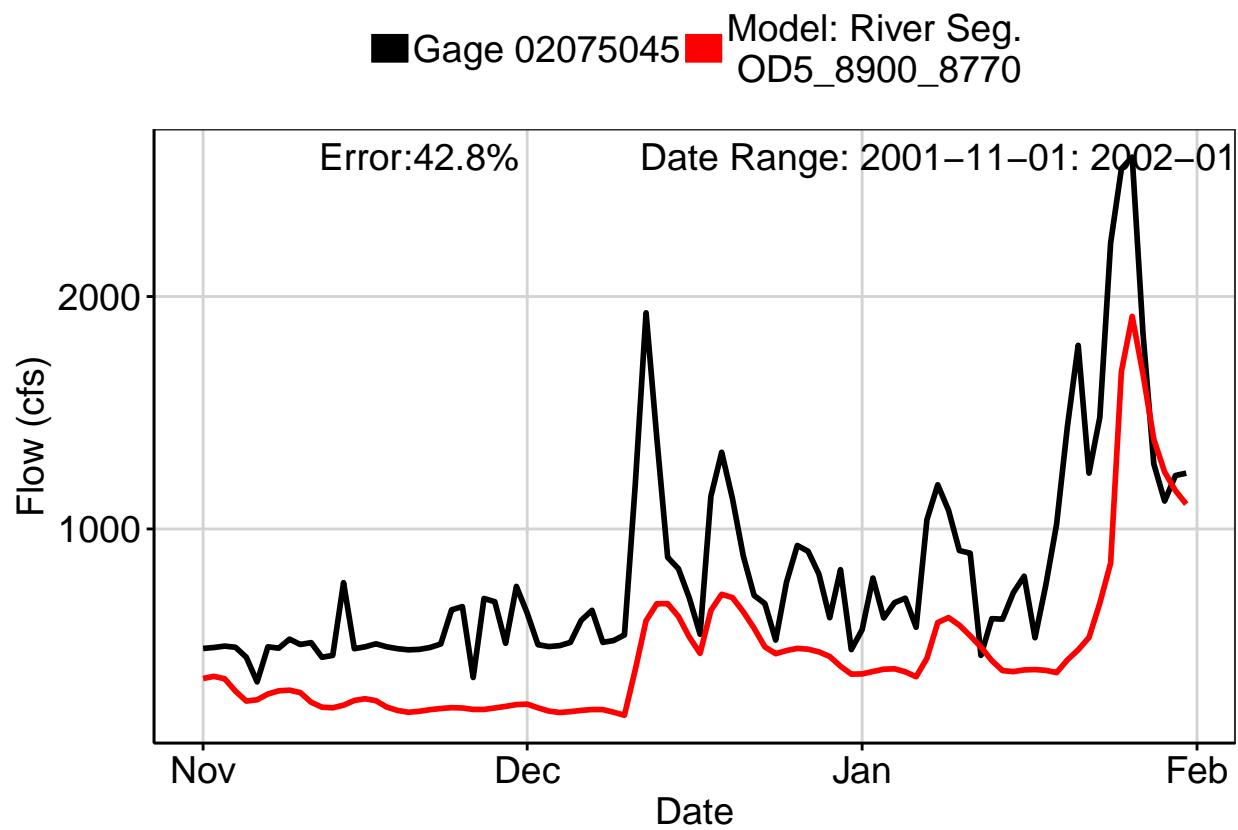
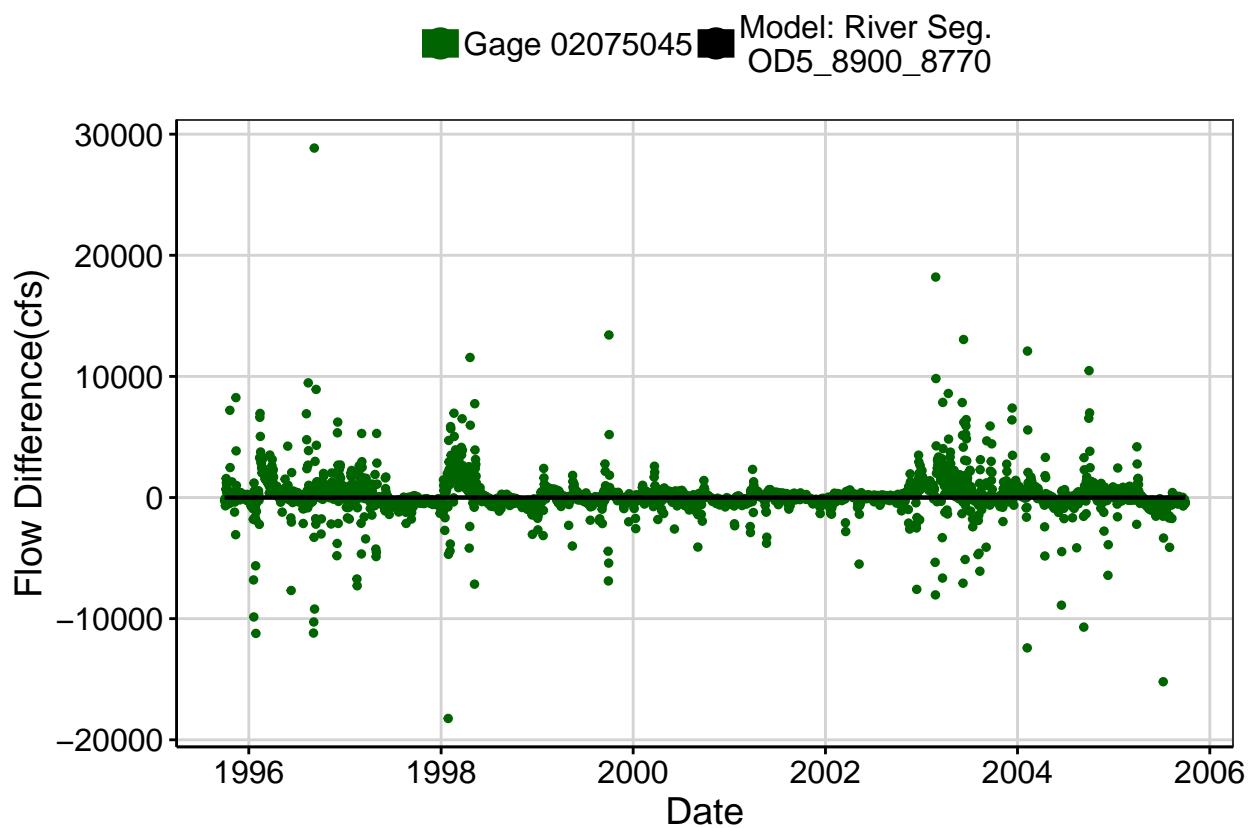
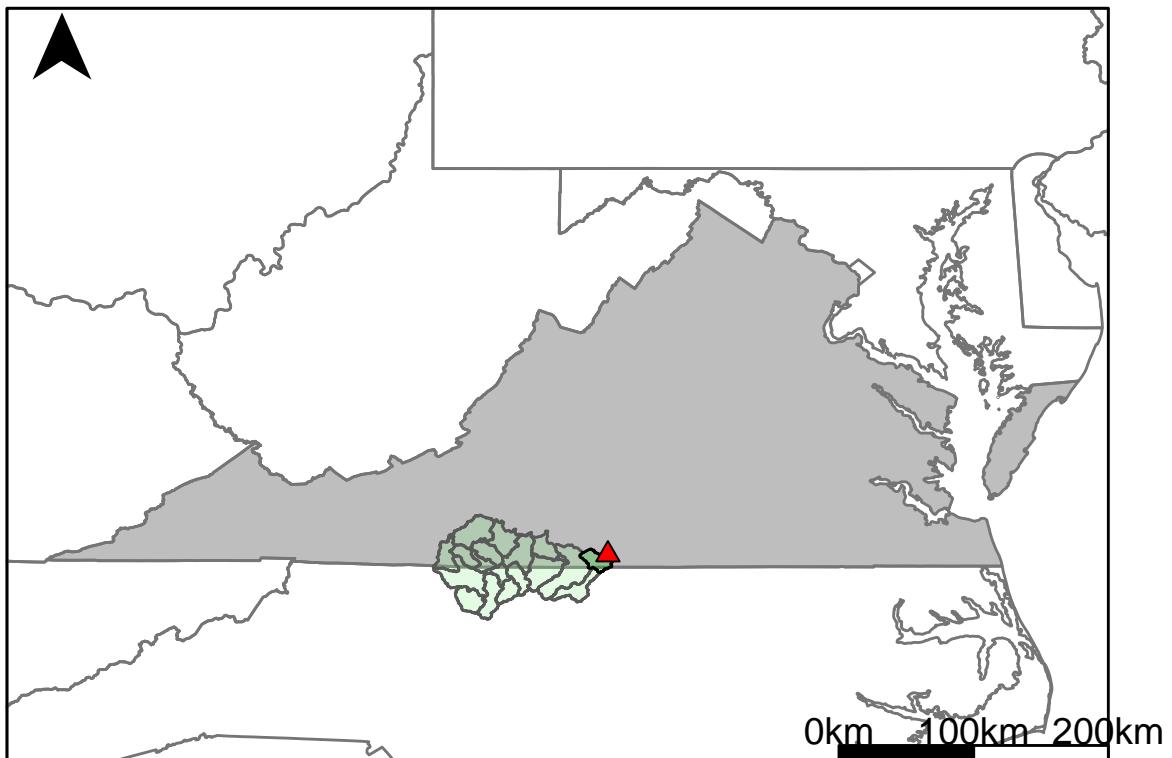


Fig. 9: Residuals Plot



## Appendix C.10: USGS Gage 02075500 vs. OD5\_8780\_8660



This river segment follows part of the flow of the Dan River. The gage is located in Halifax County, VA (Lat 36°38'32", Long 79°05'23") approximately 17 miles northeast of Danville, VA. Drainage area is 2587 sq. miles. This gage started taking data in 1950 and is still taking data. There are a number of dams and mills in Danville that regulated the low-flow conditions in this area. The average daily discharge error between the model and gage data for the 20 year timespan was 1.77%, with 35% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	770	555	27.9
Feb. Low Flow	1000	851	14.9
Mar. Low Flow	1180	1150	2.54
Apr. Low Flow	1310	1330	-1.53
May Low Flow	1720	2190	-27.3
Jun. Low Flow	1830	2450	-33.9
Jul. Low Flow	1820	1910	-4.95
Aug. Low Flow	1440	1480	-2.78
Sep. Low Flow	1260	1200	4.76
Oct. Low Flow	1050	864	17.7
Nov. Low Flow	819	695	15.1
Dec. Low Flow	736	606	17.7

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	2820	2770	1.77
Jan. Mean Flow	3430	3250	5.25
Feb. Mean Flow	3540	3850	-8.76
Mar. Mean Flow	4590	5230	-13.9
Apr. Mean Flow	3960	4280	-8.08
May Mean Flow	2930	2870	2.05
Jun. Mean Flow	2580	2450	5.04
Jul. Mean Flow	1990	1520	23.6
Aug. Mean Flow	1950	1570	19.5
Sep. Mean Flow	2330	2170	6.87
Oct. Mean Flow	1940	1900	2.06
Nov. Mean Flow	2090	1860	11
Dec. Mean Flow	2530	2340	7.51

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	2630	1640	37.6
Feb. High Flow	4810	5230	-8.73
Mar. High Flow	6410	4630	27.8
Apr. High Flow	9820	6630	32.5
May High Flow	9860	5880	40.4
Jun. High Flow	13200	11300	14.4
Jul. High Flow	9240	6950	24.8
Aug. High Flow	6570	4910	25.3
Sep. High Flow	3700	2920	21.1
Oct. High Flow	3990	2000	49.9
Nov. High Flow	3740	1450	61.2
Dec. High Flow	3040	1560	48.7

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	133	215	-61.7
Med. 1 Day Min	574	422	26.5
Min. 3 Day Min	135	218	-61.5
Med. 3 Day Min	757	436	42.4
Min. 7 Day Min	143	219	-53.1
Med. 7 Day Min	802	483	39.8
Min. 30 Day Min	230	237	-3.04
Med. 30 Day Min	1000	600	40
Min. 90 Day Min	353	388	-9.92
Med. 90 Day Min	1380	939	32
7Q10	381	275	27.8
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	872	2770	-218
Mean Baseflow	1540	1630	-5.84

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	53400	84500	-58.2
Med. 1 Day Max	28700	25000	12.9
Max. 3 Day Max	45400	60600	-33.5
Med. 3 Day Max	23100	19700	14.7
Max. 7 Day Max	30700	36000	-17.3
Med. 7 Day Max	14000	12500	10.7
Max. 30 Day Max	11900	13900	-16.8
Med. 30 Day Max	6270	6350	-1.28
Max. 90 Day Max	7980	9460	-18.5
Med. 90 Day Max	3780	4260	-12.7

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	382	286	25.1
5% Non-Exceedance	713	451	36.7
50% Non-Exceedance	1900	1700	10.5
95% Non-Exceedance	7570	8080	-6.74
99% Non-Exceedance	18900	18800	0.53
Sept. 10% Non-Exceedance	536	535	0.19

**Fig. 1: Hydrograph**

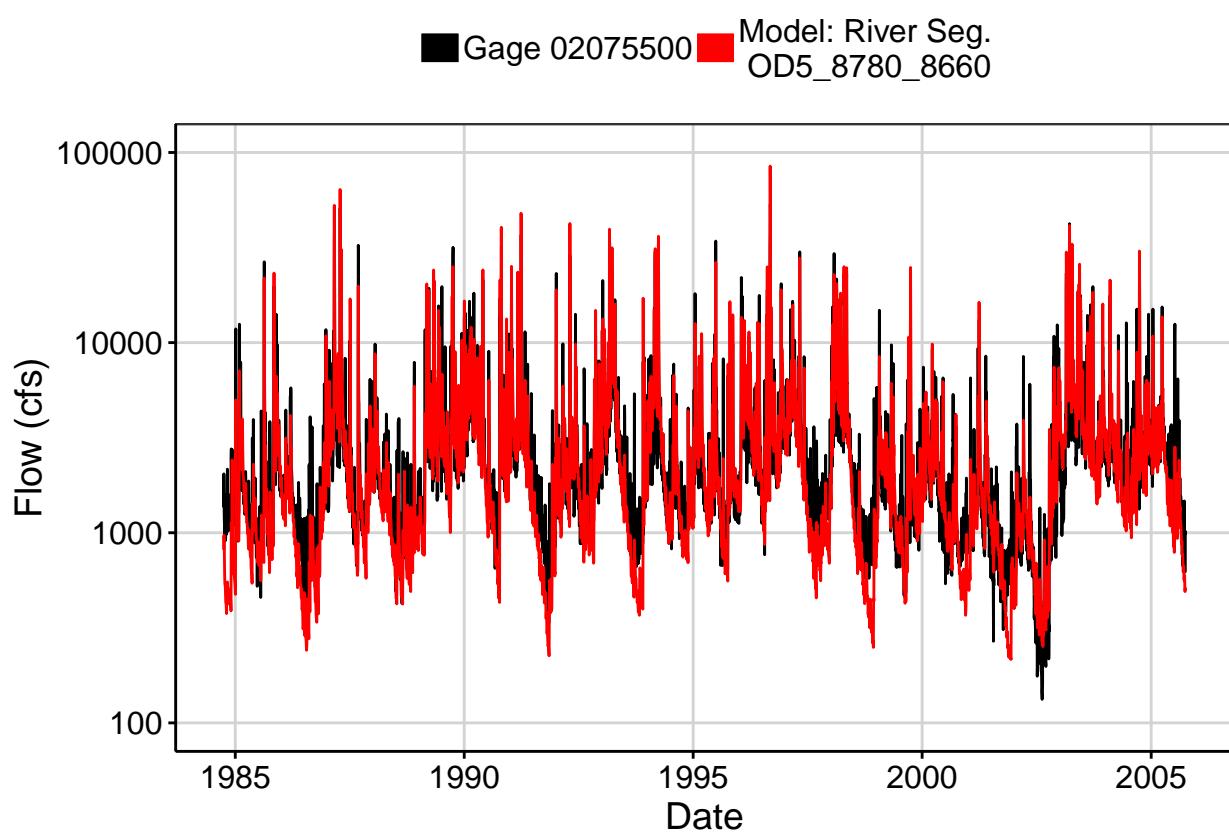


Fig. 2: Zoomed Hydrograph

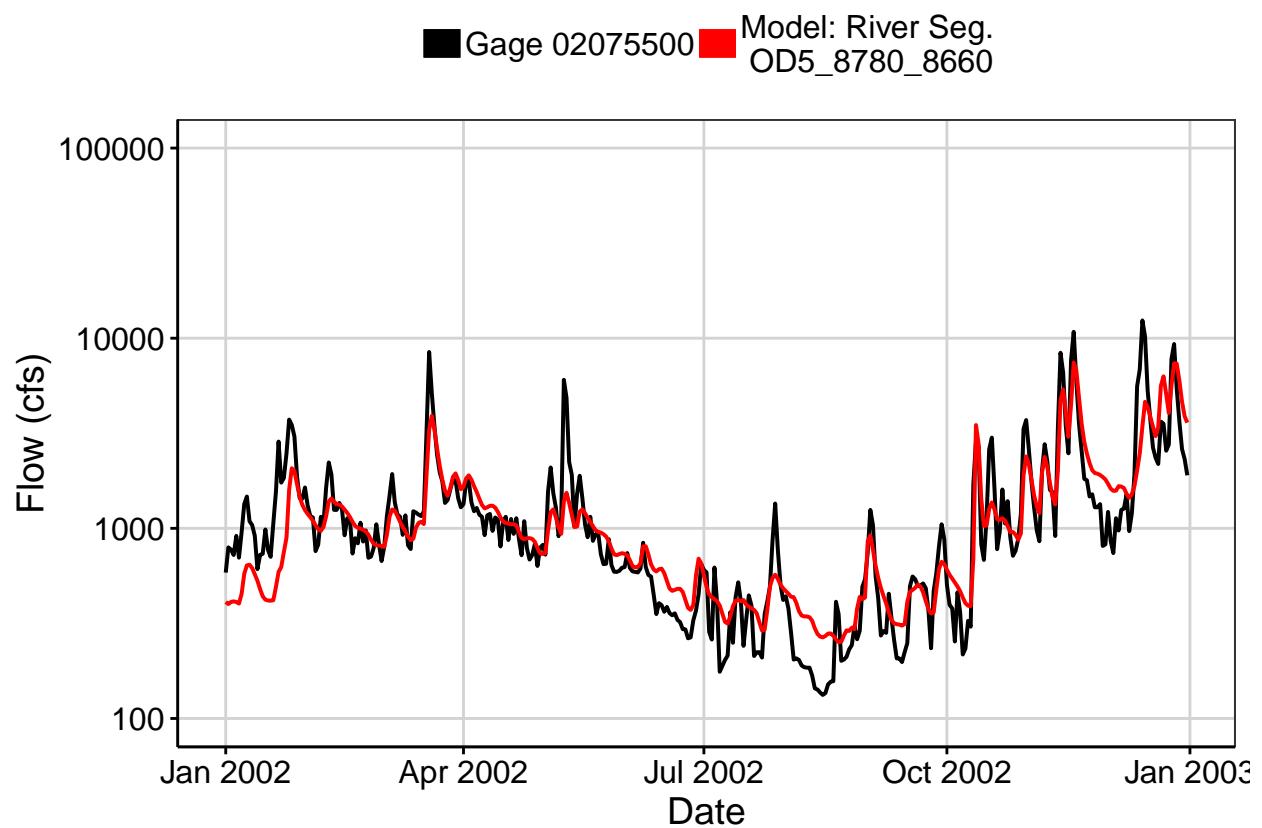


Fig. 3: Flow Exceedance

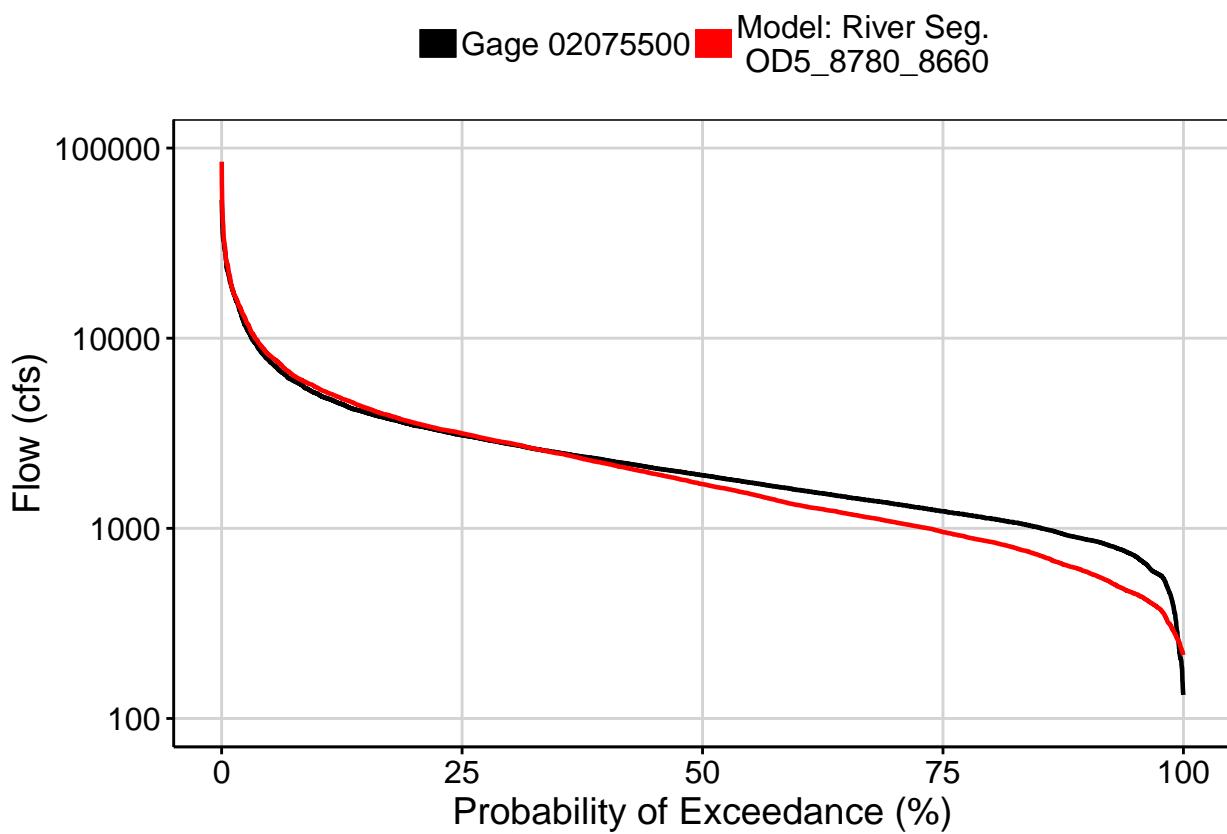


Fig. 4: Baseflow

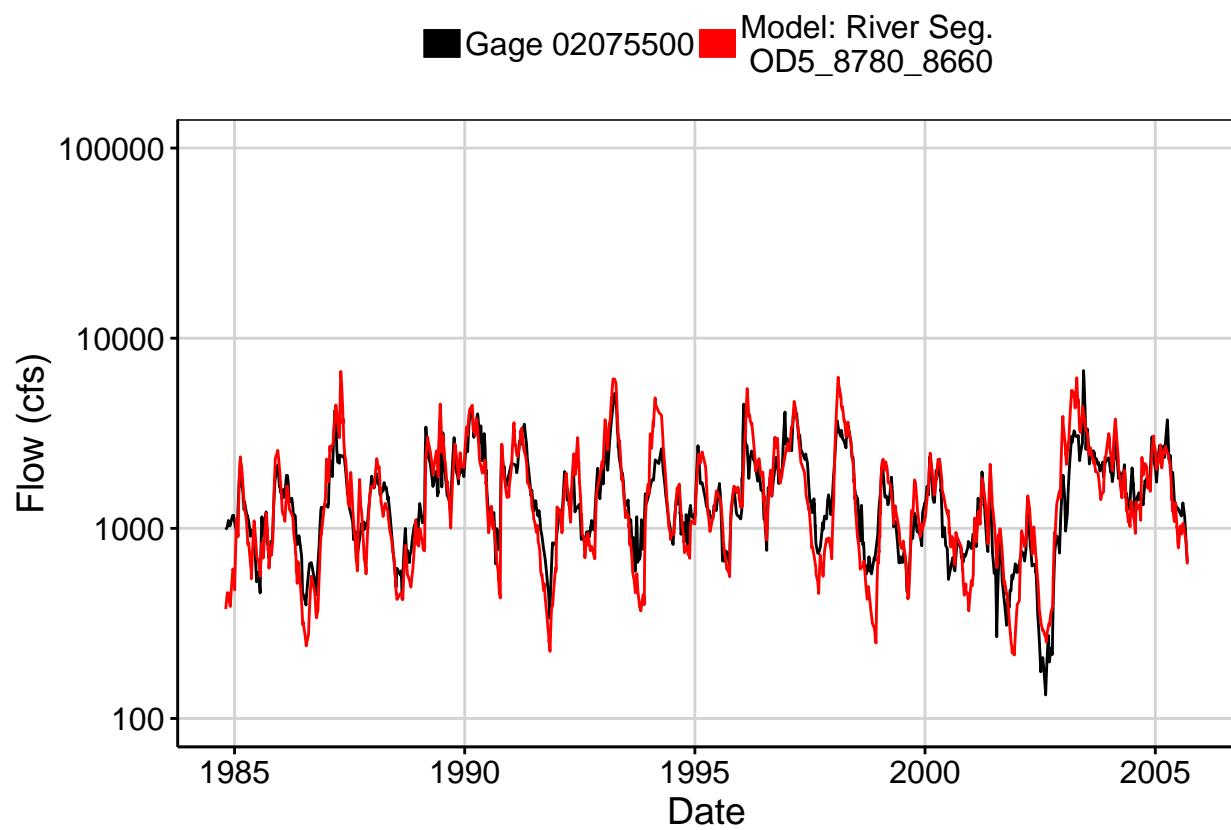


Fig. 5: Combined Baseflow

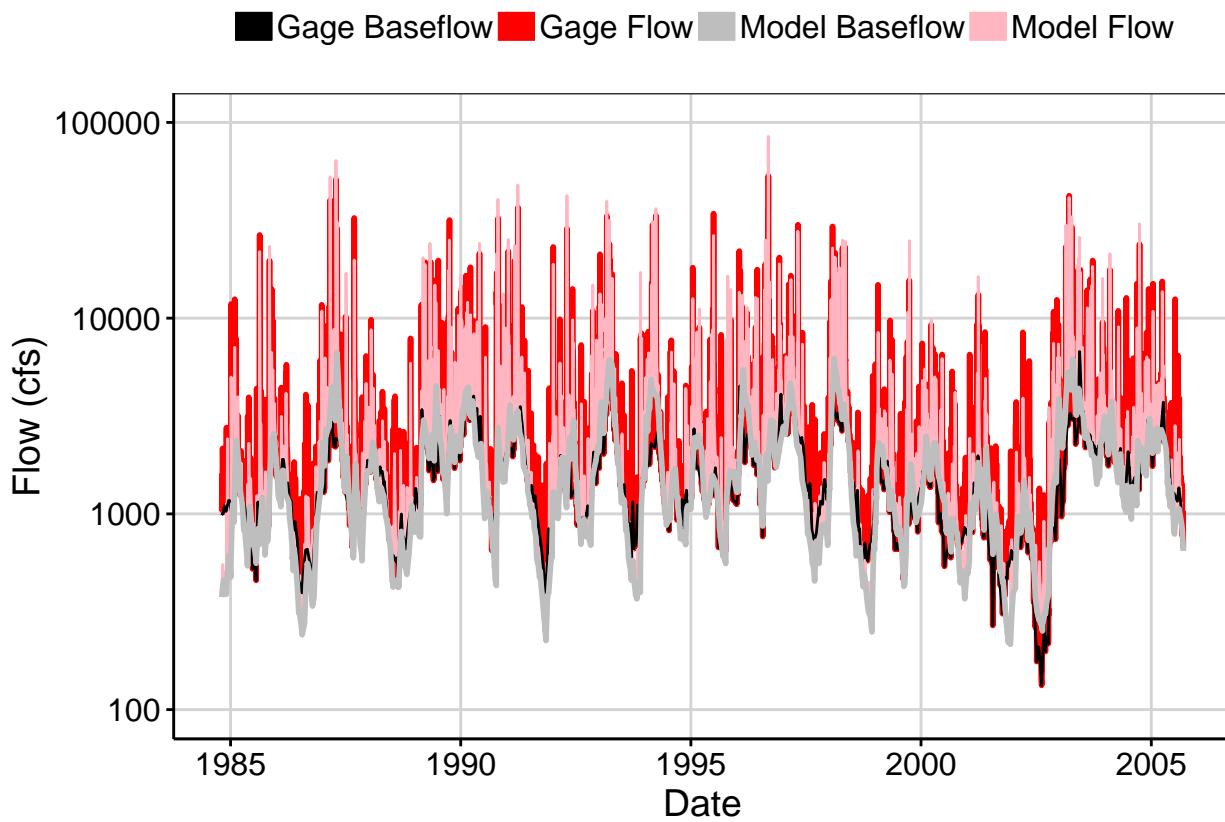


Fig. 6: Largest Error Segment

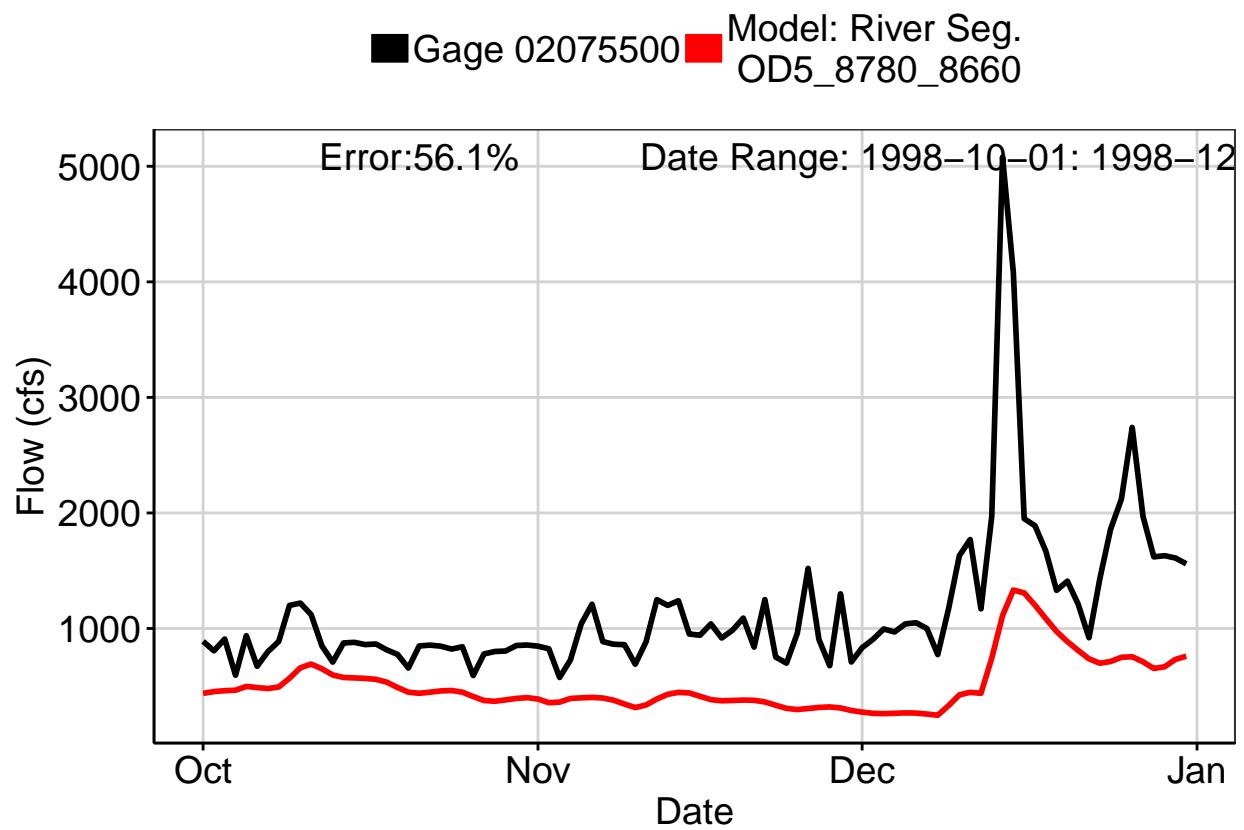


Fig. 7: Second Largest Error Segment

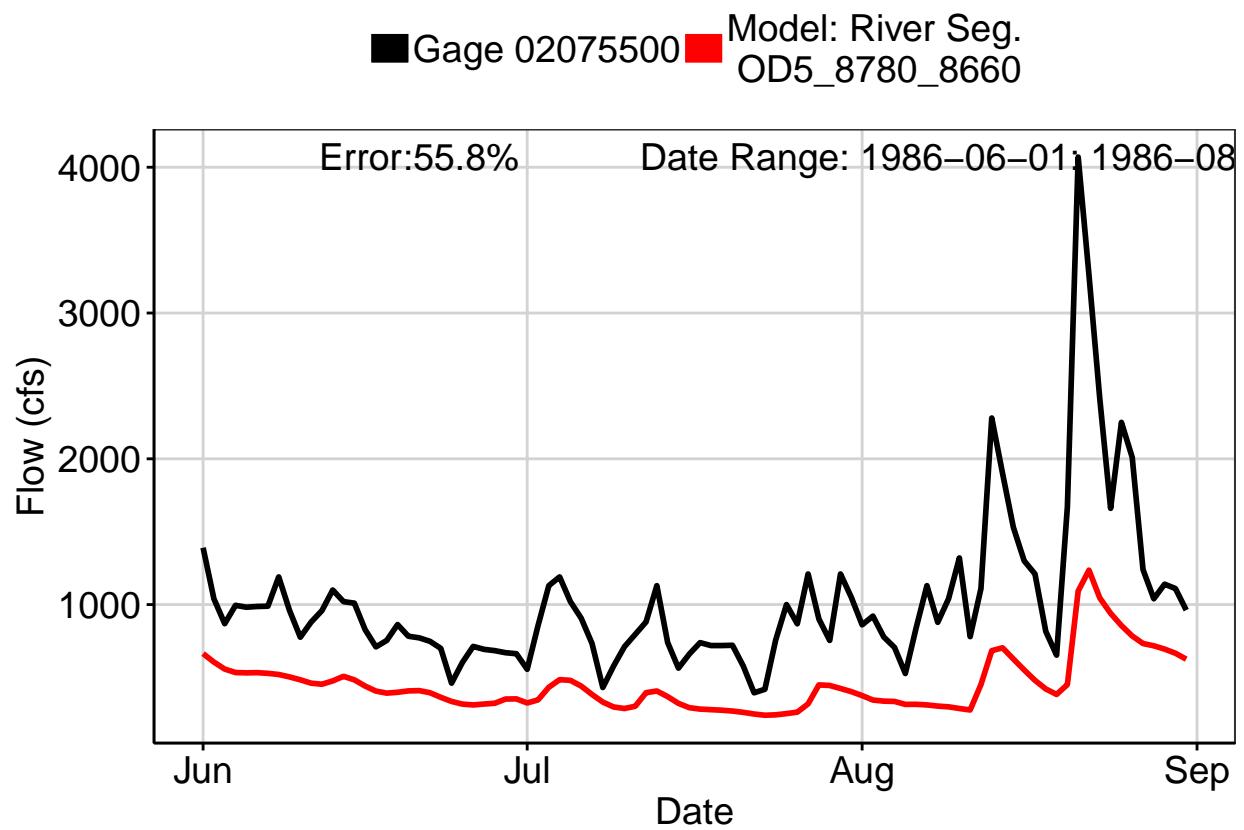


Fig. 8: Third Largest Error Segment

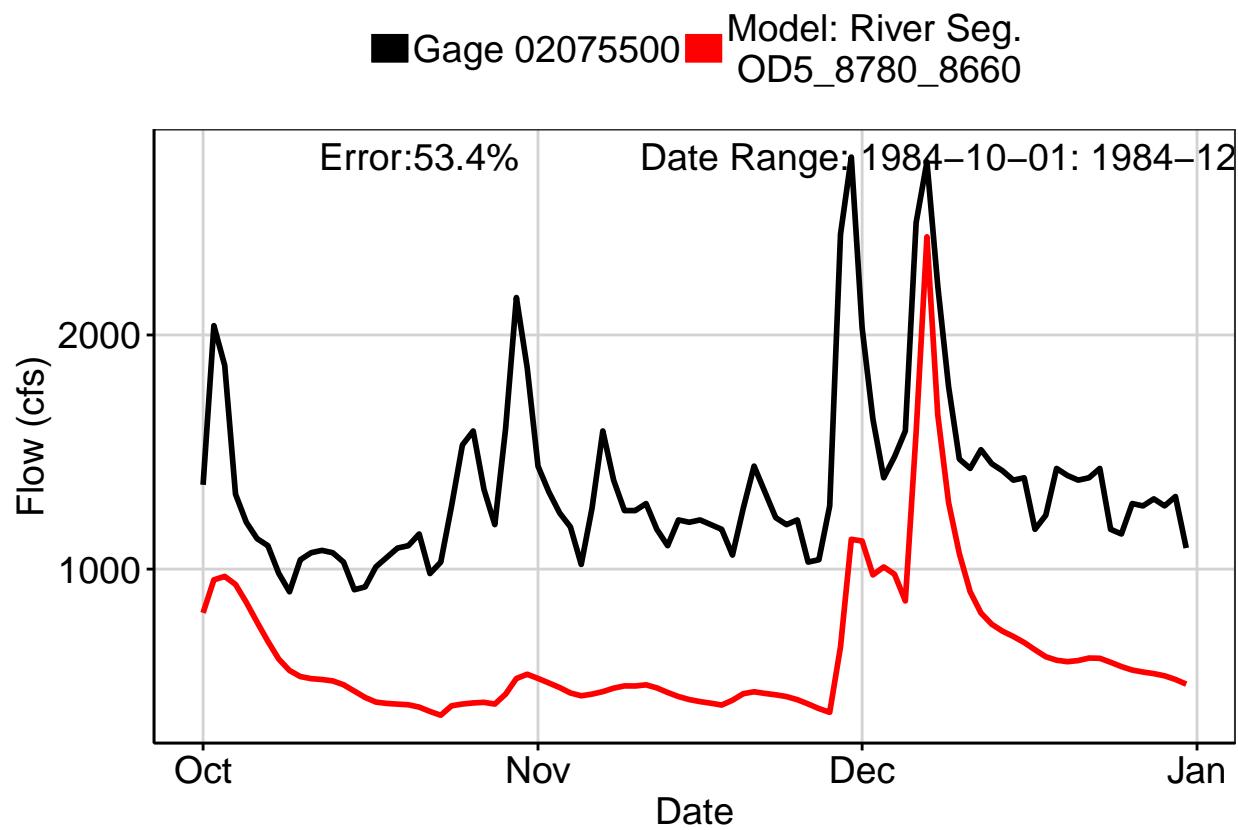
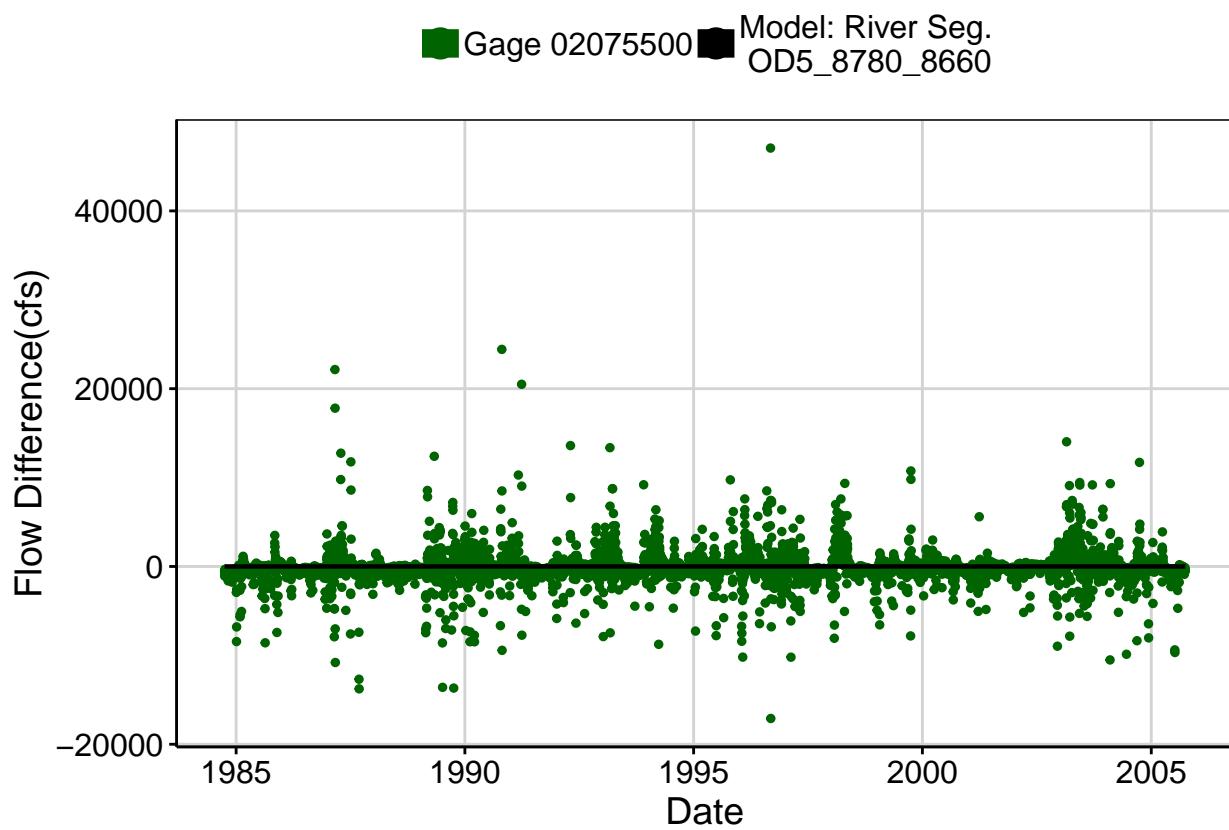
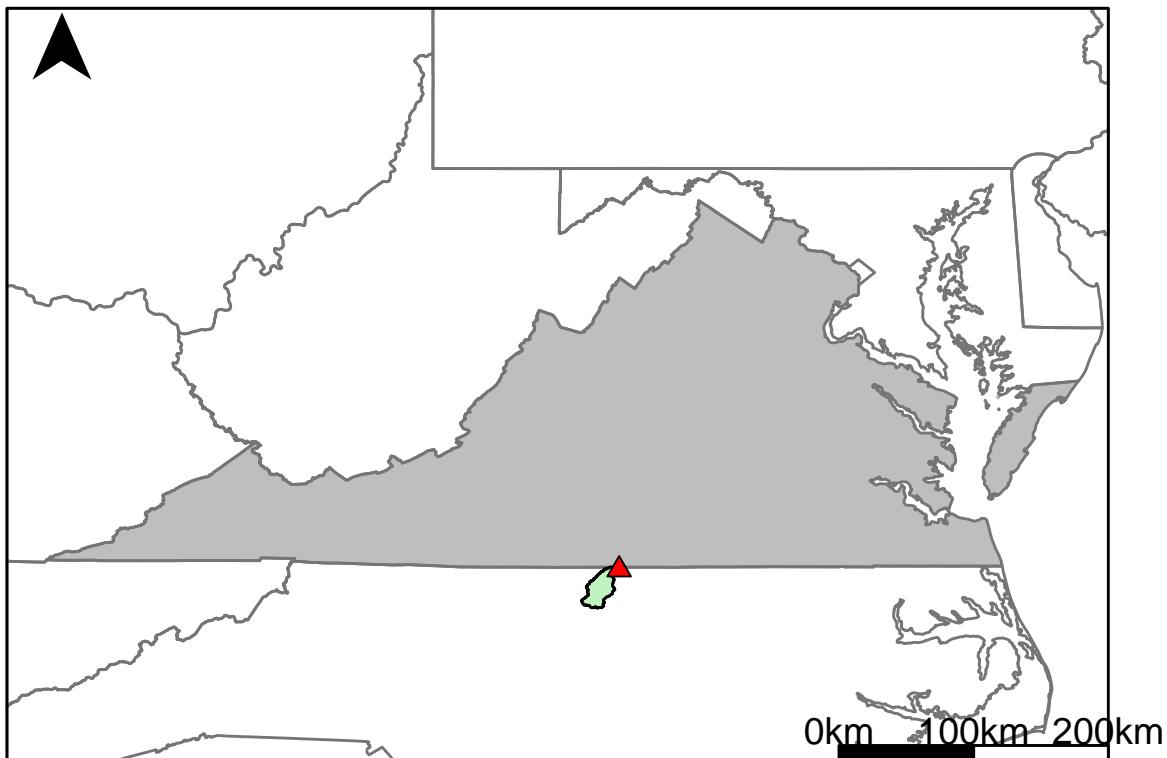


Fig. 9: Residuals Plot



## Appendix C.11: USGS Gage 02077303 vs. OD2\_8920\_8830



This river segment follows part of the flow of the Hyco River, a tributary of the Dan River. The gage is located in Person County, NC (Lat 36°31'21", Long 78°58'51") approximately 24 miles southeast of Danville, VA. Drainage area is 202 sq. miles. This gage started taking data in 1973 and is still taking data. It is regulated by the Afterbay Dam which is 200ft upstream of the gage. The cities of Roxboro and Oxford use the Dam in cases of emergency to supply their citizens with water. The average daily discharge error between the model and gage data for the 20 year timespan was -33.8%, with 68.3% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	16	15.1	5.63
Feb. Low Flow	13	54.9	-322
Mar. Low Flow	15	92.8	-519
Apr. Low Flow	18	150	-733
May Low Flow	57	225	-295
Jun. Low Flow	54	184	-241
Jul. Low Flow	20	176	-780
Aug. Low Flow	16.5	13	21.2
Sep. Low Flow	15	32	-113
Oct. Low Flow	13	18.4	-41.5
Nov. Low Flow	14	13	7.14
Dec. Low Flow	14.4	13	9.72

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	148	198	-33.8
Jan. Mean Flow	253	330	-30.4
Feb. Mean Flow	271	335	-23.6
Mar. Mean Flow	385	428	-11.2
Apr. Mean Flow	231	339	-46.8
May Mean Flow	106	114	-7.55
Jun. Mean Flow	82.3	133	-61.6
Jul. Mean Flow	45.1	73.7	-63.4
Aug. Mean Flow	64.5	65.7	-1.86
Sep. Mean Flow	89.9	152	-69.1
Oct. Mean Flow	60.7	126	-108
Nov. Mean Flow	75.6	121	-60.1
Dec. Mean Flow	118	173	-46.6

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	25	96.5	-286
Feb. High Flow	18	191	-961
Mar. High Flow	355	258	27.3
Apr. High Flow	983	499	49.2
May High Flow	940	499	46.9
Jun. High Flow	1490	716	51.9
Jul. High Flow	1120	578	48.4
Aug. High Flow	188	287	-52.7
Sep. High Flow	35	91.2	-161
Oct. High Flow	36	58.7	-63.1
Nov. High Flow	36	34.2	5
Dec. High Flow	26	63.8	-145

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	0.27	13	-4710
Med. 1 Day Min	8.8	13	-47.7
Min. 3 Day Min	0.33	13	-3800
Med. 3 Day Min	8.8	13	-47.7
Min. 7 Day Min	0.45	13	-2810
Med. 7 Day Min	9.03	13	-44
Min. 30 Day Min	0.8	13	-1520
Med. 30 Day Min	13.5	13.1	2.96
Min. 90 Day Min	4.12	13	-216
Med. 90 Day Min	17.1	24.2	-41.5
7Q10	1.77	13.3	-651
Year of 90-Day Min. Flow	2002	1986	100
Drought Year Mean	5.11	198	-3770
Mean Baseflow	40	119	-198

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	7000	11100	-58.6
Med. 1 Day Max	3280	1590	51.5
Max. 3 Day Max	4570	6140	-34.4
Med. 3 Day Max	2500	1300	48
Max. 7 Day Max	2650	3650	-37.7
Med. 7 Day Max	1540	1090	29.2
Max. 30 Day Max	1250	1300	-4
Med. 30 Day Max	578	503	13
Max. 90 Day Max	772	831	-7.64
Med. 90 Day Max	274	371	-35.4

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	1.99	13	-553
5% Non-Exceedance	4.21	13	-209
50% Non-Exceedance	23	118	-413
95% Non-Exceedance	697	673	3.44
99% Non-Exceedance	2000	1370	31.5
Sept. 10% Non-Exceedance	12.9	13	-0.78

**Fig. 1: Hydrograph**

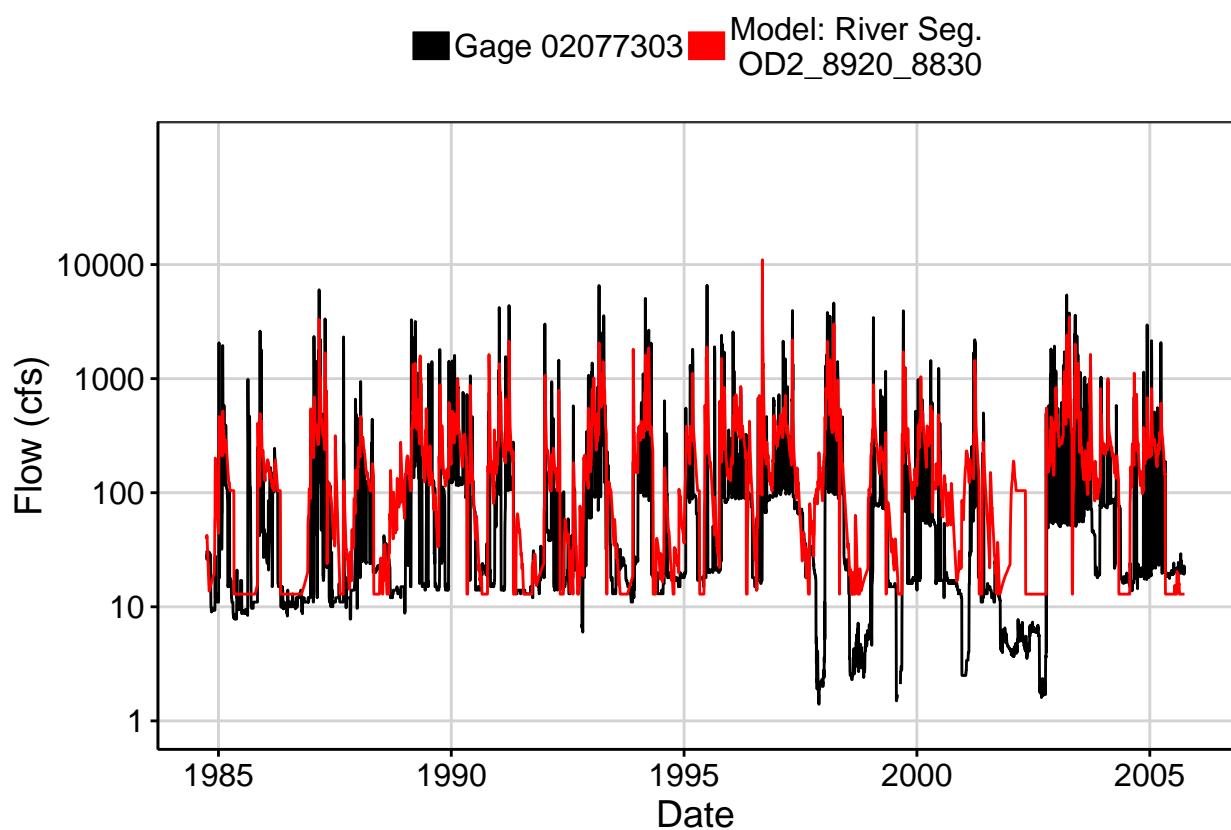


Fig. 2: Zoomed Hydrograph

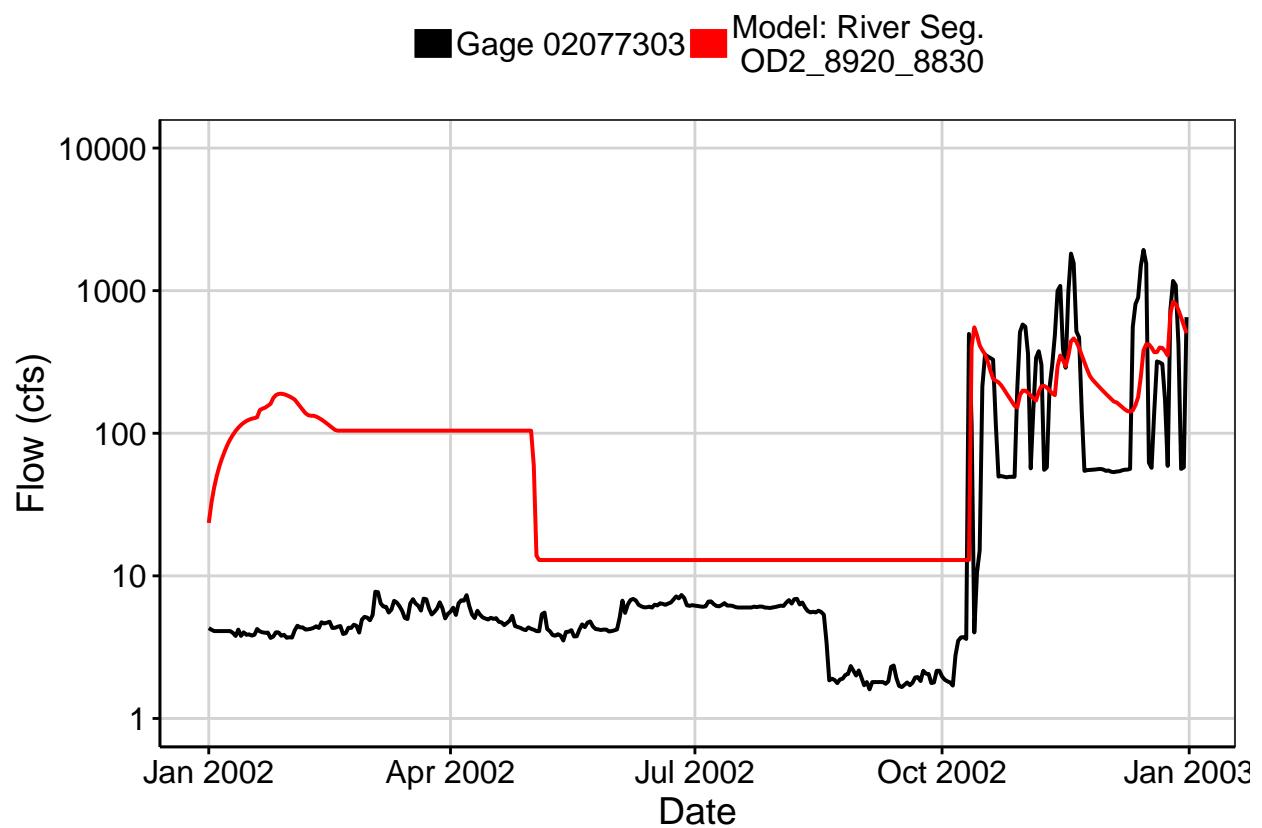


Fig. 3: Flow Exceedance

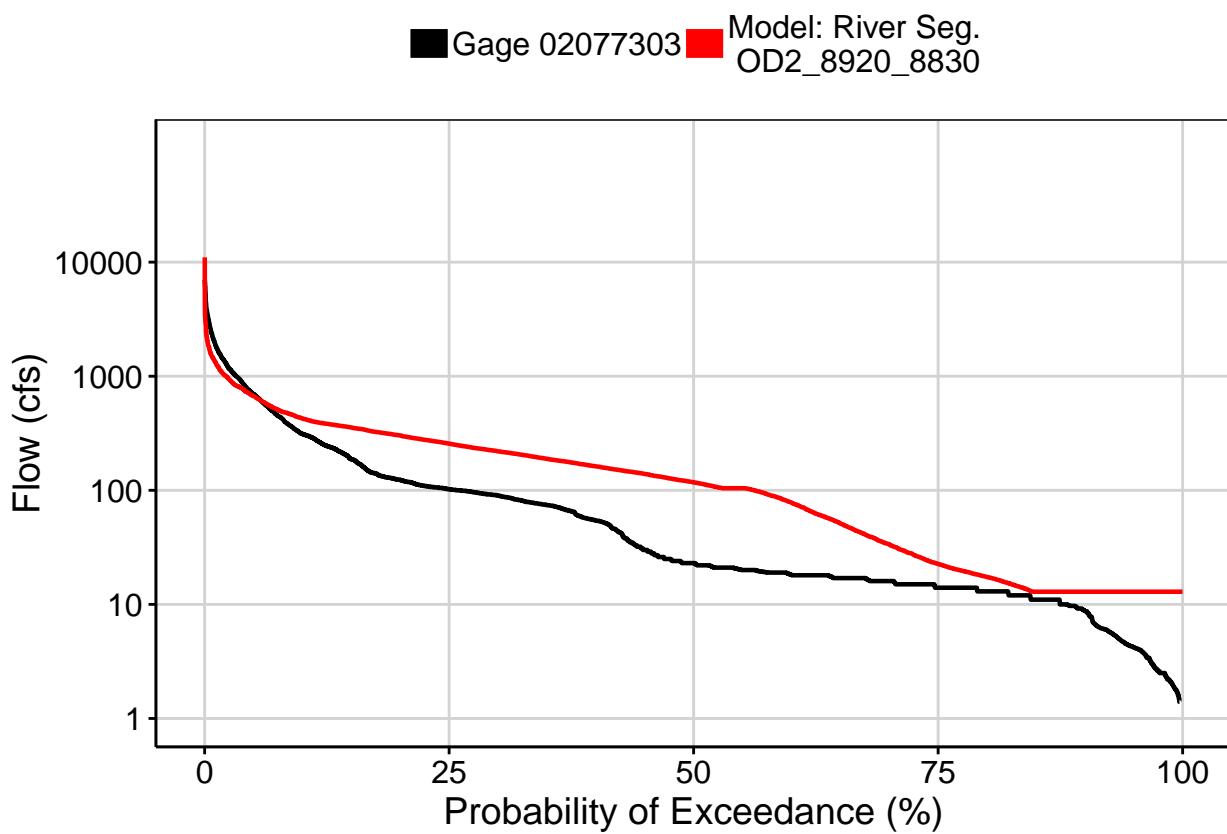


Fig. 4: Baseflow

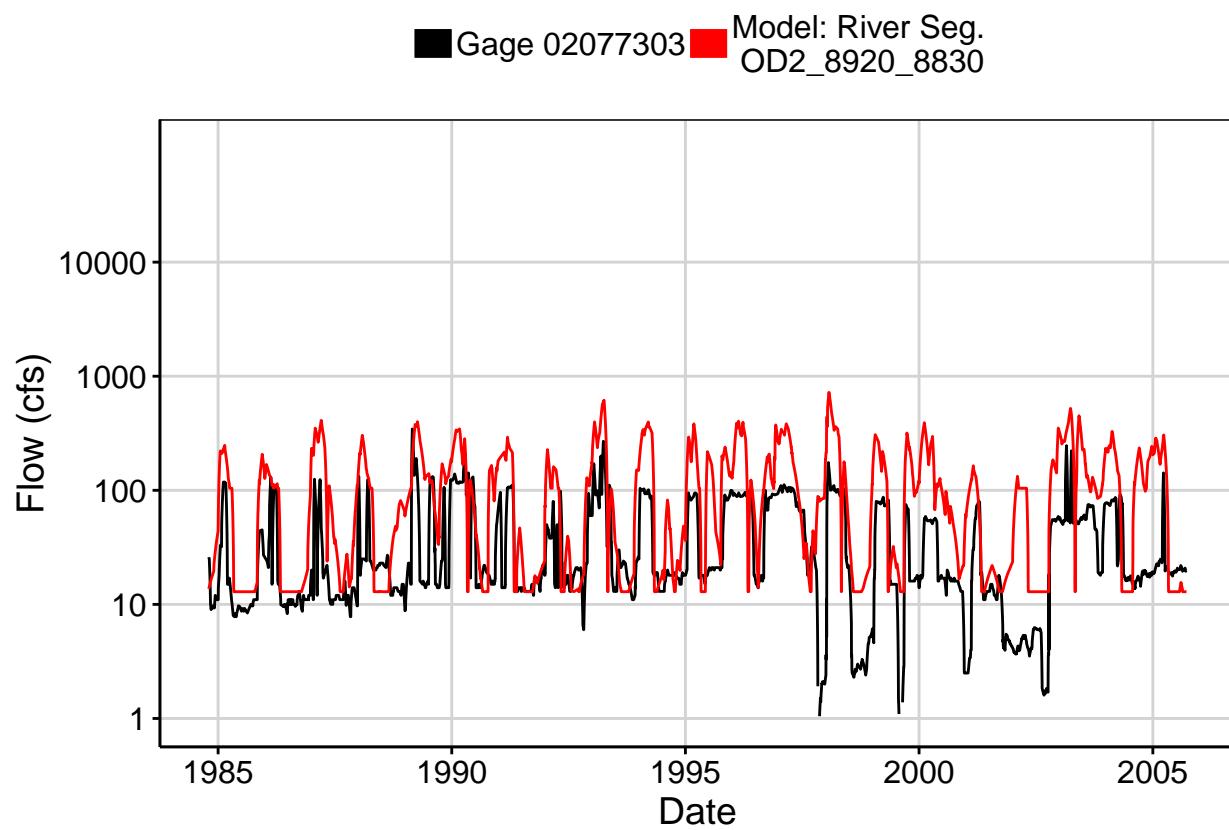


Fig. 5: Combined Baseflow

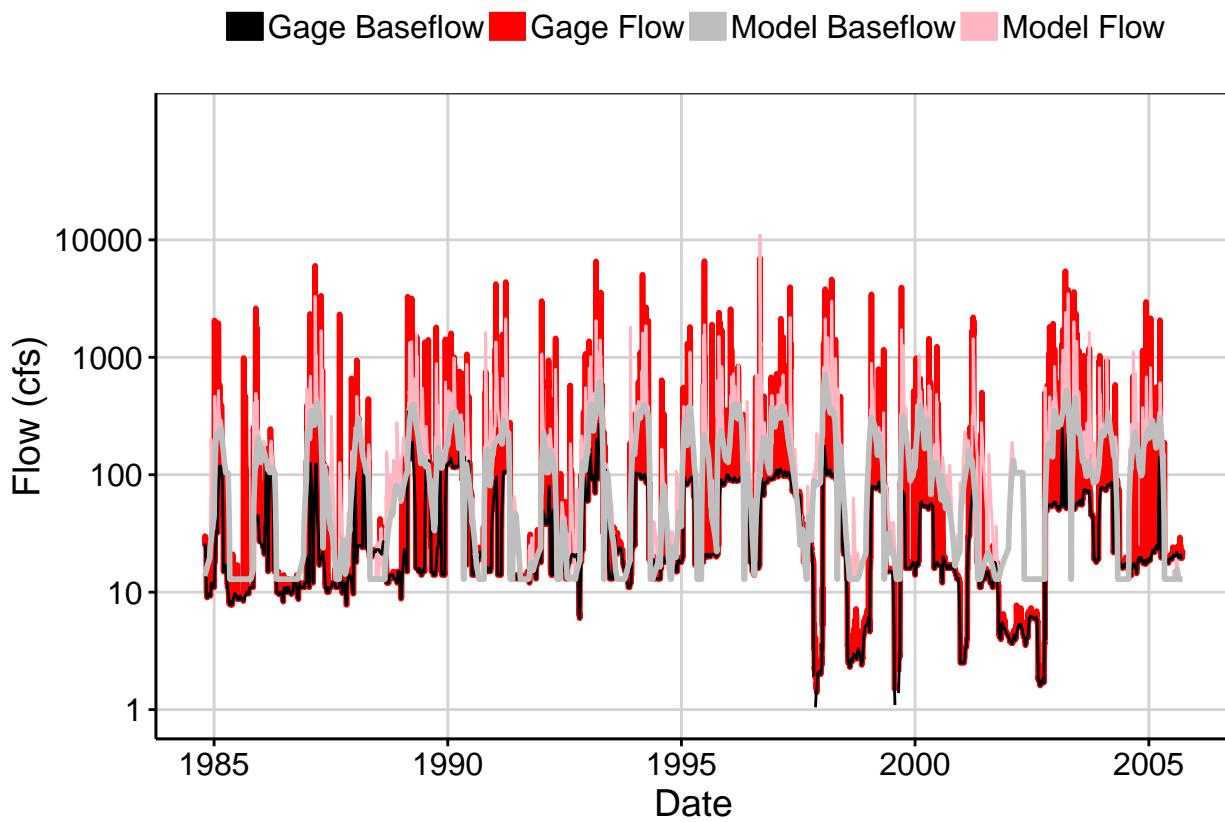


Fig. 6: Largest Error Segment

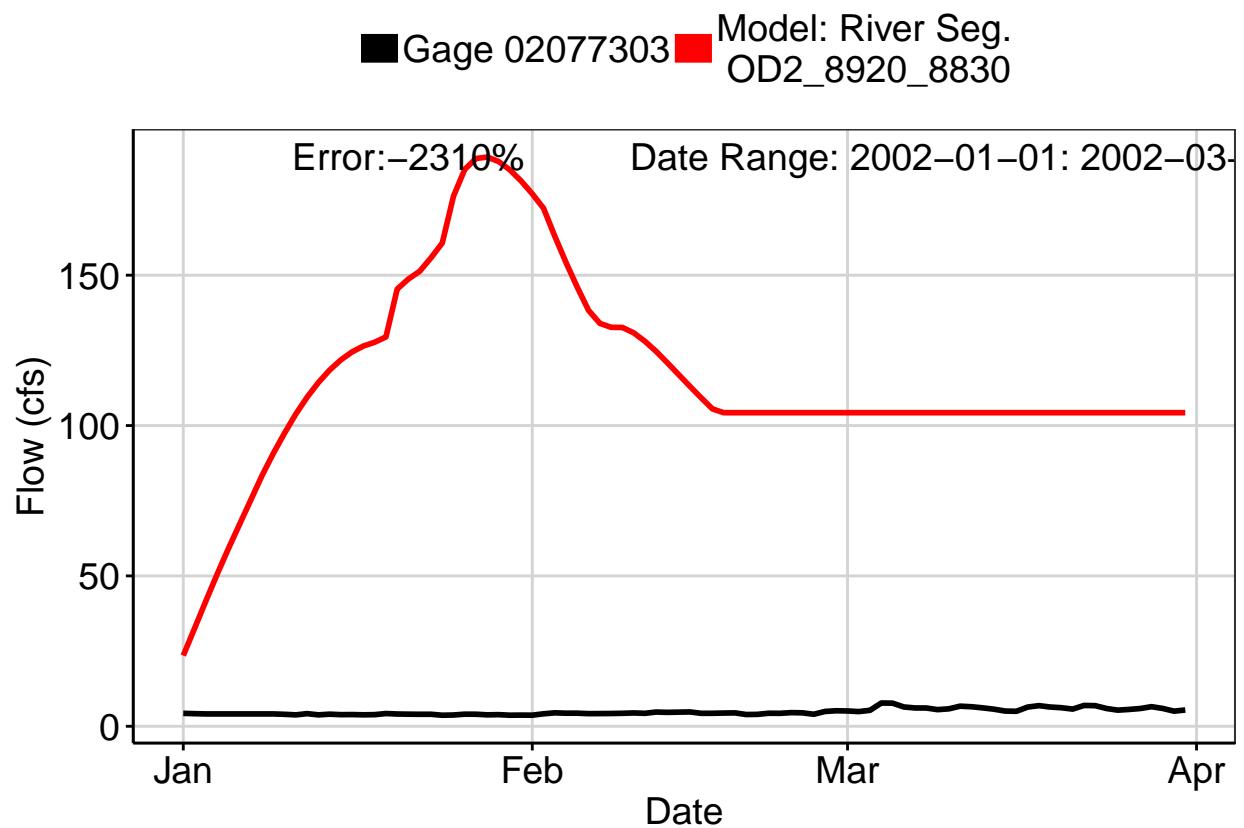


Fig. 7: Second Largest Error Segment

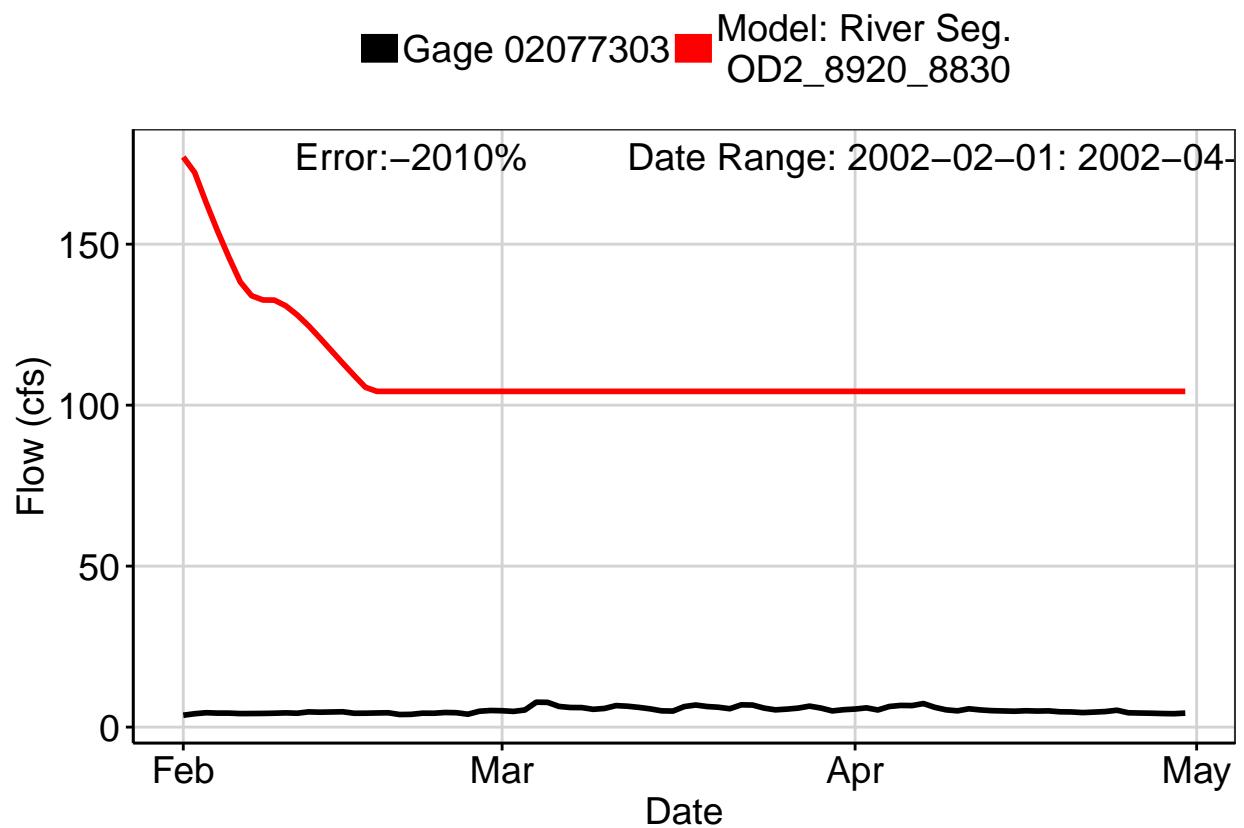


Fig. 8: Third Largest Error Segment

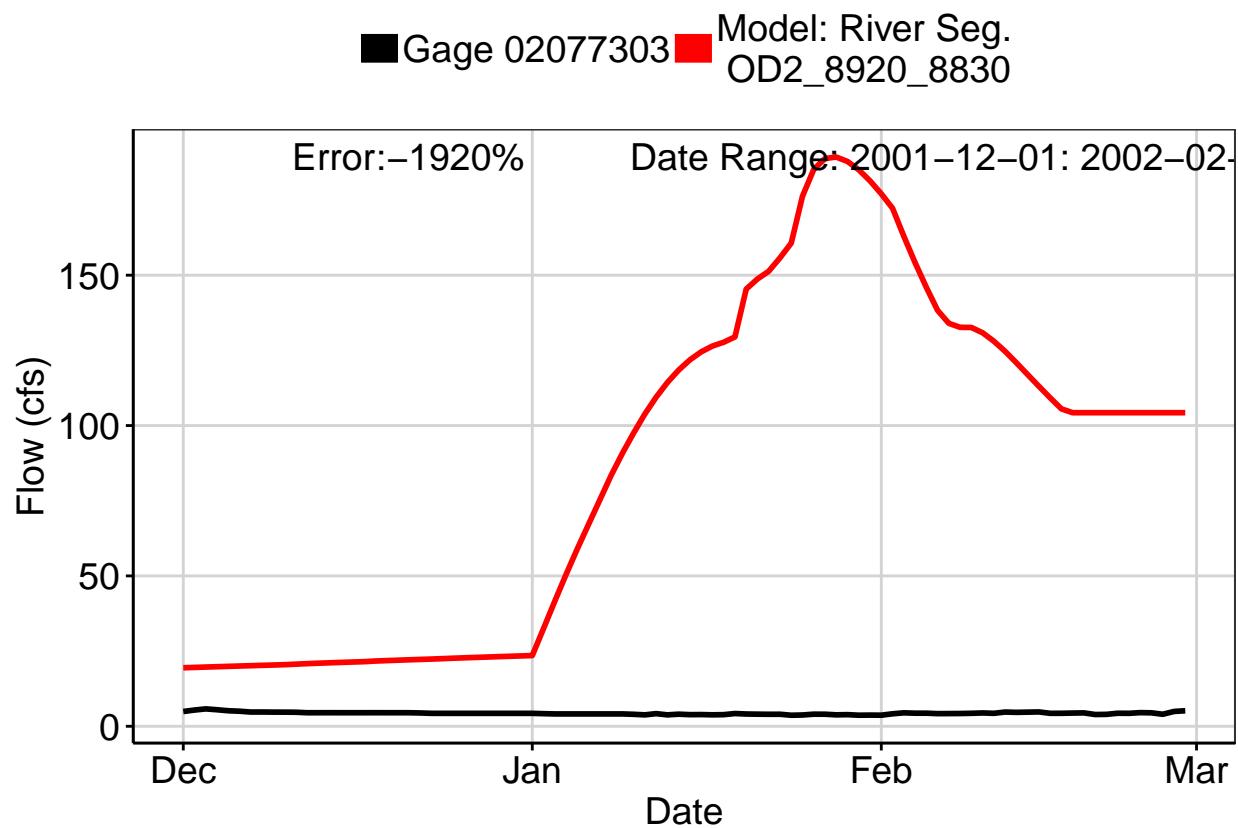
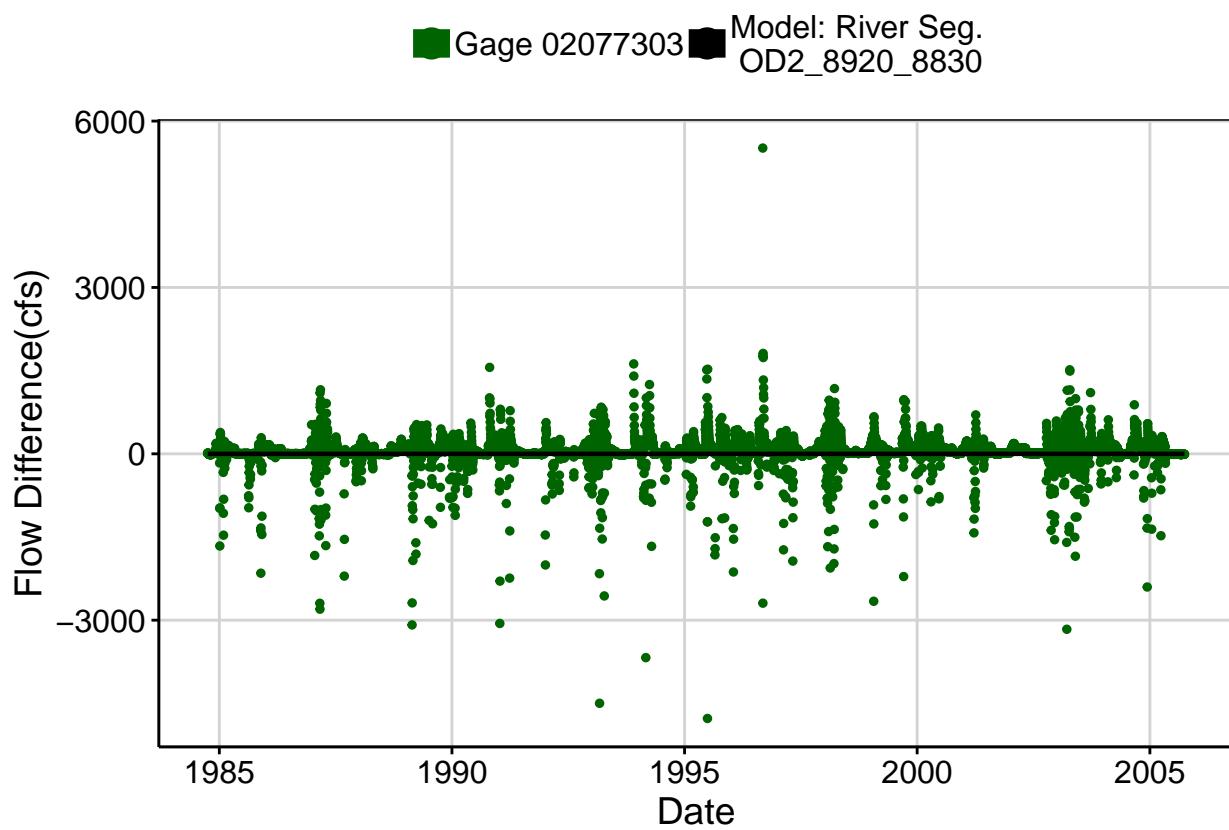
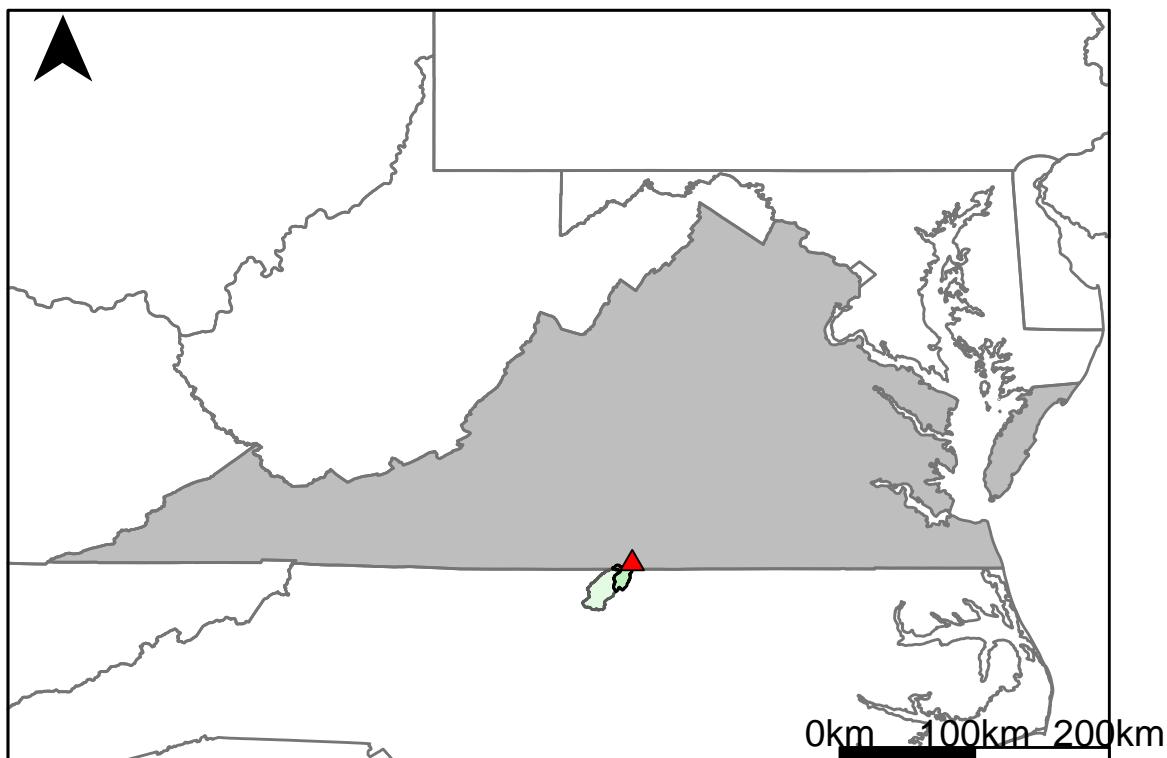


Fig. 9: Residuals Plot



## Appendix C.12: USGS Gage 02077500 vs. OD2\_8830\_8710



This river segment follows part of the flow of the Hyco River, a tributary of the Dan River. The gage is located in Halifax County, VA (Lat 36°35'16", Long 78°53'56") approximately 30 miles east of Danville, VA. Drainage area is 288 sq. miles. This gage started taking data in 1929 but was decommissioned in March of 2014. There is a small diurnal fluctuation caused by a gristmill approximately 15 miles upstream that will likely effect low-flow conditions. The Hyco Lake is 15.7 miles upstream which is home to the Roxboro Stream Electric Generating Plant and Afterbay Reservoir. The average daily discharge error between the model and gage data for the 20 year timespan was -2.67%, with 52.9% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	21	8.41	60
Feb. Low Flow	26	70	-169
Mar. Low Flow	35	106	-203
Apr. Low Flow	50	177	-254
May Low Flow	101	269	-166
Jun. Low Flow	116	225	-94
Jul. Low Flow	96	210	-119
Aug. Low Flow	36	31.2	13.3
Sep. Low Flow	26	35.1	-35
Oct. Low Flow	21	18.3	12.9
Nov. Low Flow	24	6.4	73.3
Dec. Low Flow	20.9	7.72	63.1

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	262	269	-2.67
Jan. Mean Flow	418	427	-2.15
Feb. Mean Flow	461	458	0.65
Mar. Mean Flow	634	602	5.05
Apr. Mean Flow	414	453	-9.42
May Mean Flow	201	178	11.4
Jun. Mean Flow	157	179	-14
Jul. Mean Flow	87.9	92.3	-5.01
Aug. Mean Flow	122	86.6	29
Sep. Mean Flow	176	208	-18.2
Oct. Mean Flow	112	166	-48.2
Nov. Mean Flow	144	164	-13.9
Dec. Mean Flow	224	231	-3.12

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	112	123	-9.82
Feb. High Flow	224	310	-38.4
Mar. High Flow	515	428	16.9
Apr. High Flow	1360	748	45
May High Flow	1410	814	42.3
Jun. High Flow	2100	1170	44.3
Jul. High Flow	1410	1040	26.2
Aug. High Flow	392	328	16.3
Sep. High Flow	138	121	12.3
Oct. High Flow	119	84.7	28.8
Nov. High Flow	102	186	-82.4
Dec. High Flow	130	130	0

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	2.5	0	100
Med. 1 Day Min	17	2.87	83.1
Min. 3 Day Min	2.97	0	100
Med. 3 Day Min	17.3	3.12	82
Min. 7 Day Min	3.43	0	100
Med. 7 Day Min	18	3.2	82.2
Min. 30 Day Min	4.64	0.16	96.6
Med. 30 Day Min	22.3	9.37	58
Min. 90 Day Min	10	3.58	64.2
Med. 90 Day Min	31.2	24.8	20.5
7Q10	7.29	0	100
Year of 90-Day Min. Flow	2002	1986	100
Drought Year Mean	21.5	269	-1150
Mean Baseflow	75.9	149	-96.3

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	9240	13400	-45
Med. 1 Day Max	3930	3420	13
Max. 3 Day Max	7520	9560	-27.1
Med. 3 Day Max	3370	2170	35.6
Max. 7 Day Max	4470	5380	-20.4
Med. 7 Day Max	2390	1680	29.7
Max. 30 Day Max	2330	1890	18.9
Med. 30 Day Max	945	732	22.5
Max. 90 Day Max	1450	1180	18.6
Med. 90 Day Max	501	530	-5.79

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	7.6	0	100
5% Non-Exceedance	14	3.41	75.6
50% Non-Exceedance	65	151	-132
95% Non-Exceedance	1270	935	26.4
99% Non-Exceedance	3020	2060	31.8
Sept. 10% Non-Exceedance	1.01	1.01	0

**Fig. 1: Hydrograph**

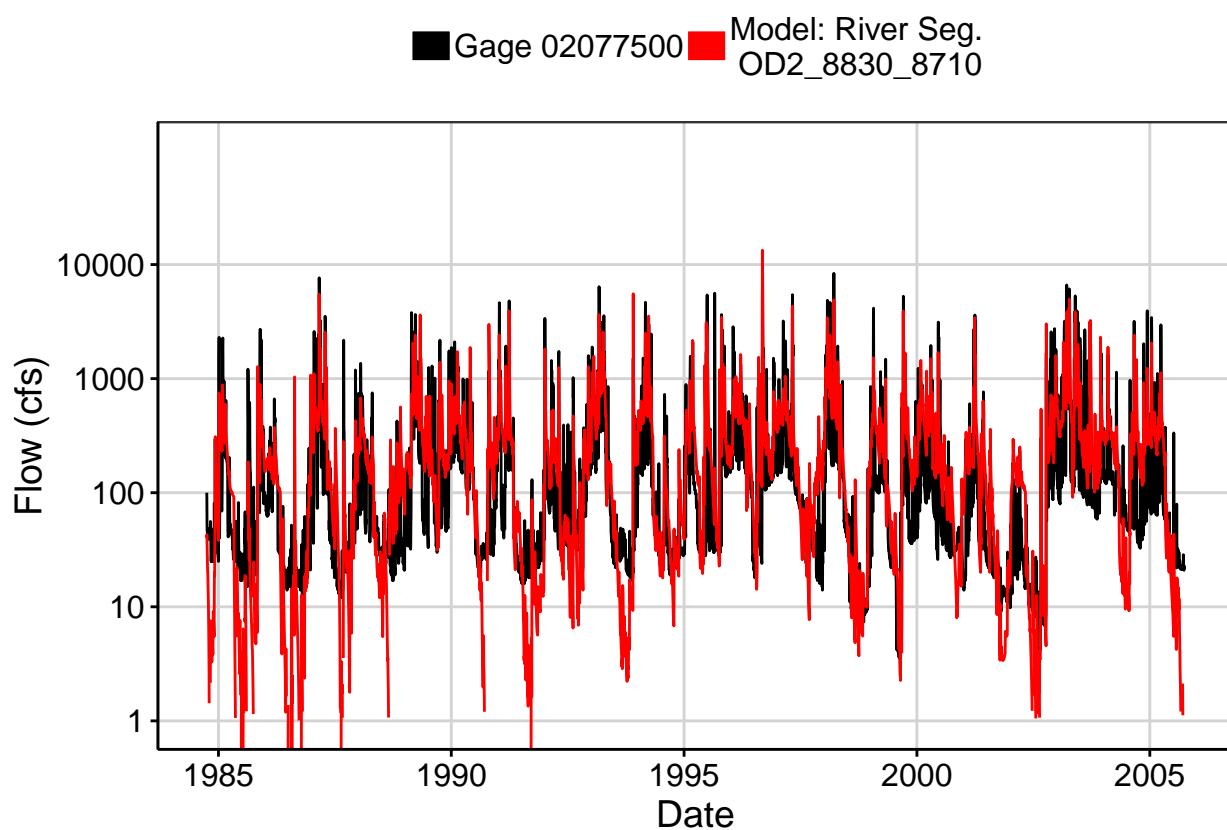


Fig. 2: Zoomed Hydrograph

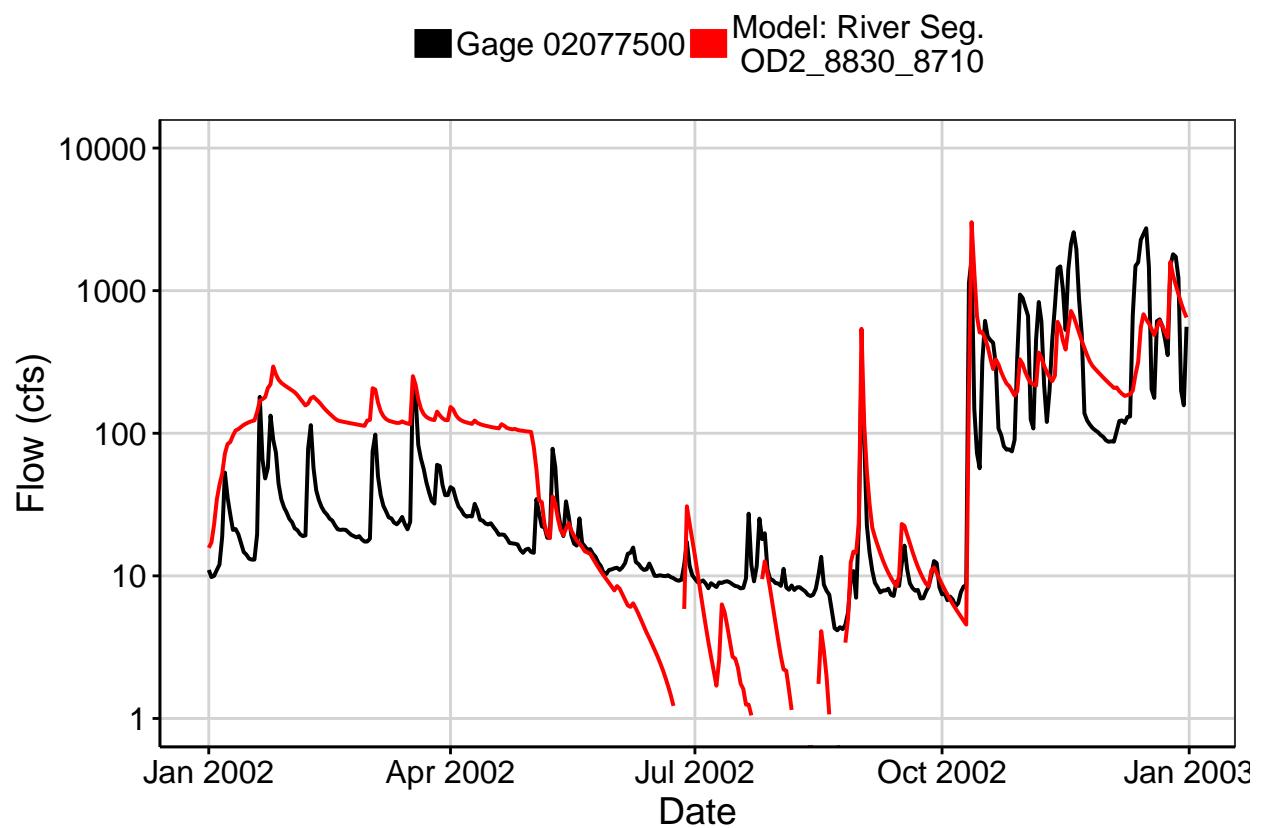


Fig. 3: Flow Exceedance

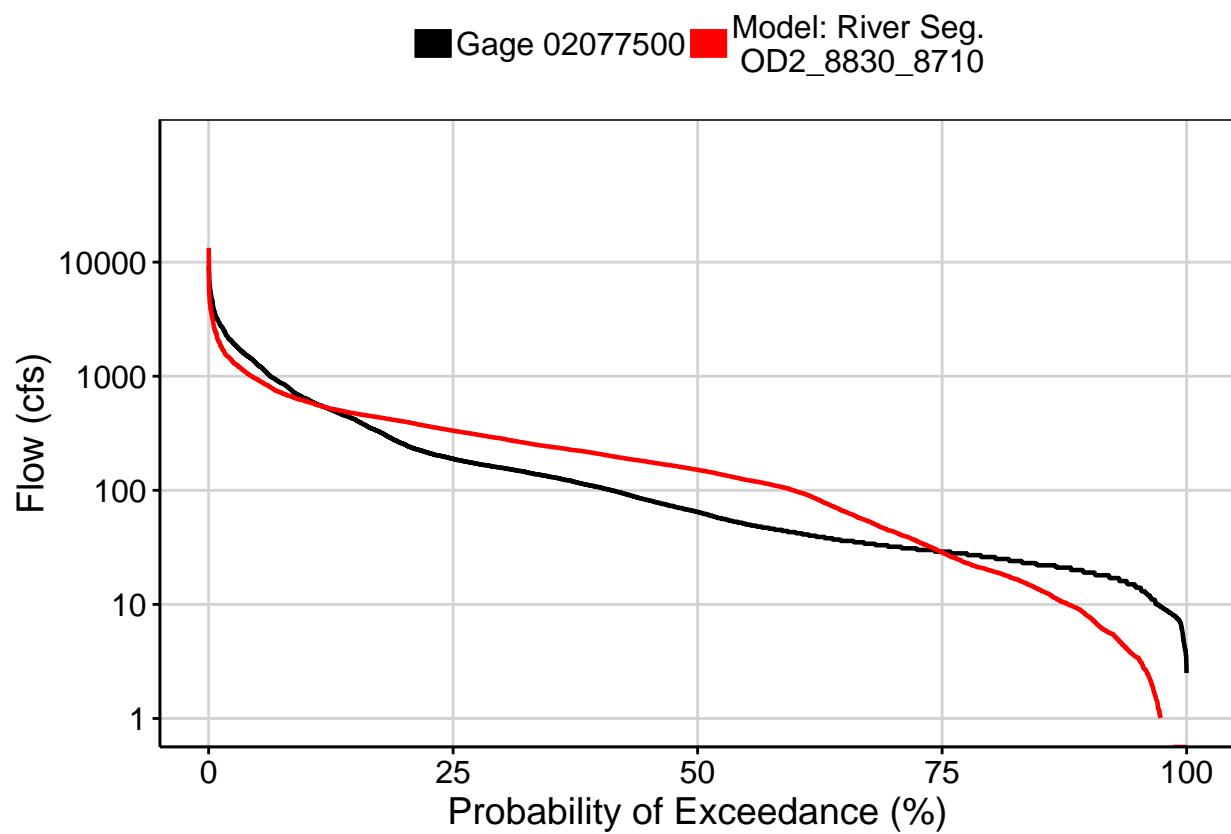


Fig. 4: Baseflow

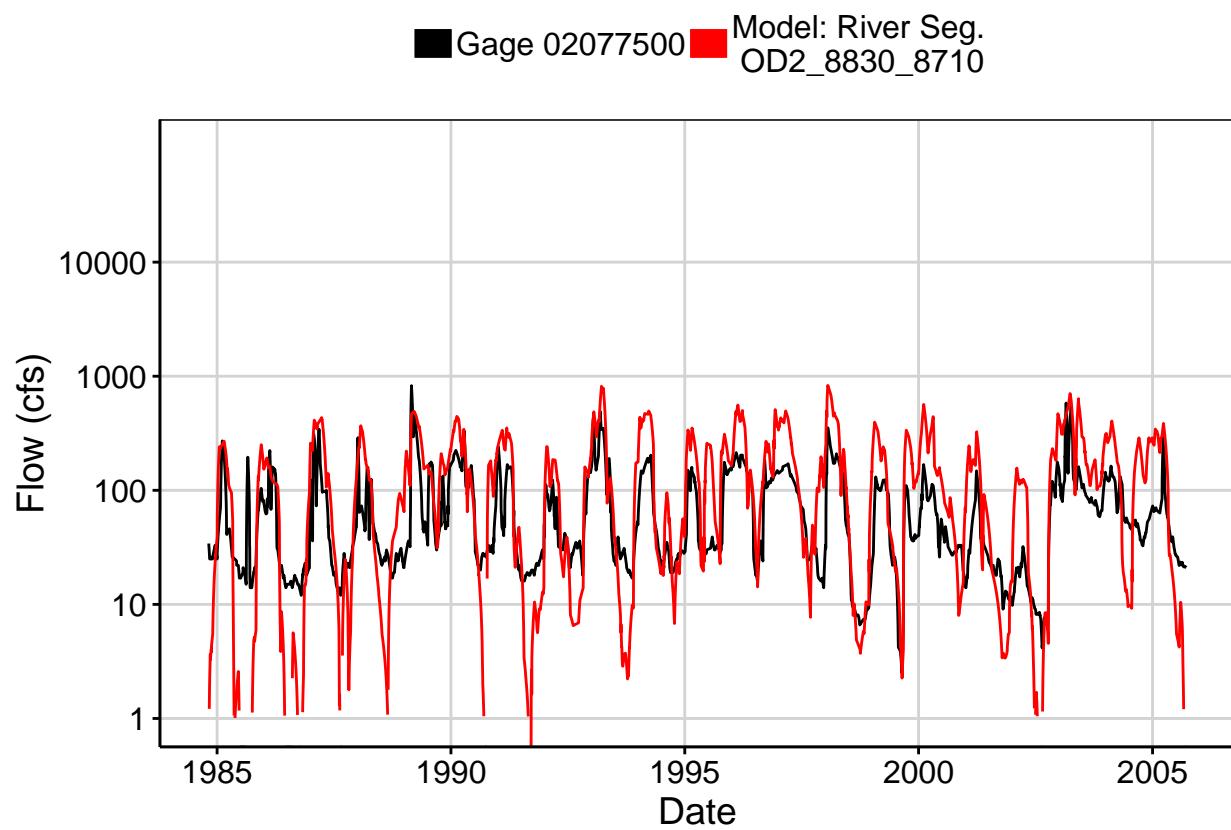


Fig. 5: Combined Baseflow

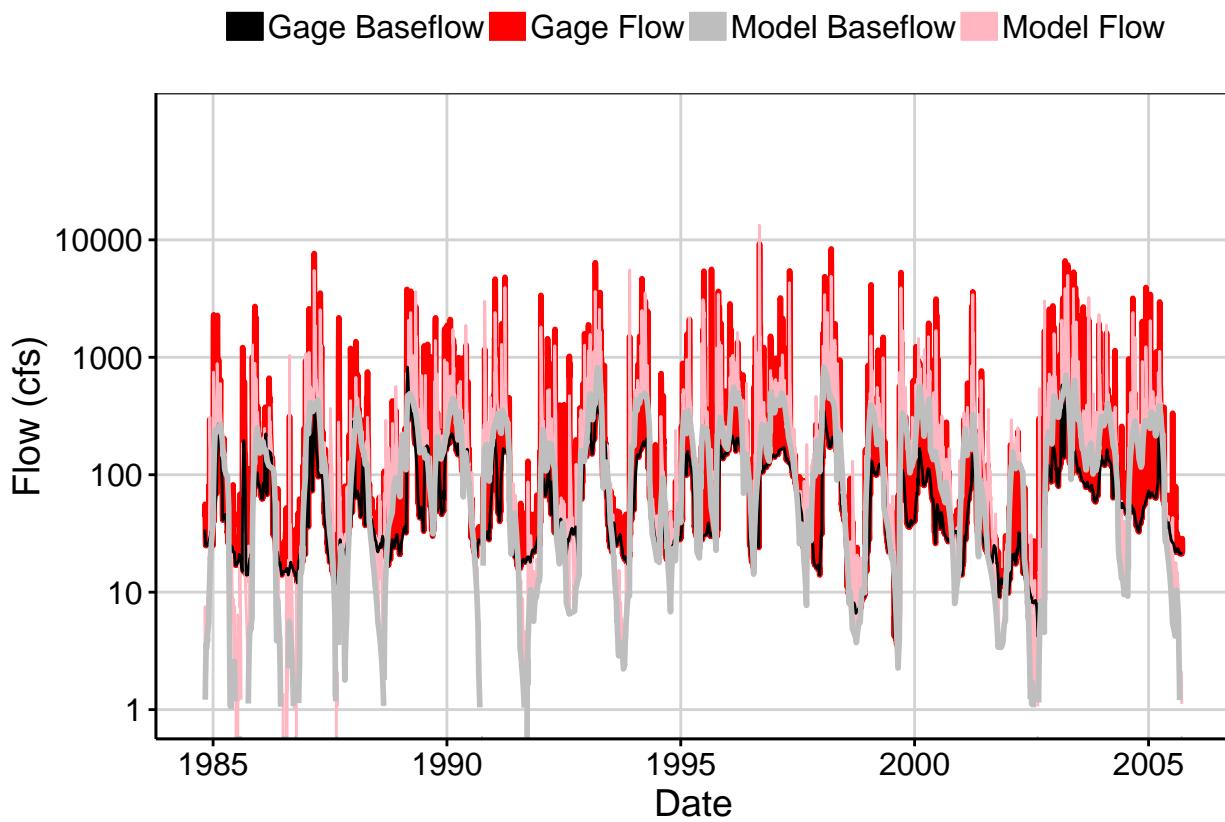


Fig. 6: Largest Error Segment

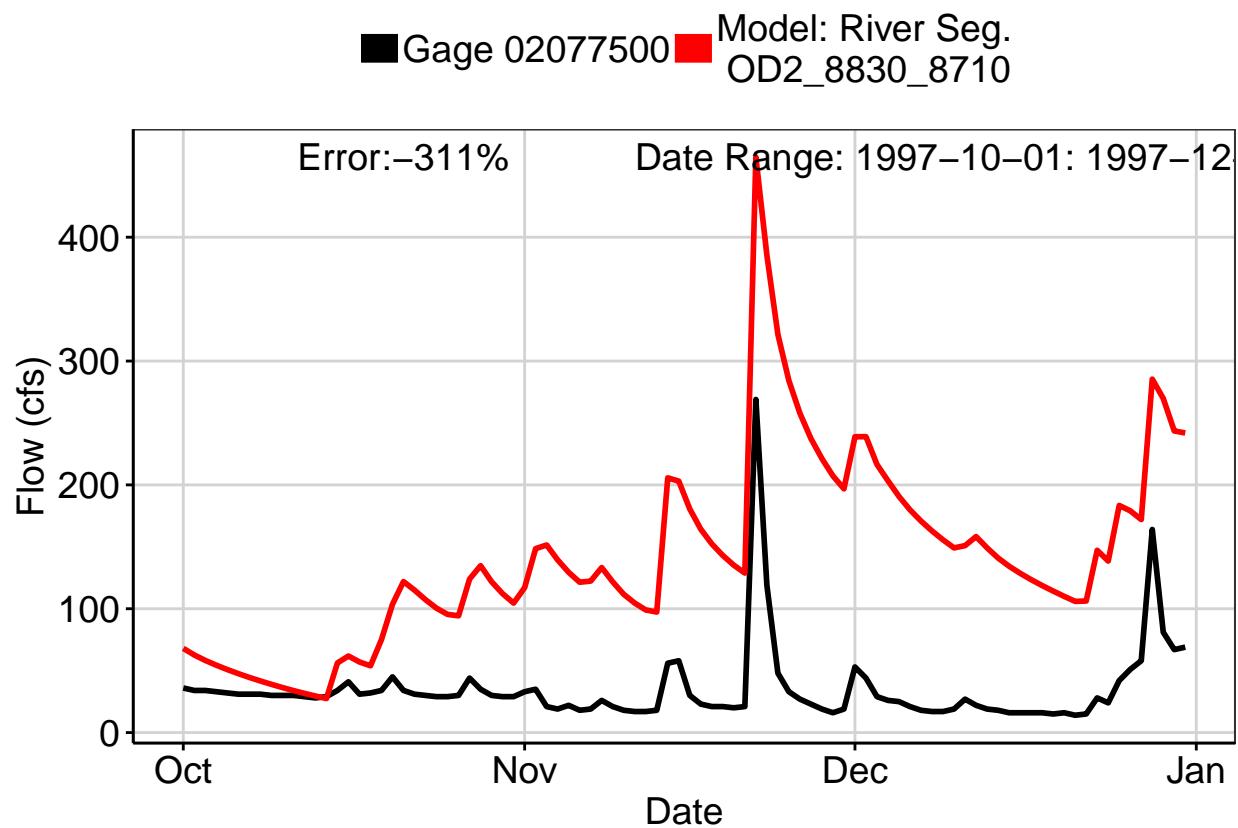


Fig. 7: Second Largest Error Segment

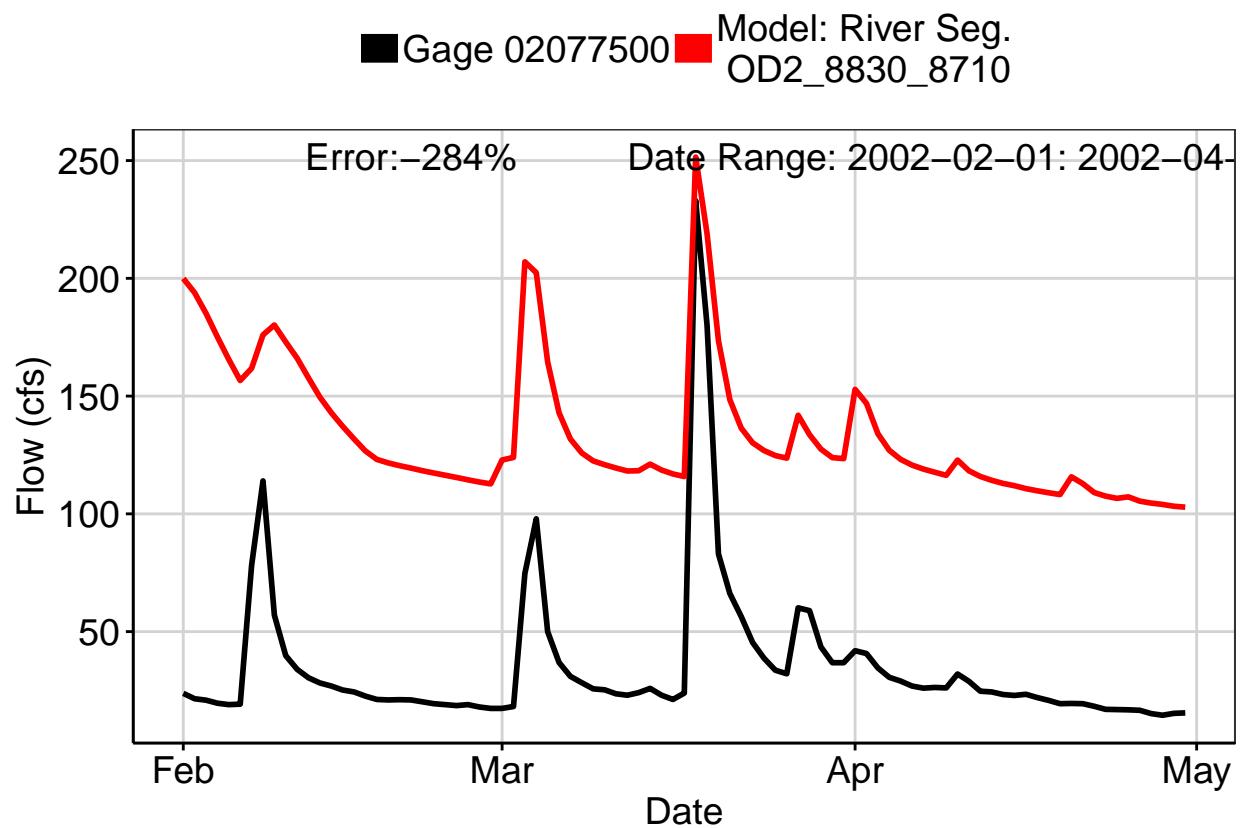


Fig. 8: Third Largest Error Segment

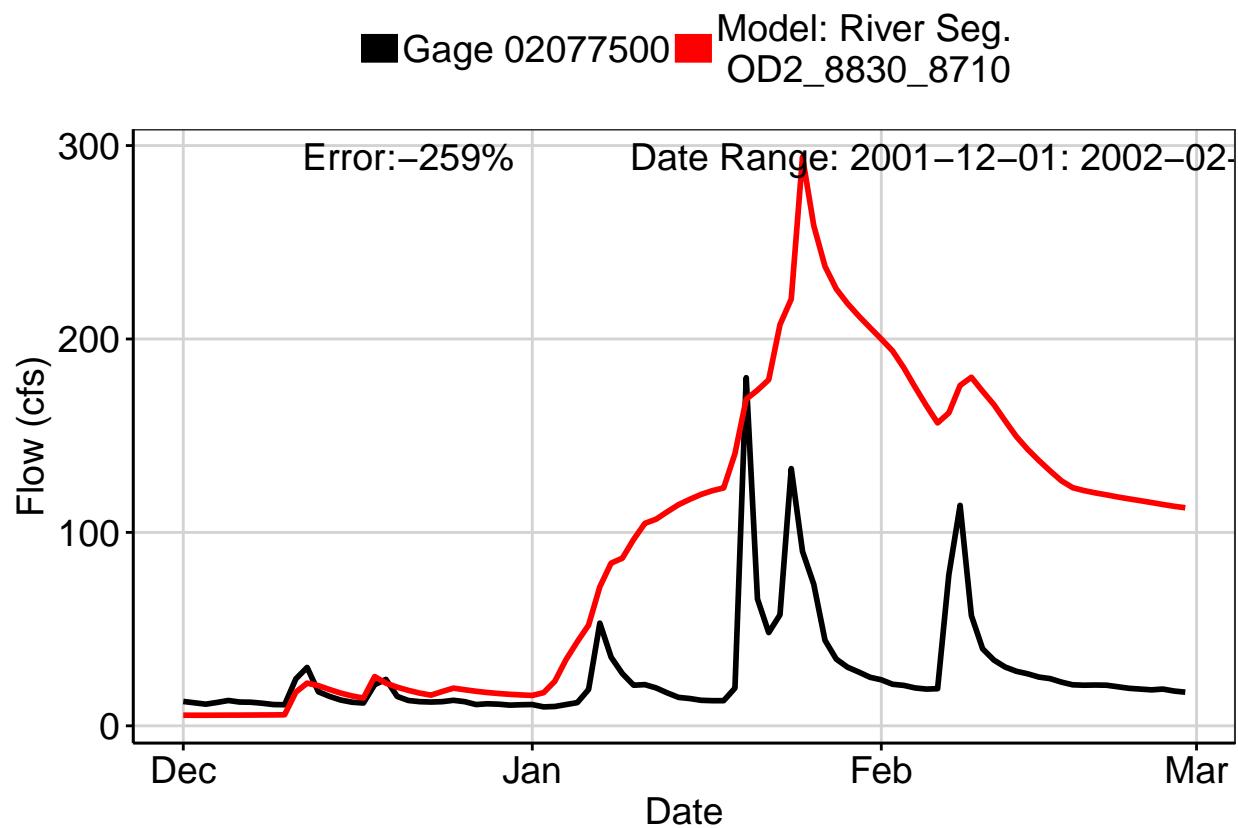
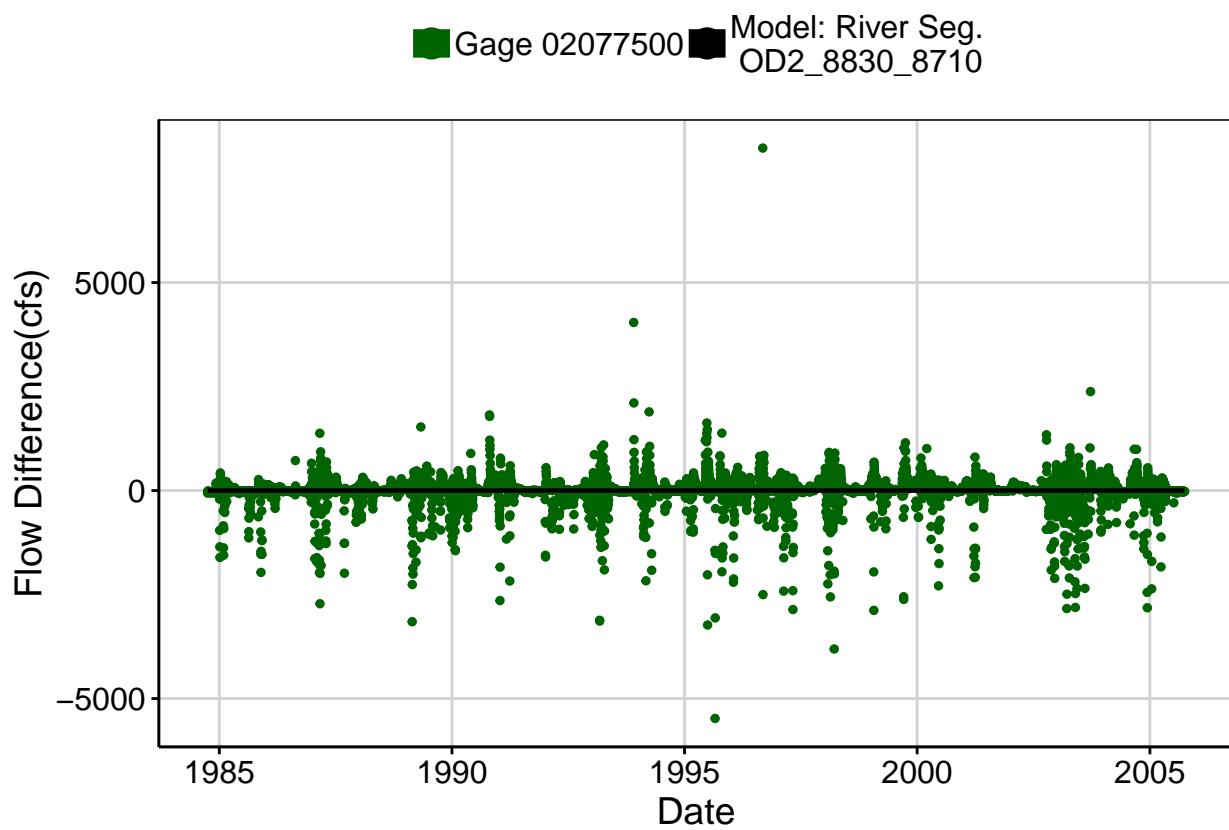
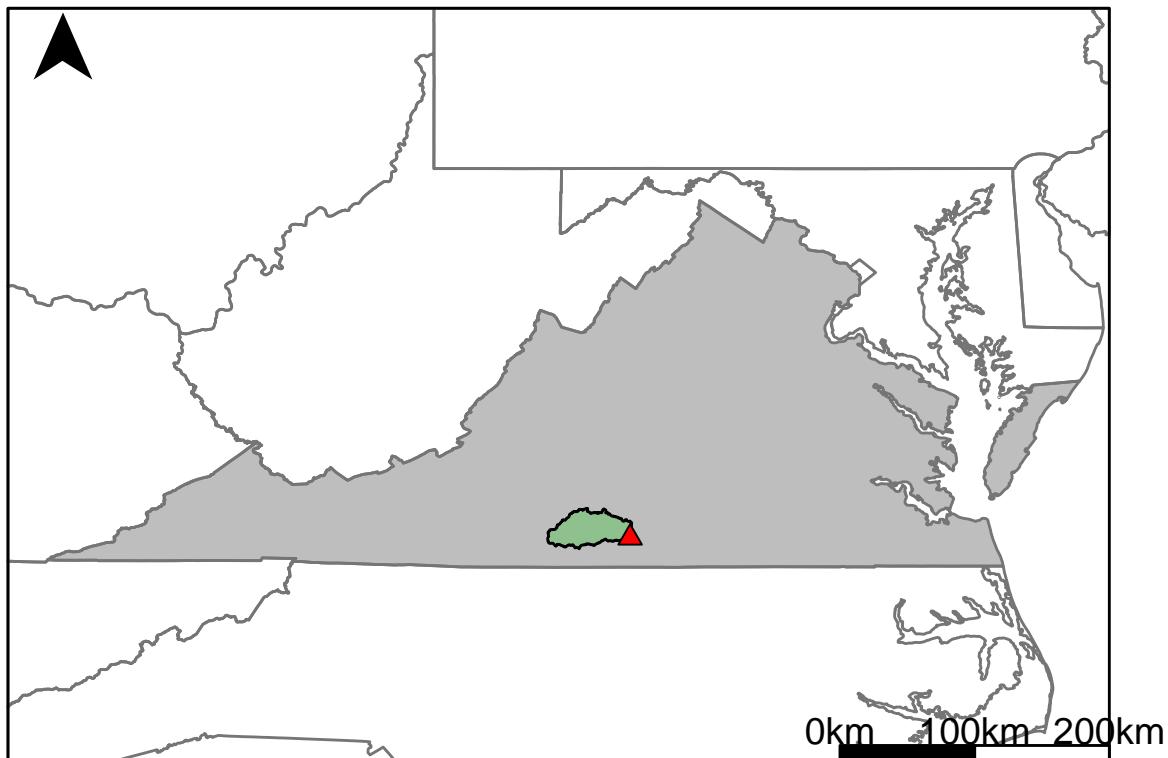


Fig. 9: Residuals Plot



## Appendix C.13: USGS Gage 02077000 vs. OD3\_8340\_8520



This river segment follows part of the flow of the Banister River, a tributary of the Dan River. The gage is located in Halifax County, VA (Lat 36°46'35", Long 78°54'58") approximately 30 miles northeast of Danville, VA. Drainage area is 547 sq. miles. This gage started taking data in 1904 and is still taking data. Flow in this area is regulated by a reservoir and hydroelectric generating facility about a half mile upstream. The average daily discharge error between the model and gage data for the 20 year timespan was -3.41%, with 46.7% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	91	66.7	26.7
Feb. Low Flow	174	83.8	51.8
Mar. Low Flow	215	167	22.3
Apr. Low Flow	213	253	-18.8
May Low Flow	323	453	-40.2
Jun. Low Flow	365	444	-21.6
Jul. Low Flow	308	323	-4.87
Aug. Low Flow	215	203	5.58
Sep. Low Flow	159	136	14.5
Oct. Low Flow	107	83.2	22.2
Nov. Low Flow	107	63.2	40.9
Dec. Low Flow	93	49	47.3

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	498	515	-3.41
Jan. Mean Flow	660	654	0.91
Feb. Mean Flow	711	831	-16.9
Mar. Mean Flow	863	1100	-27.5
Apr. Mean Flow	696	792	-13.8
May Mean Flow	505	505	0
Jun. Mean Flow	398	405	-1.76
Jul. Mean Flow	263	200	24
Aug. Mean Flow	269	204	24.2
Sep. Mean Flow	416	413	0.72
Oct. Mean Flow	317	312	1.58
Nov. Mean Flow	408	351	14
Dec. Mean Flow	493	437	11.4

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	427	237	44.5
Feb. High Flow	1260	873	30.7
Mar. High Flow	1290	1450	-12.4
Apr. High Flow	1960	1890	3.57
May High Flow	2170	1660	23.5
Jun. High Flow	2420	3330	-37.6
Jul. High Flow	1460	2120	-45.2
Aug. High Flow	894	746	16.6
Sep. High Flow	791	377	52.3
Oct. High Flow	495	279	43.6
Nov. High Flow	456	209	54.2
Dec. High Flow	376	194	48.4

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	18	0.25	98.6
Med. 1 Day Min	70	31	55.7
Min. 3 Day Min	18	0.58	96.8
Med. 3 Day Min	90.3	32.7	63.8
Min. 7 Day Min	18.3	1.35	92.6
Med. 7 Day Min	93.8	36.7	60.9
Min. 30 Day Min	22.2	4.5	79.7
Med. 30 Day Min	123	55.6	54.8
Min. 90 Day Min	39.6	22.5	43.2
Med. 90 Day Min	184	100	45.7
7Q10	33.7	6.97	79.3
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	136	515	-279
Mean Baseflow	239	268	-12.1

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	22300	36600	-64.1
Med. 1 Day Max	5910	7830	-32.5
Max. 3 Day Max	18300	21000	-14.8
Med. 3 Day Max	4450	5070	-13.9
Max. 7 Day Max	10900	12500	-14.7
Med. 7 Day Max	2970	2880	3.03
Max. 30 Day Max	3080	3660	-18.8
Med. 30 Day Max	1180	1450	-22.9
Max. 90 Day Max	1640	2150	-31.1
Med. 90 Day Max	865	1030	-19.1

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	29	8.59	70.4
5% Non-Exceedance	80	32.6	59.2
50% Non-Exceedance	292	269	7.88
95% Non-Exceedance	1460	1590	-8.9
99% Non-Exceedance	4400	4620	-5
Sept. 10% Non-Exceedance	32.7	32.7	0

**Fig. 1: Hydrograph**

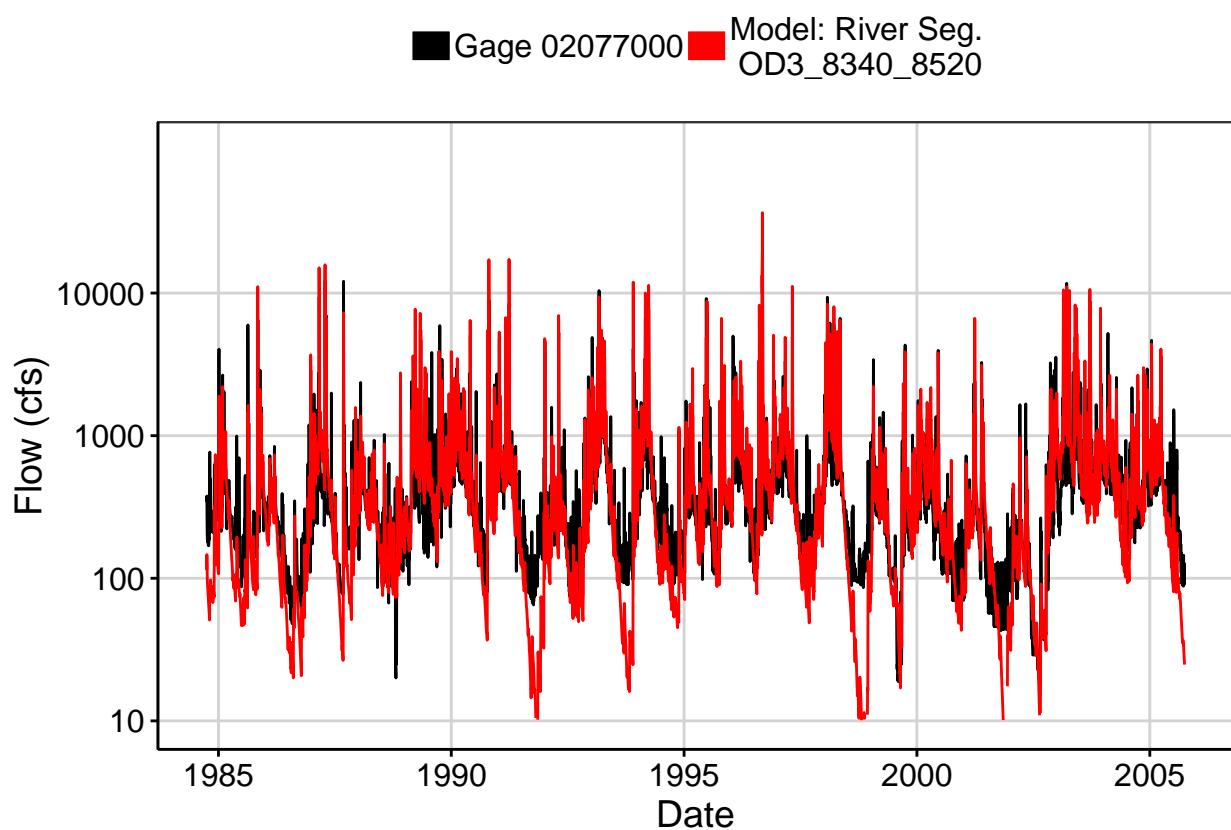


Fig. 2: Zoomed Hydrograph

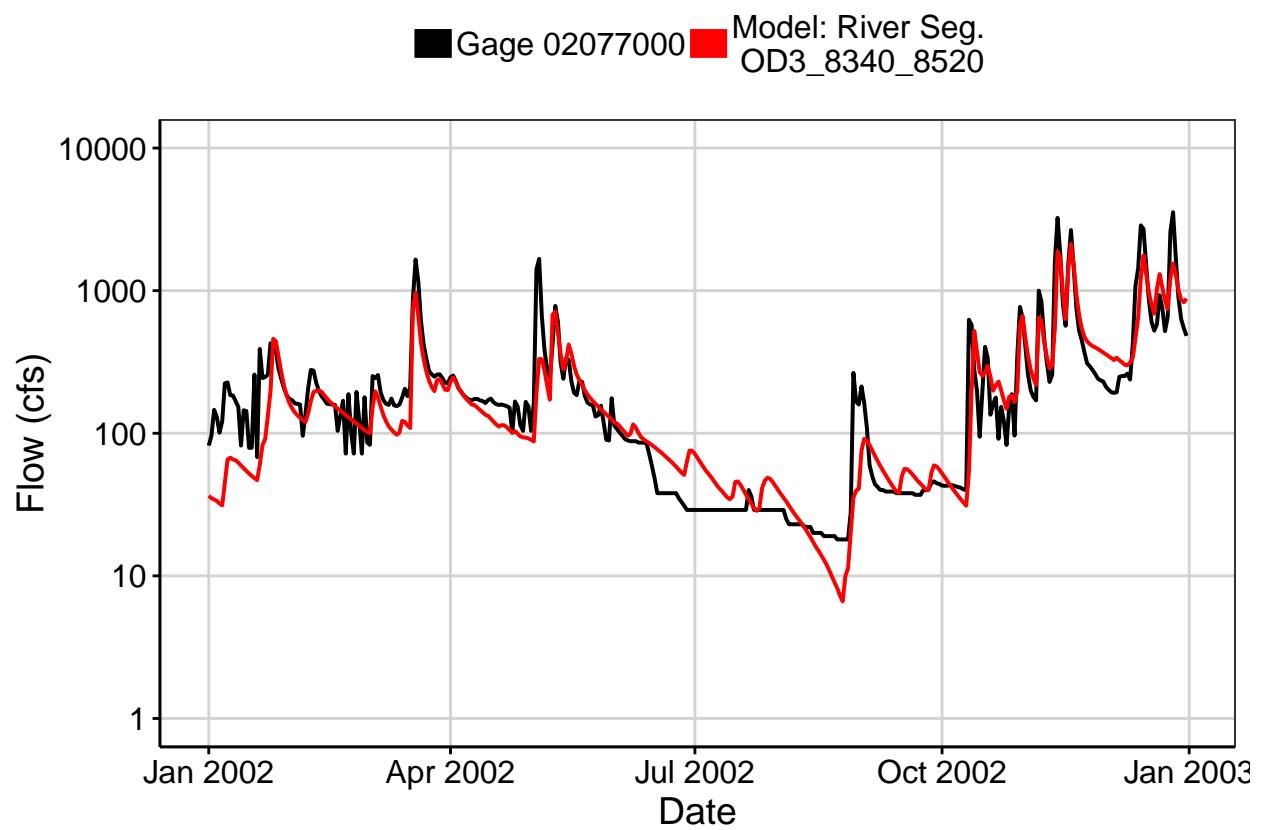


Fig. 3: Flow Exceedance

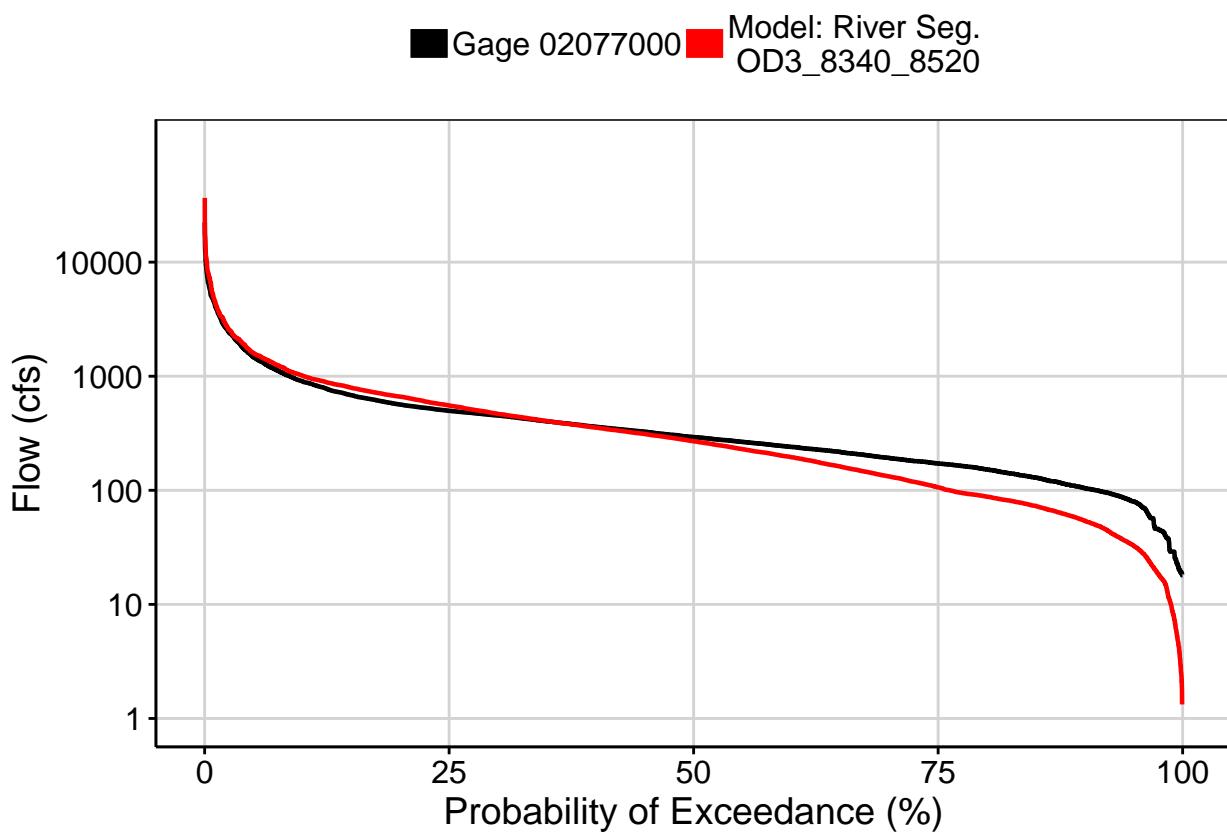
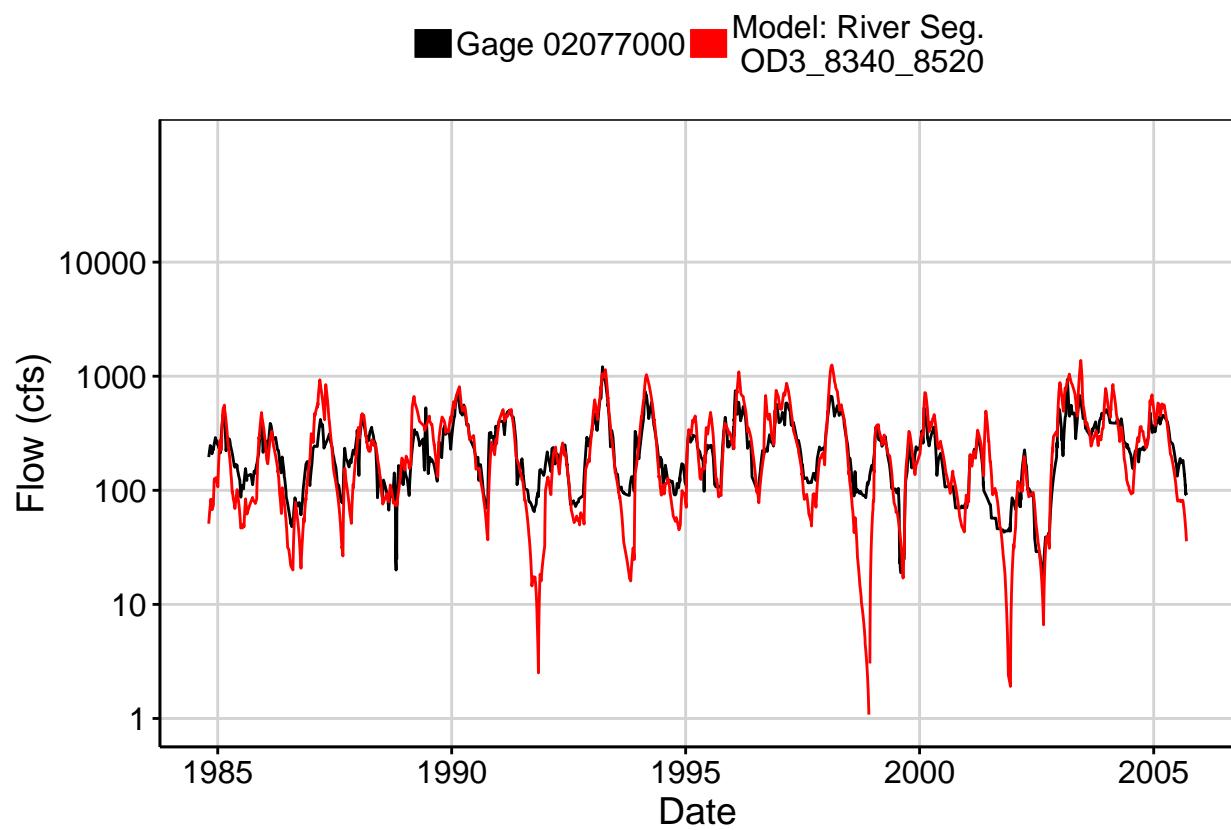


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

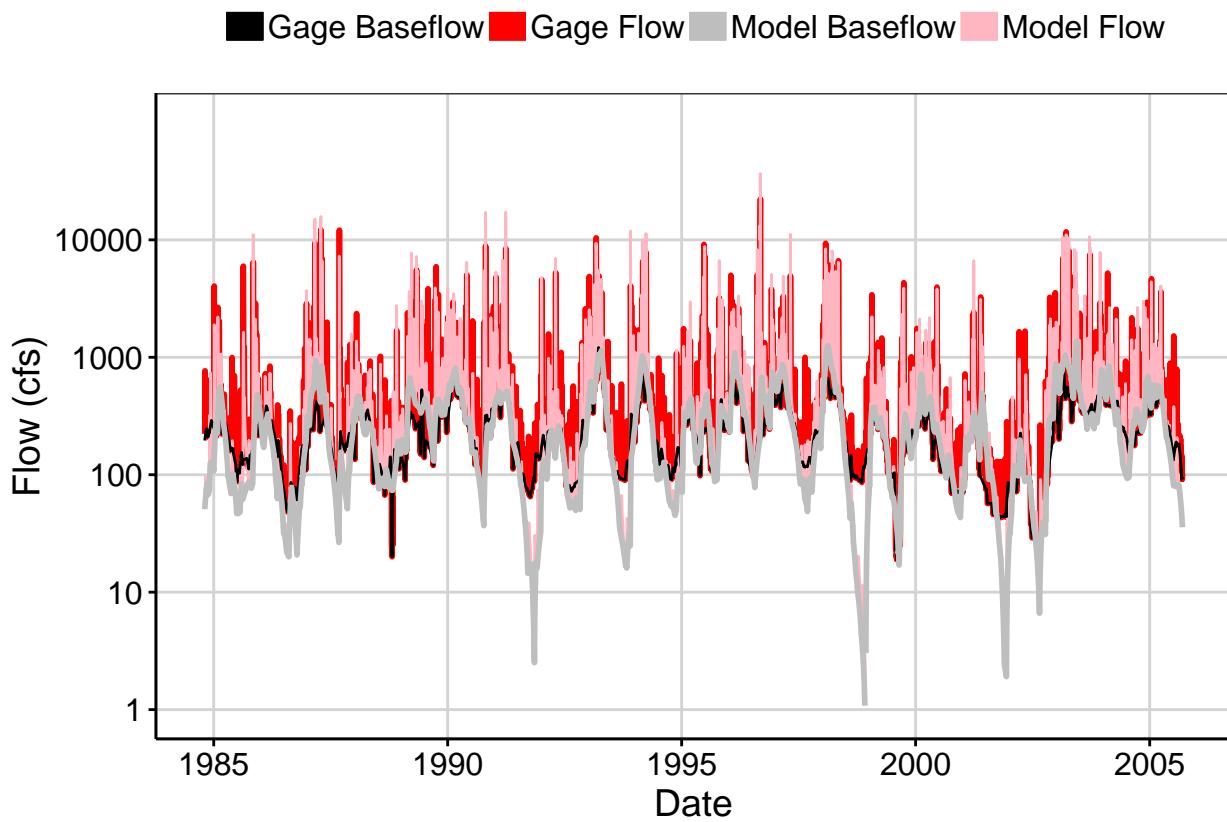


Fig. 6: Largest Error Segment

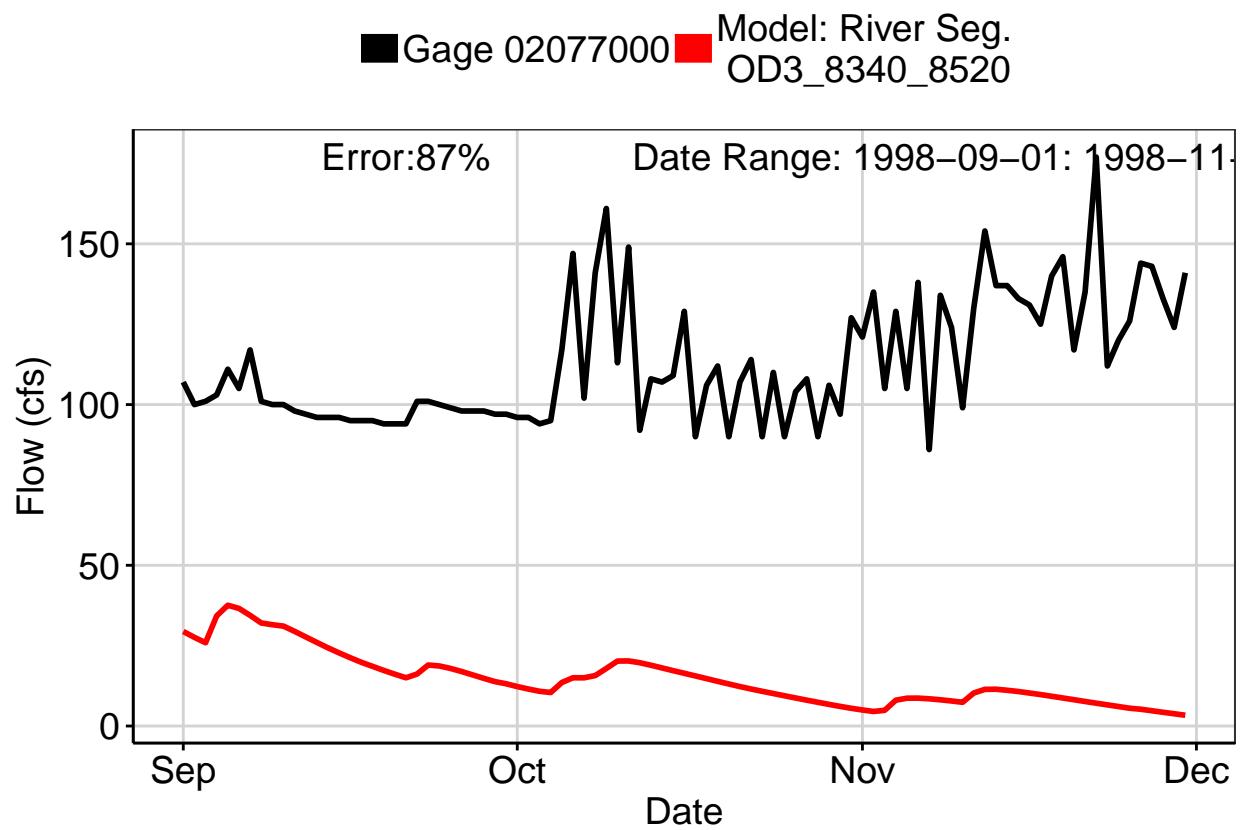


Fig. 7: Second Largest Error Segment

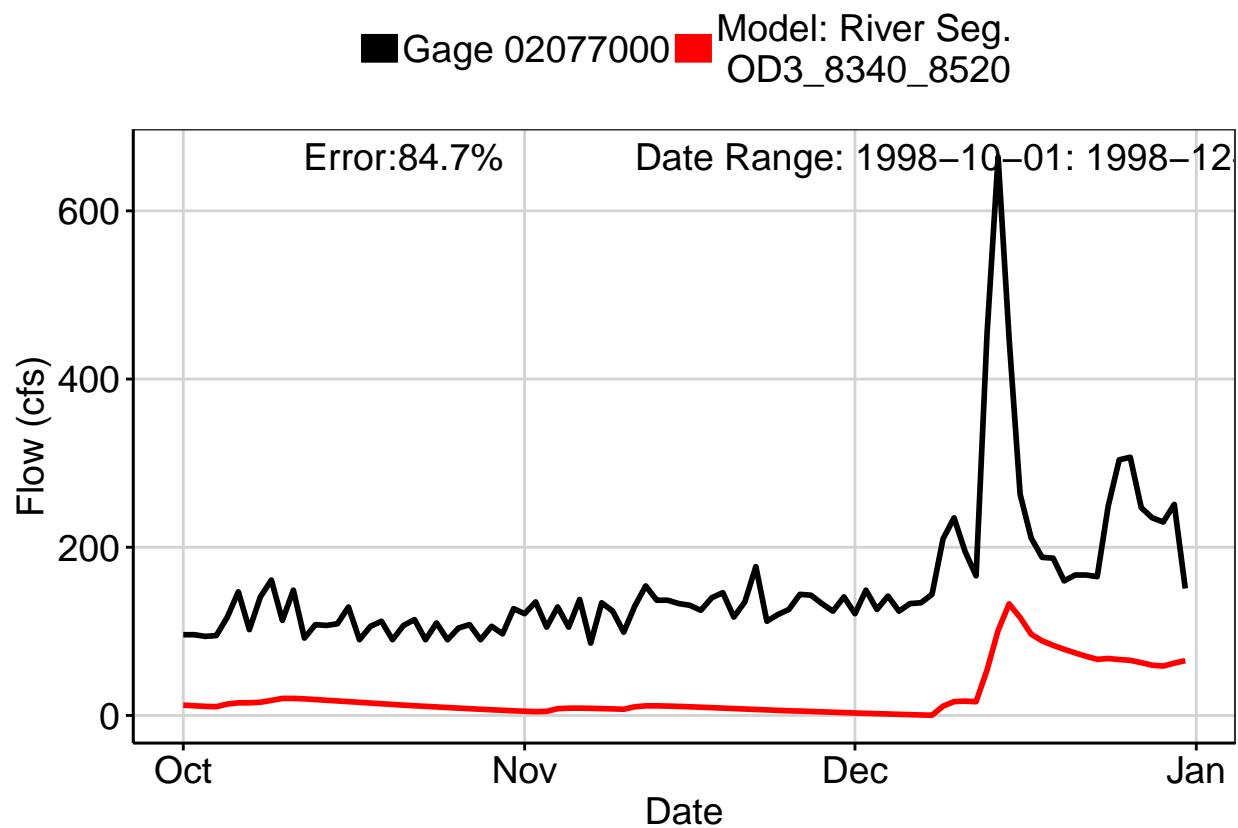


Fig. 8: Third Largest Error Segment

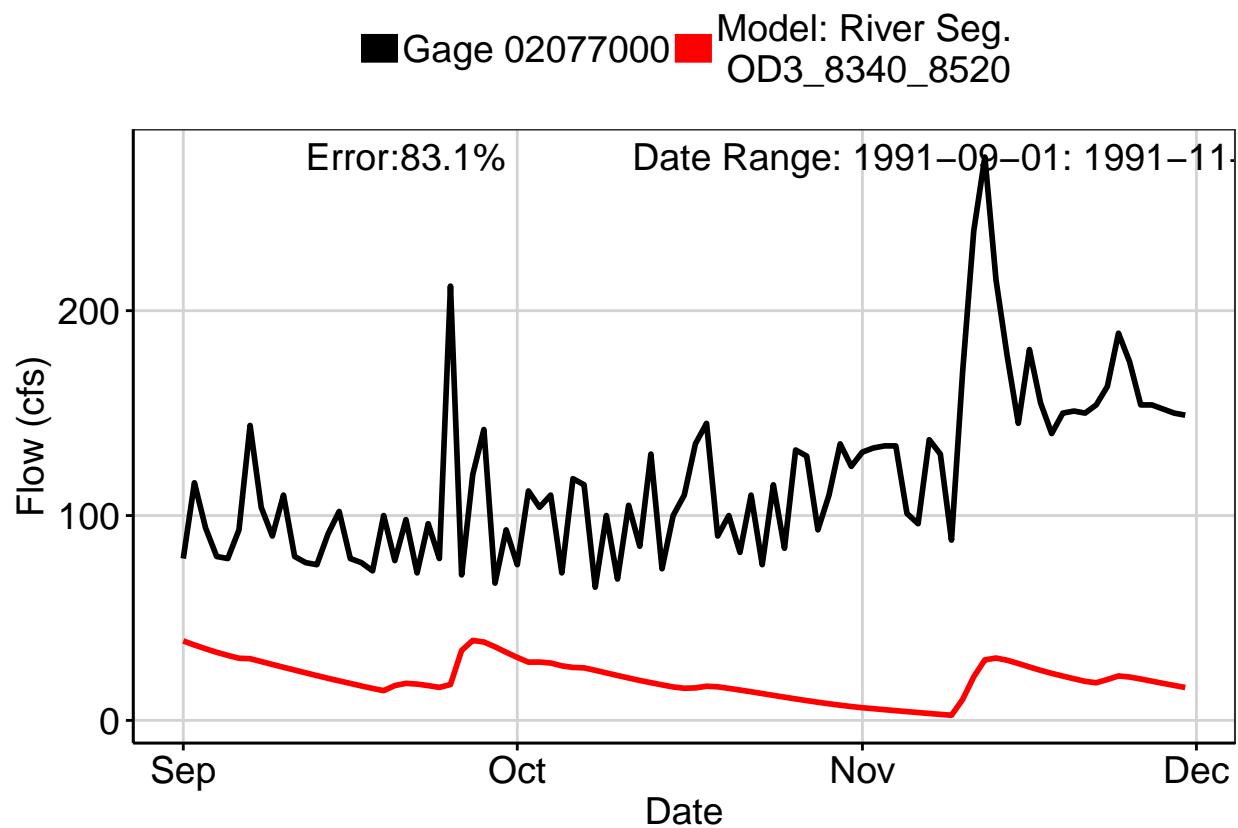
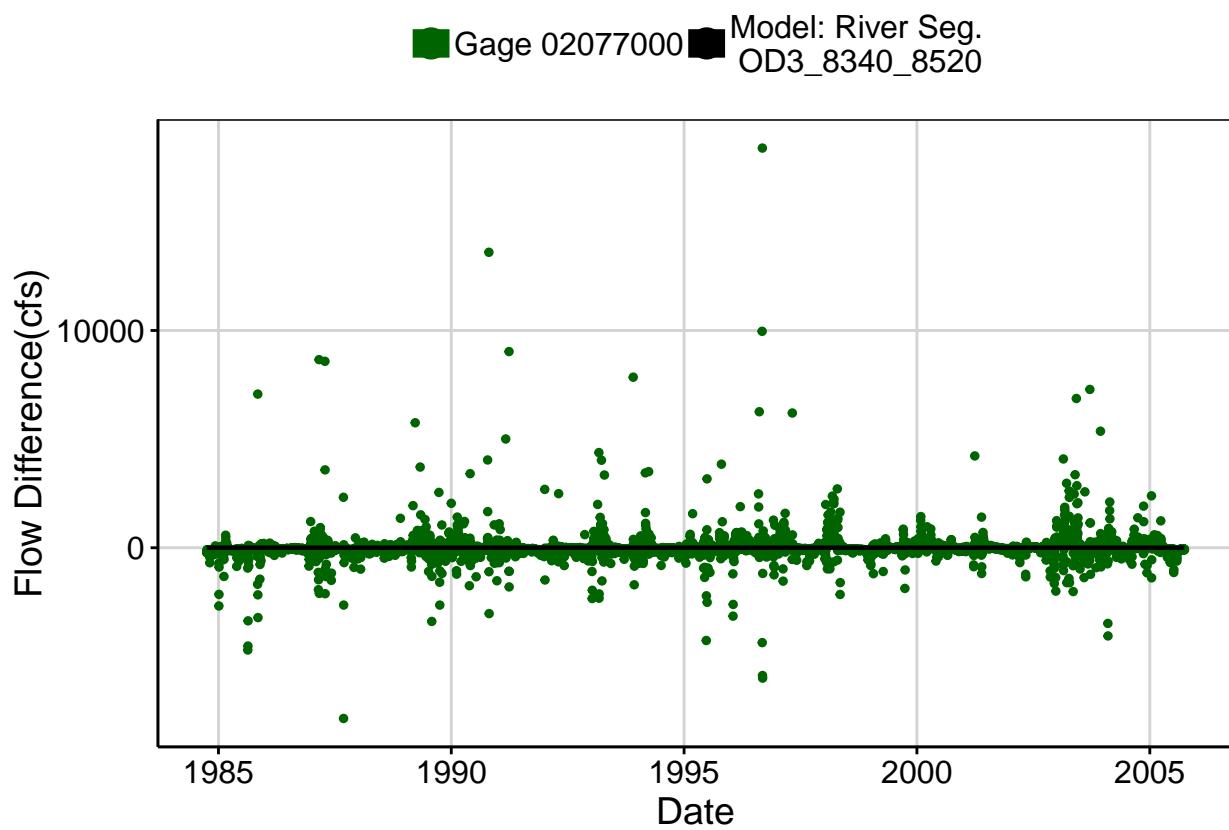
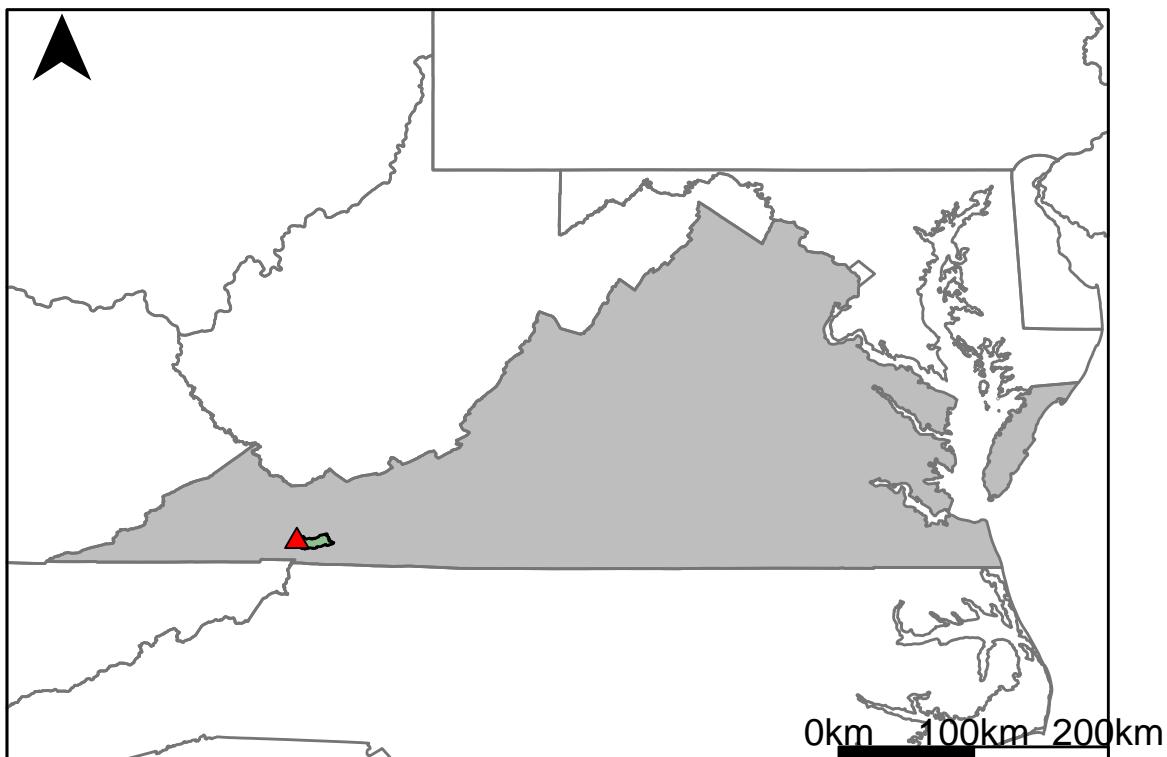


Fig. 9: Residuals Plot



## Appendix D: Holston River Gages

### Appendix D.1: USGS Gage 03471500 vs. TU2\_8950\_9040



This river segment follows part of the flow of the South Fork of the Holston River, a tributary of the Tennessee River. The gage is located in Smyth County, VA (Lat 36°45'37", Long 81°37'53") approximately 33 miles northeast of Bristol, VA. Drainage area is 76.6 sq. miles. This gage started taking data in 1920 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 1.83%, with 45.4% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	25	18.6	25.6
Feb. Low Flow	30	30.1	-0.33
Mar. Low Flow	42	43.9	-4.52
Apr. Low Flow	47	55.7	-18.5
May Low Flow	77	67	13
Jun. Low Flow	92	89.8	2.39
Jul. Low Flow	91	66.5	26.9
Aug. Low Flow	67	46.9	30
Sep. Low Flow	47	33.4	28.9
Oct. Low Flow	35.9	24.5	31.8
Nov. Low Flow	31	26	16.1
Dec. Low Flow	25	22	12

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	109	107	1.83
Jan. Mean Flow	144	140	2.78
Feb. Mean Flow	192	198	-3.12
Mar. Mean Flow	197	201	-2.03
Apr. Mean Flow	169	149	11.8
May Mean Flow	131	103	21.4
Jun. Mean Flow	96.9	84.7	12.6
Jul. Mean Flow	70.6	60.7	14
Aug. Mean Flow	54.1	60.8	-12.4
Sep. Mean Flow	51.7	54.3	-5.03
Oct. Mean Flow	42.8	57.4	-34.1
Nov. Mean Flow	68.2	79.3	-16.3
Dec. Mean Flow	95.7	105	-9.72

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	47	52.4	-11.5
Feb. High Flow	122	120	1.64
Mar. High Flow	318	186	41.5
Apr. High Flow	439	429	2.28
May High Flow	524	559	-6.68
Jun. High Flow	730	568	22.2
Jul. High Flow	322	316	1.86
Aug. High Flow	356	238	33.1
Sep. High Flow	203	143	29.6
Oct. High Flow	105	104	0.95
Nov. High Flow	69	80	-15.9
Dec. High Flow	53	75.5	-42.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	16	2.49	84.4
Med. 1 Day Min	22	9.46	57
Min. 3 Day Min	16	2.68	83.2
Med. 3 Day Min	22.7	10.8	52.4
Min. 7 Day Min	16.6	3.02	81.8
Med. 7 Day Min	22.9	12.3	46.3
Min. 30 Day Min	17.3	6.99	59.6
Med. 30 Day Min	25.9	17.3	33.2
Min. 90 Day Min	20.2	21	-3.96
Med. 90 Day Min	34.2	35.1	-2.63
7Q10	19.1	5.5	71.2
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	53.8	107	-98.9
Mean Baseflow	62.1	62	0.16

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	3780	2340	38.1
Med. 1 Day Max	1470	1250	15
Max. 3 Day Max	2090	1480	29.2
Med. 3 Day Max	900	759	15.7
Max. 7 Day Max	1090	861	21
Med. 7 Day Max	556	486	12.6
Max. 30 Day Max	581	559	3.79
Med. 30 Day Max	271	263	2.95
Max. 90 Day Max	377	373	1.06
Med. 90 Day Max	207	212	-2.42

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	20	8.8	56
5% Non-Exceedance	23	15.6	32.2
50% Non-Exceedance	68	70.1	-3.09
95% Non-Exceedance	308	291	5.52
99% Non-Exceedance	686	649	5.39
Sept. 10% Non-Exceedance	13.2	13.2	0

**Fig. 1: Hydrograph**

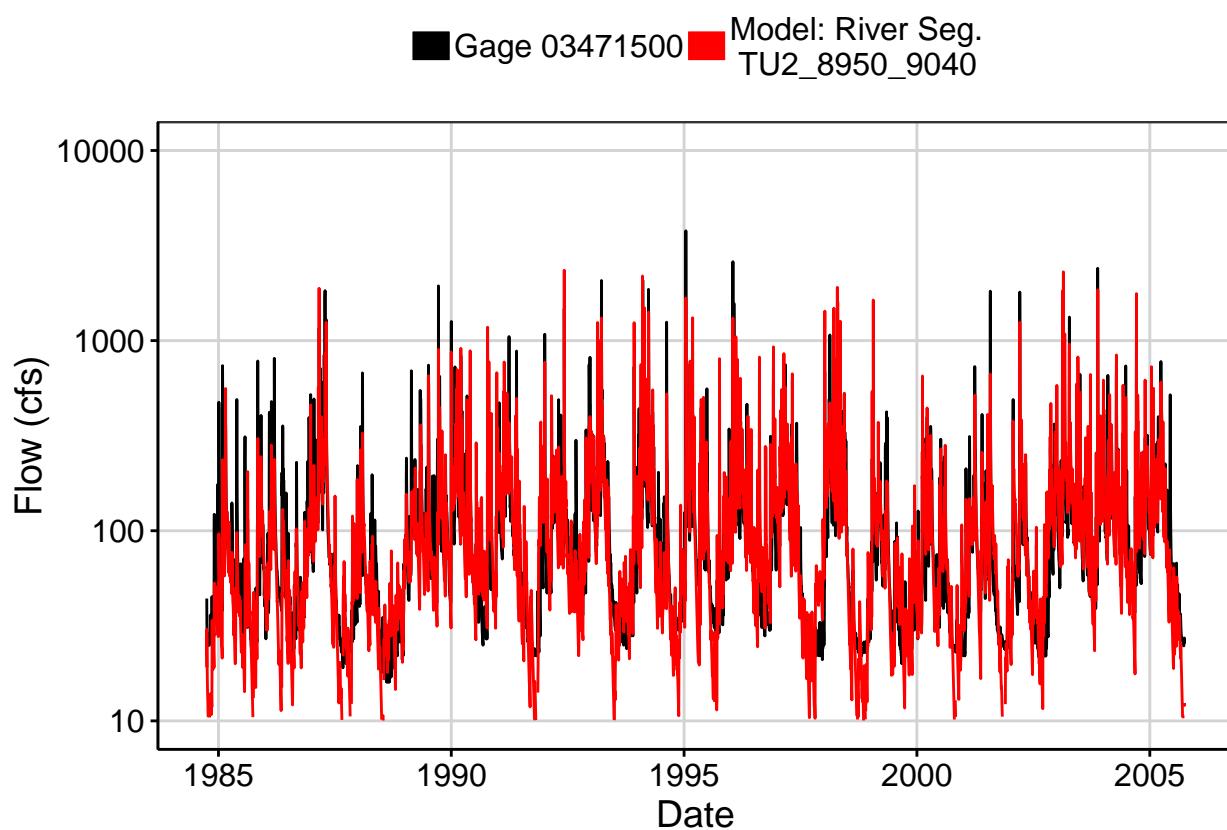


Fig. 2: Zoomed Hydrograph

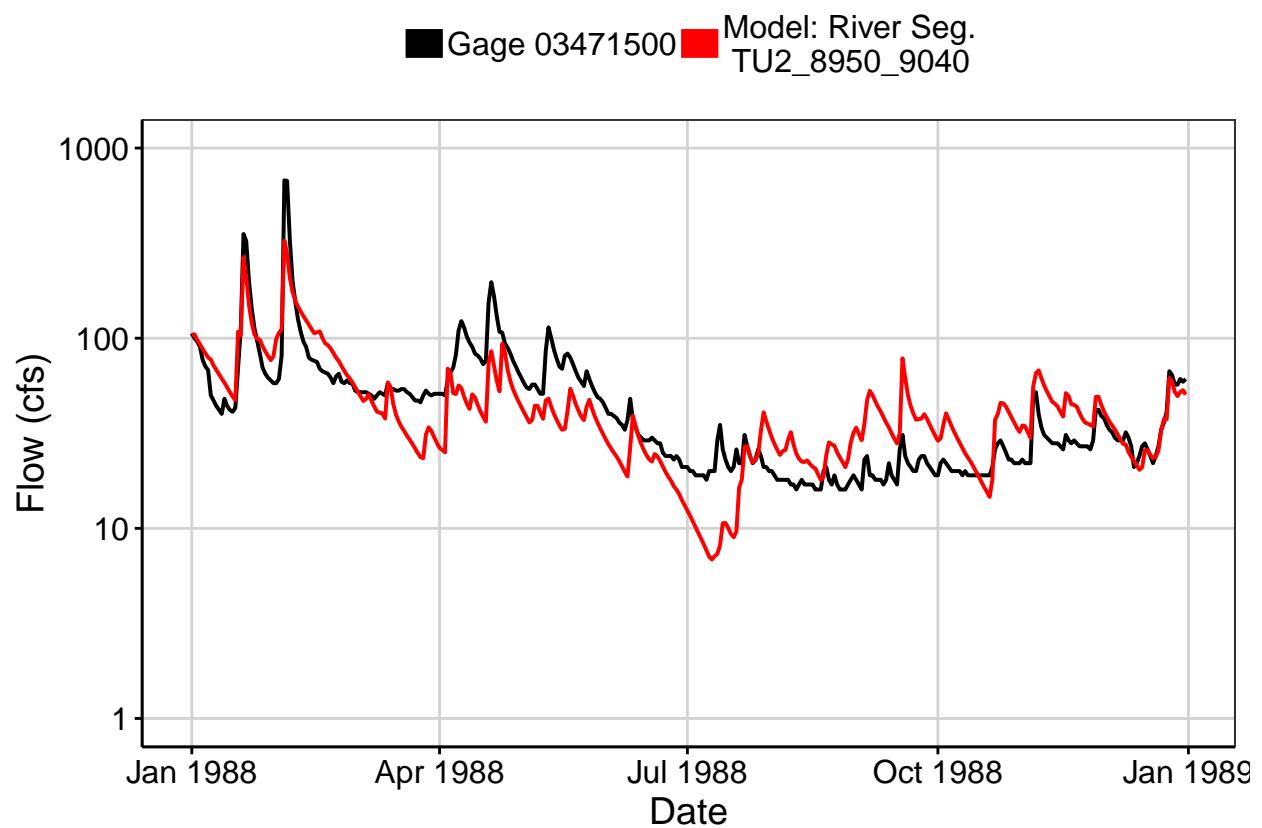


Fig. 3: Flow Exceedance

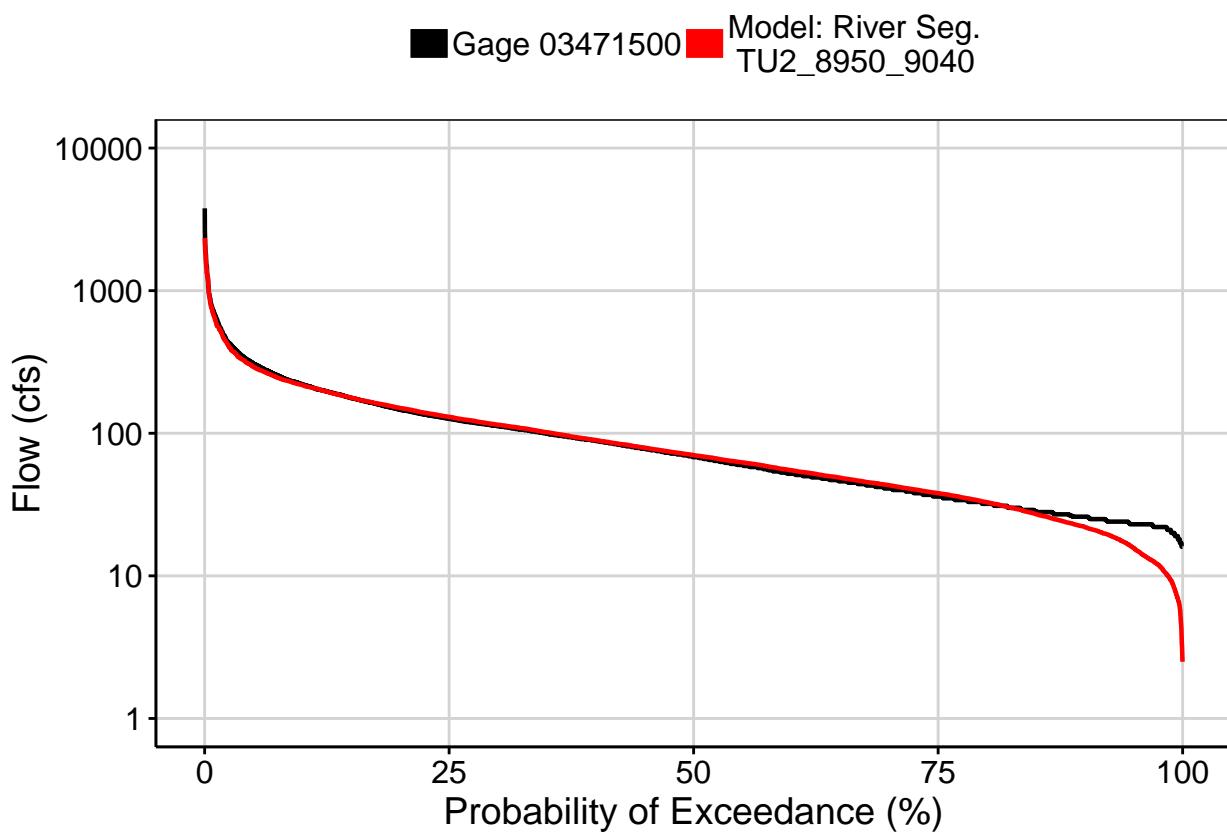


Fig. 4: Baseflow

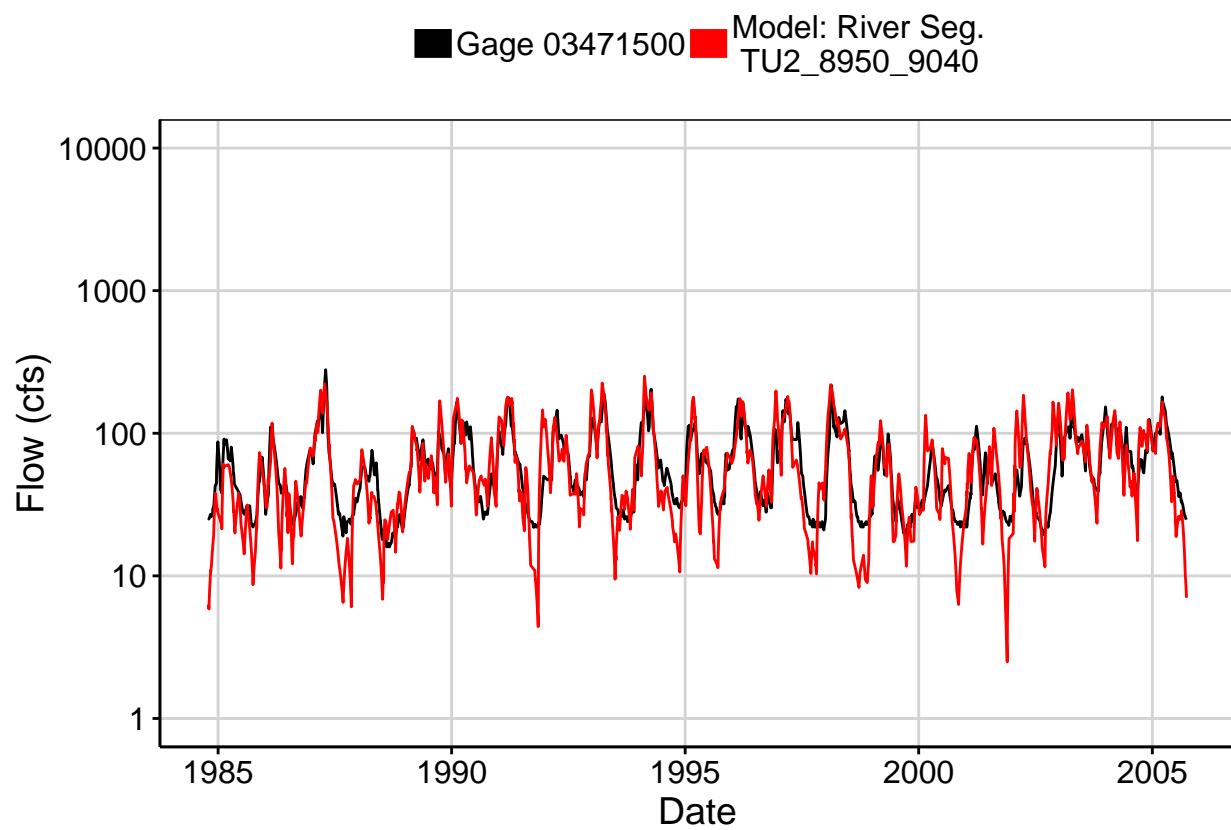


Fig. 5: Combined Baseflow

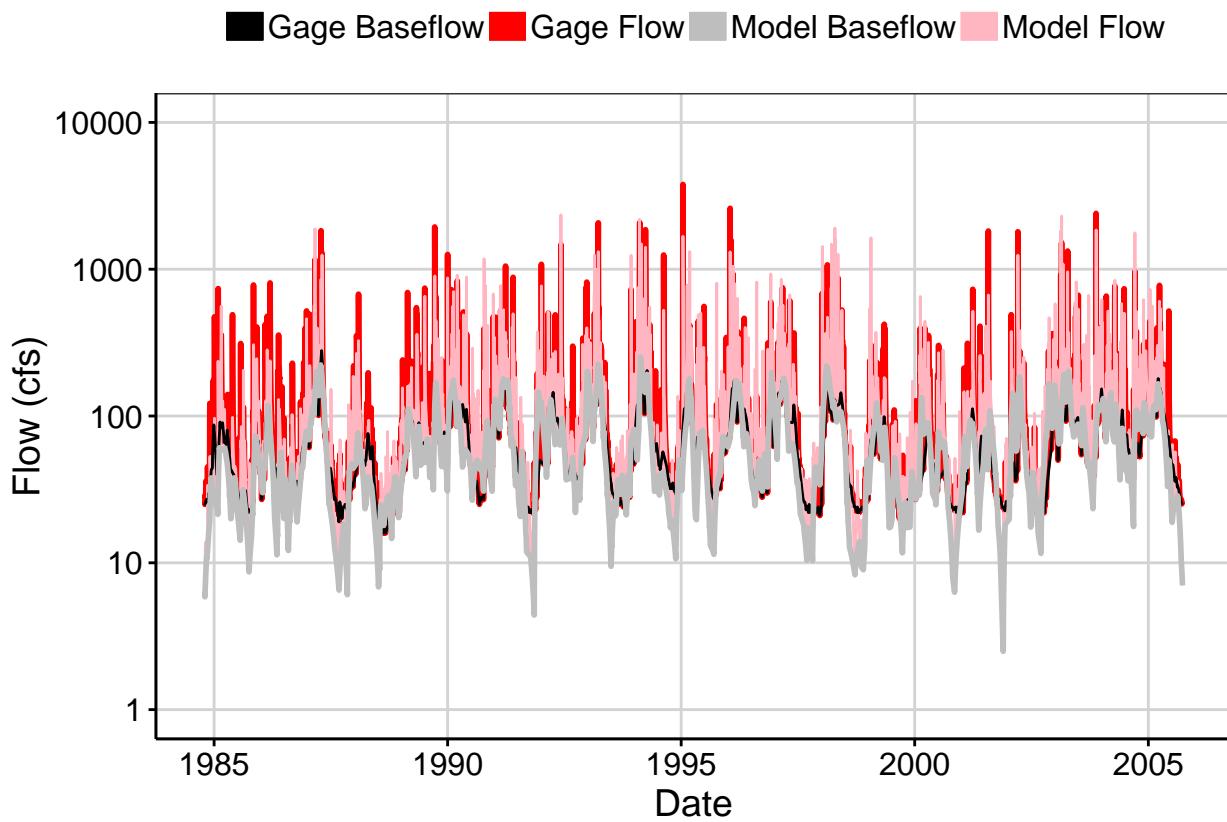


Fig. 6: Largest Error Segment

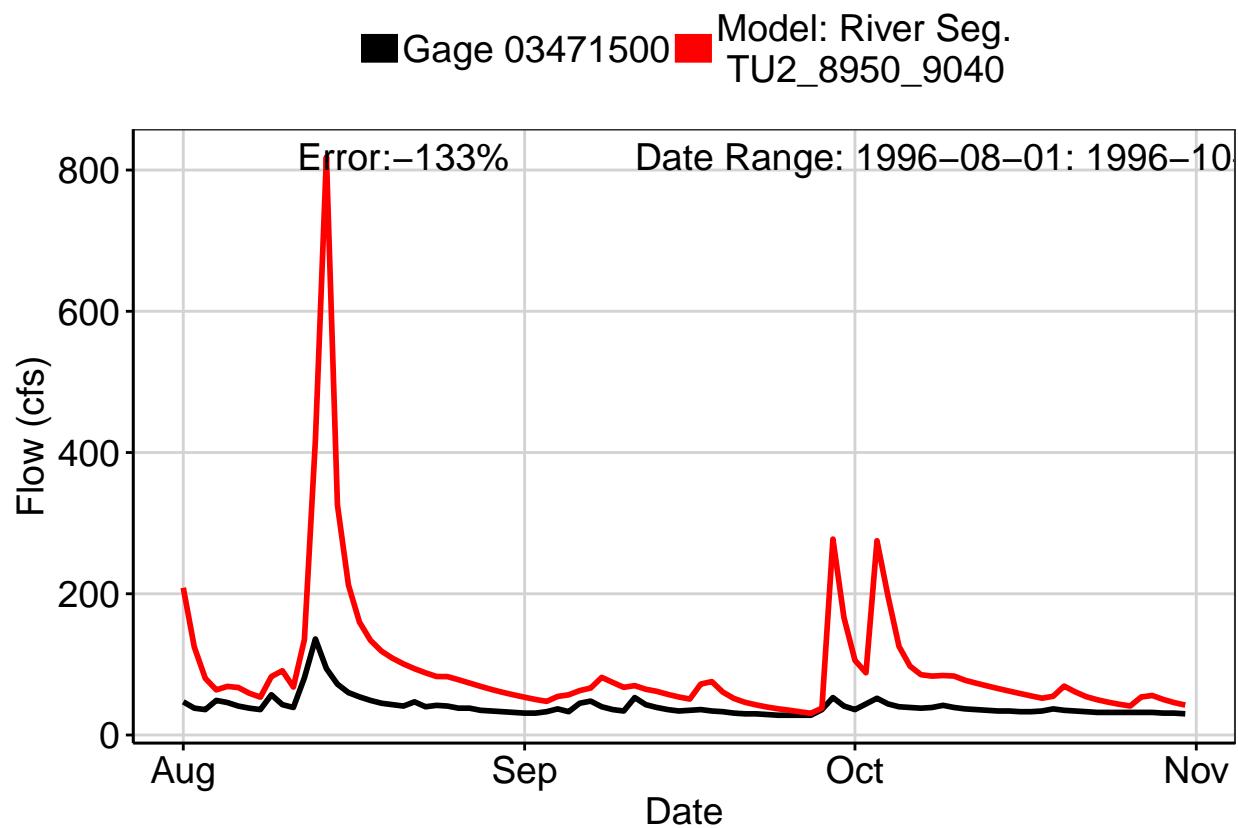


Fig. 7: Second Largest Error Segment

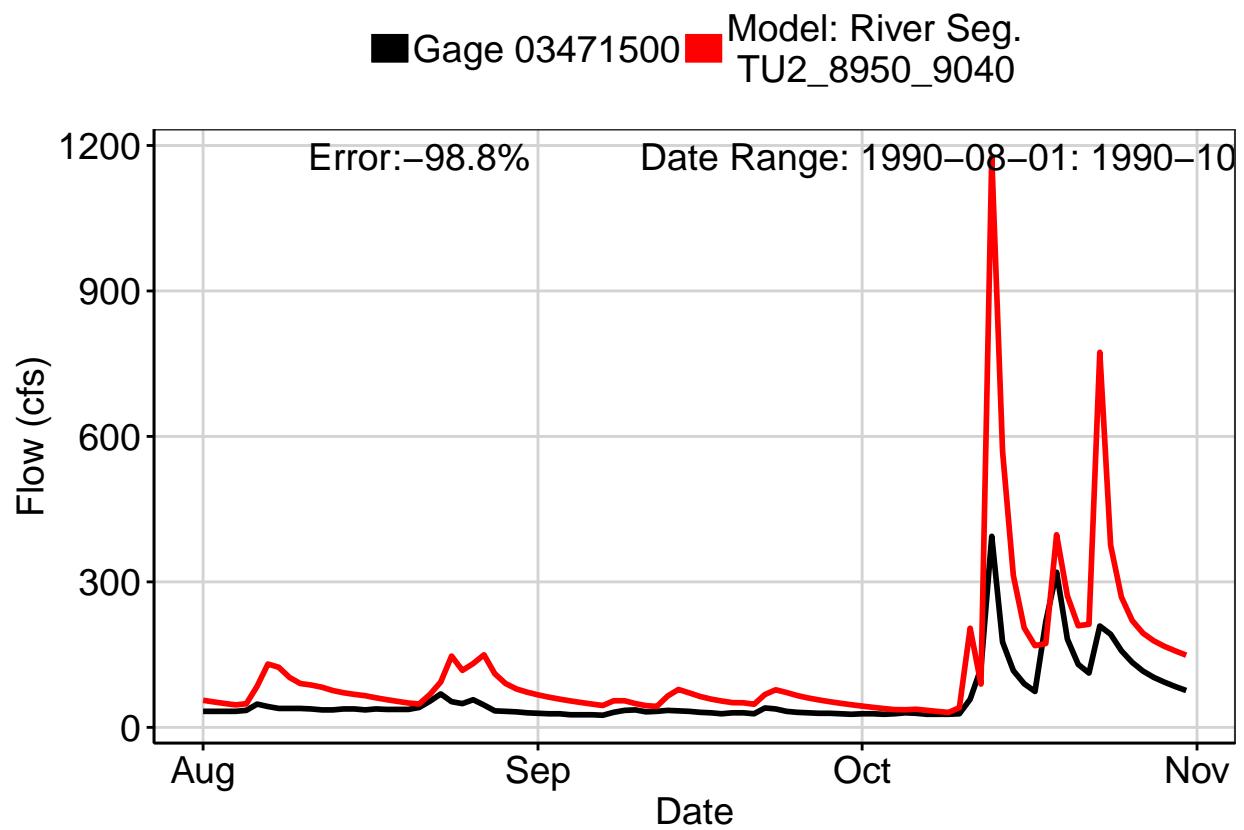


Fig. 8: Third Largest Error Segment

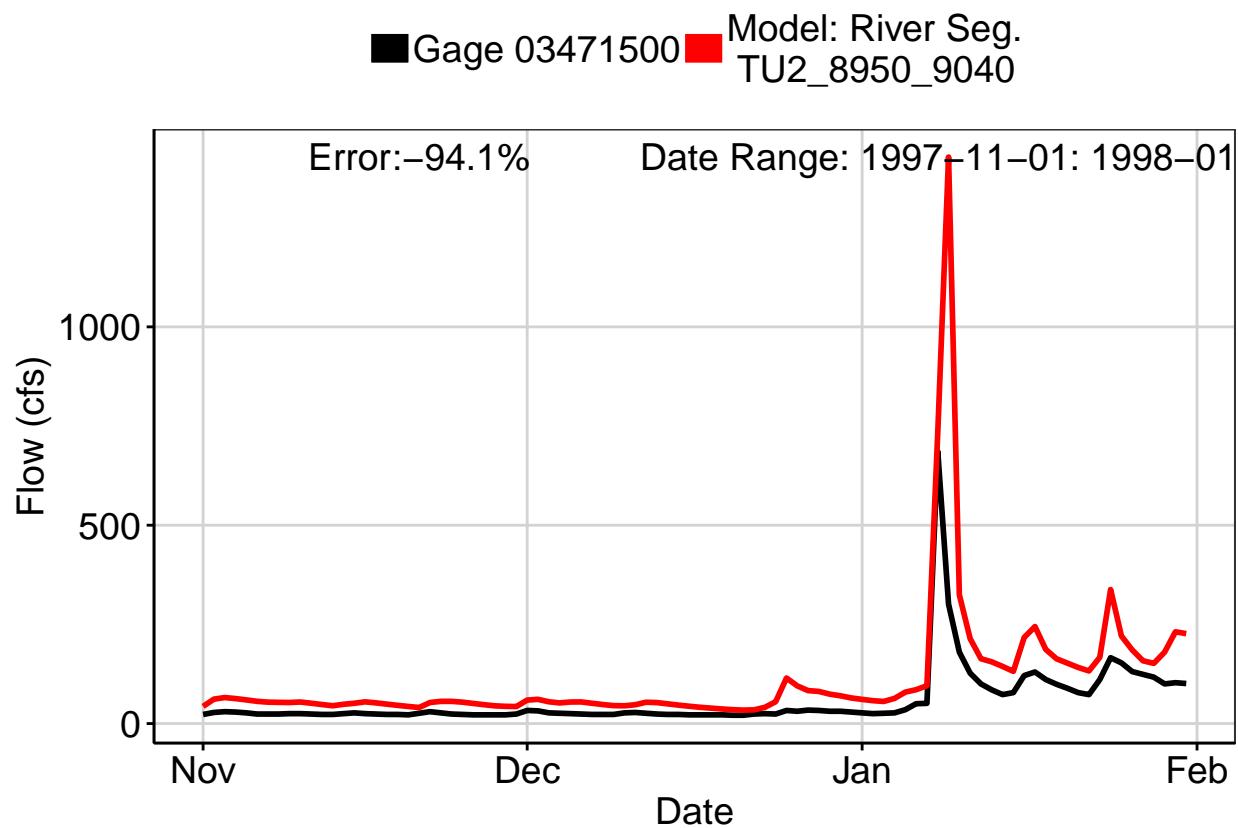
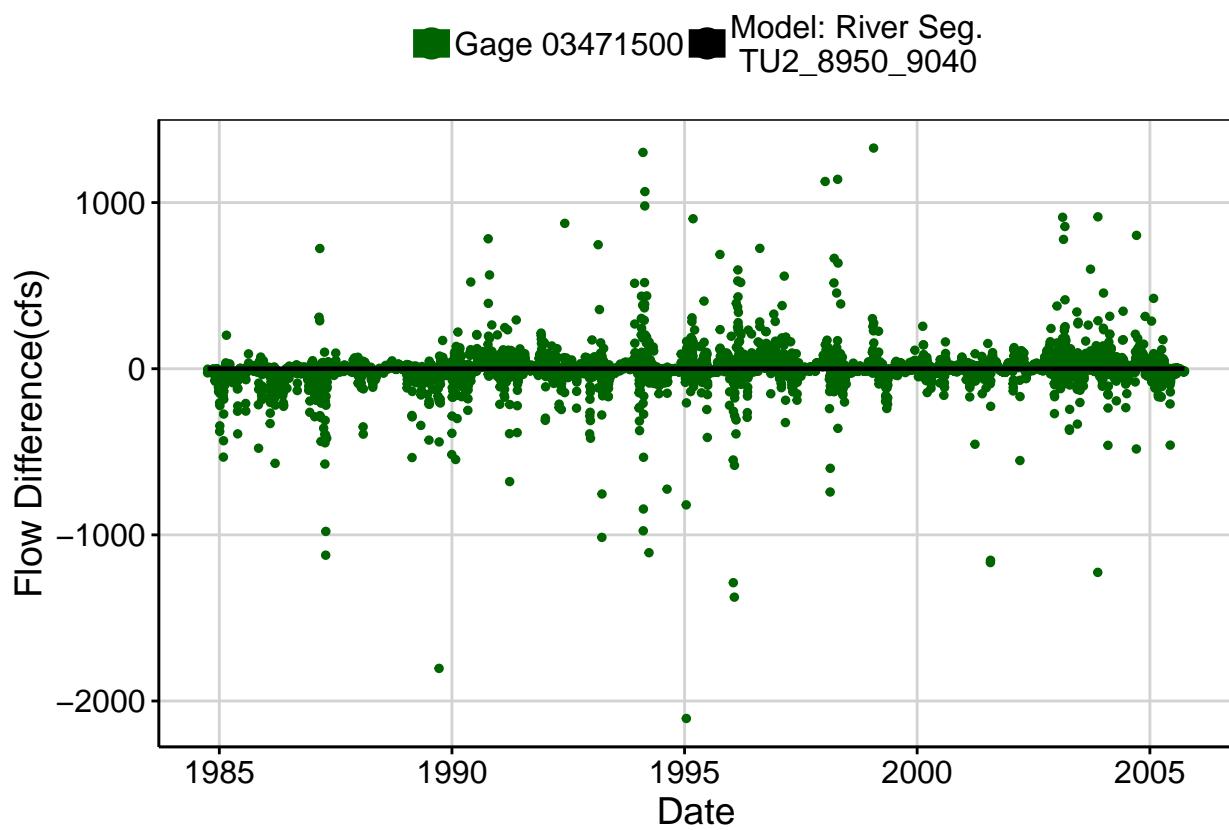
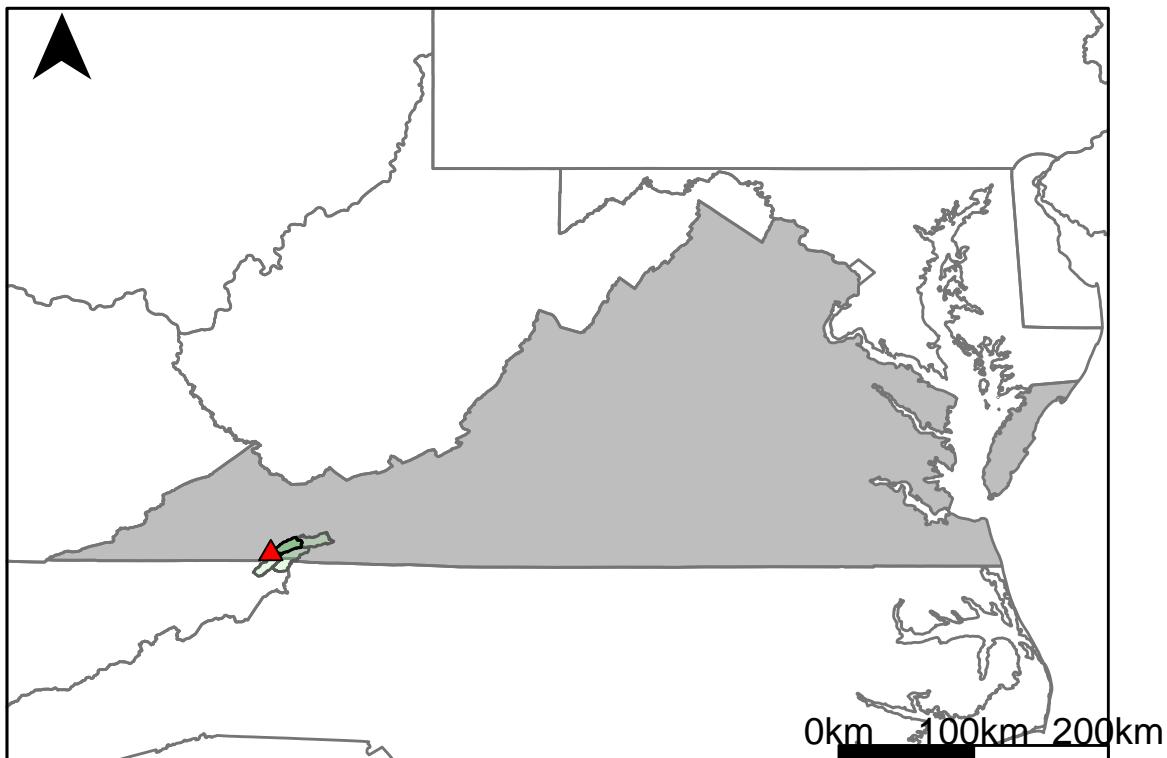


Fig. 9: Residuals Plot



## Appendix D.2: USGS Gage 03473000 vs. TU3\_9040\_9180+TU2\_9200\_9180



This river segment follows part of the flow of the South Fork of the Holston River, a tributary of the Tennessee River. The gage is located in Washington County, VA (Lat 36°39'06", Long 81°50'39") approximately 20 miles northeast of Bristol, VA. Drainage area is 303 sq. miles. This gage started taking data in 1931 and is still taking data. There may be some diurnal fluctuations during low flows due to a number of small dams upstream, as years have gone on many dams have been removed but the total number is unknown. The average daily discharge error between the model and gage data for the 20 year timespan was 59.7%, with 36.7% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	97	34.5	64.4
Feb. Low Flow	111	54.5	50.9
Mar. Low Flow	183	71.3	61
Apr. Low Flow	210	112	46.7
May Low Flow	339	152	55.2
Jun. Low Flow	373	175	53.1
Jul. Low Flow	378	131	65.3
Aug. Low Flow	289	92.1	68.1
Sep. Low Flow	182	84.2	53.7
Oct. Low Flow	131	54.3	58.5
Nov. Low Flow	122	56.4	53.8
Dec. Low Flow	100	43.2	56.8

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	469	189	59.7
Jan. Mean Flow	616	247	59.9
Feb. Mean Flow	826	347	58
Mar. Mean Flow	806	353	56.2
Apr. Mean Flow	730	269	63.2
May Mean Flow	599	189	68.4
Jun. Mean Flow	407	153	62.4
Jul. Mean Flow	300	112	62.7
Aug. Mean Flow	225	108	52
Sep. Mean Flow	202	92.3	54.3
Oct. Mean Flow	176	95.8	45.6
Nov. Mean Flow	306	132	56.9
Dec. Mean Flow	459	183	60.1

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	205	90.7	55.8
Feb. High Flow	526	189	64.1
Mar. High Flow	1450	261	82
Apr. High Flow	1650	782	52.6
May High Flow	2640	781	70.4
Jun. High Flow	2080	974	53.2
Jul. High Flow	1420	461	67.5
Aug. High Flow	1530	401	73.8
Sep. High Flow	802	232	71.1
Oct. High Flow	596	175	70.6
Nov. High Flow	362	150	58.6
Dec. High Flow	285	123	56.8

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	65	7.43	88.6
Med. 1 Day Min	83	21.9	73.6
Min. 3 Day Min	65	7.63	88.3
Med. 3 Day Min	84	22.7	73
Min. 7 Day Min	66.9	8.4	87.4
Med. 7 Day Min	88.6	24	72.9
Min. 30 Day Min	86.3	16.1	81.3
Med. 30 Day Min	101	33	67.3
Min. 90 Day Min	96.2	38.8	59.7
Med. 90 Day Min	174	64.9	62.7
7Q10	71.5	12.5	82.5
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	245	189	22.9
Mean Baseflow	266	119	55.3

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	10400	3880	62.7
Med. 1 Day Max	4840	1970	59.3
Max. 3 Day Max	6920	2560	63
Med. 3 Day Max	3430	1310	61.8
Max. 7 Day Max	4480	1590	64.5
Med. 7 Day Max	2200	764	65.3
Max. 30 Day Max	2000	954	52.3
Med. 30 Day Max	1160	460	60.3
Max. 90 Day Max	1330	662	50.2
Med. 90 Day Max	891	380	57.4

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	79	18	77.2
5% Non-Exceedance	93	30.6	67.1
50% Non-Exceedance	312	129	58.7
95% Non-Exceedance	1310	502	61.7
99% Non-Exceedance	2670	1050	60.7
Sept. 10% Non-Exceedance	64.4	27.4	57.5

**Fig. 1: Hydrograph**

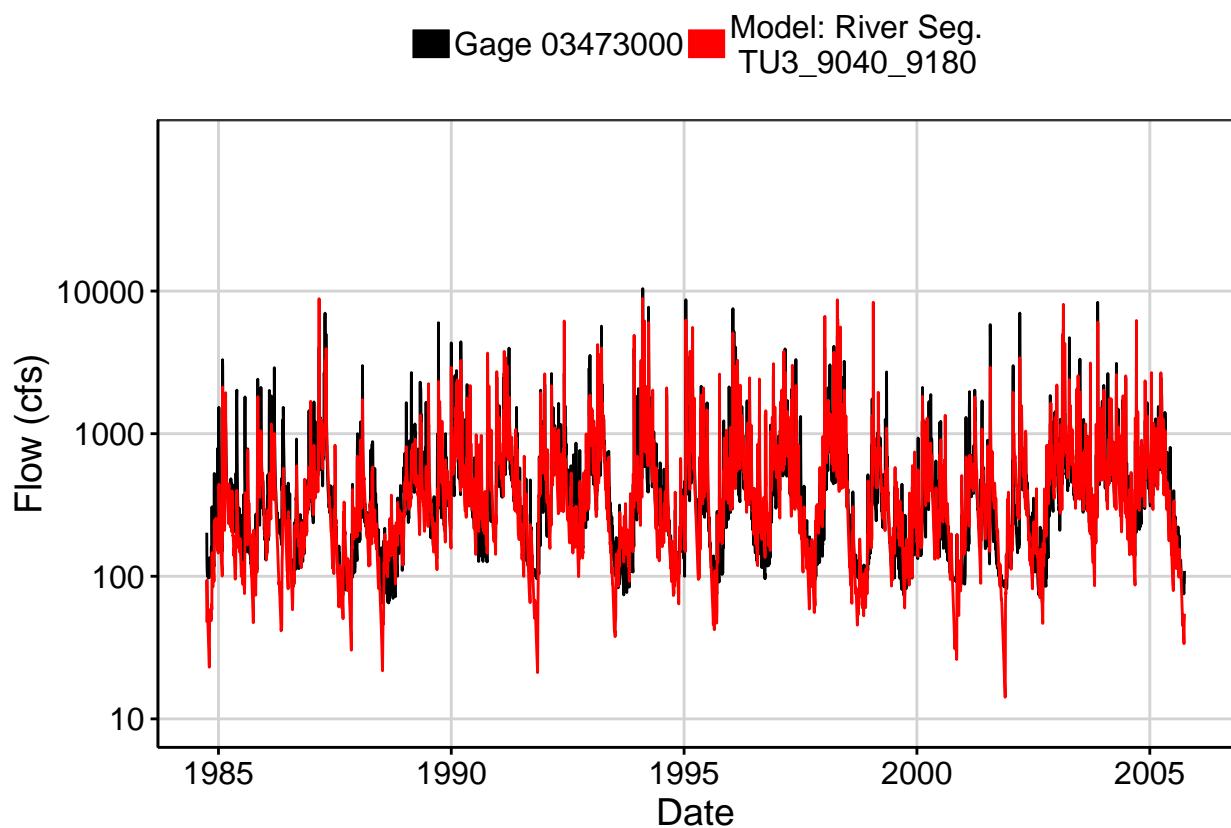


Fig. 2: Zoomed Hydrograph

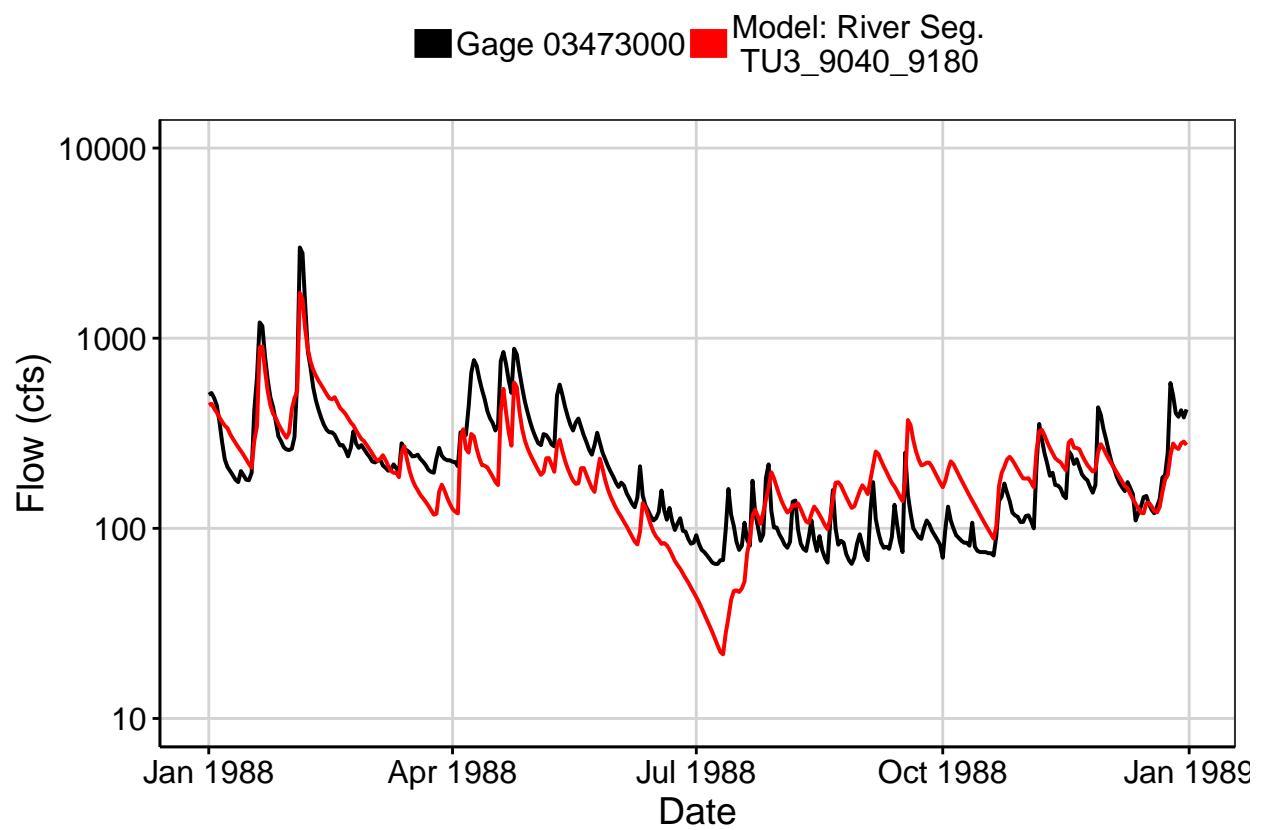


Fig. 3: Flow Exceedance

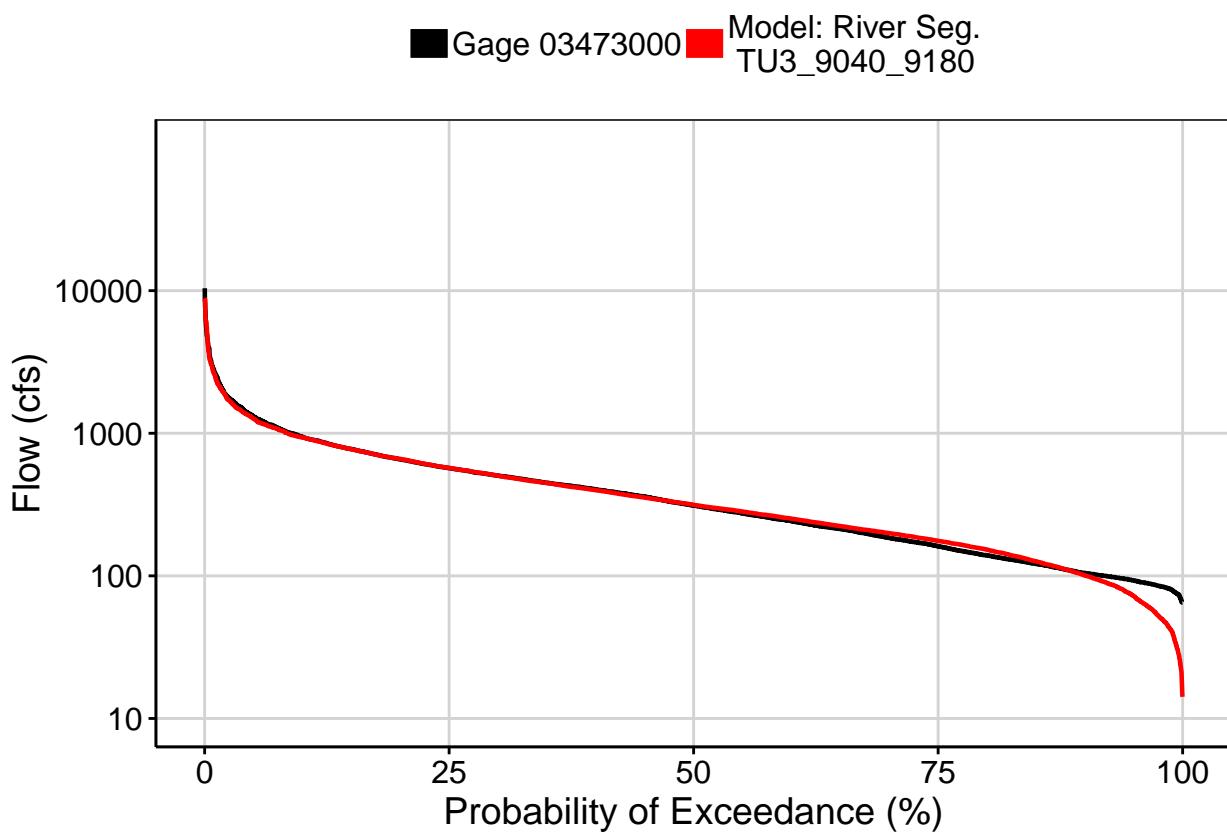


Fig. 4: Baseflow

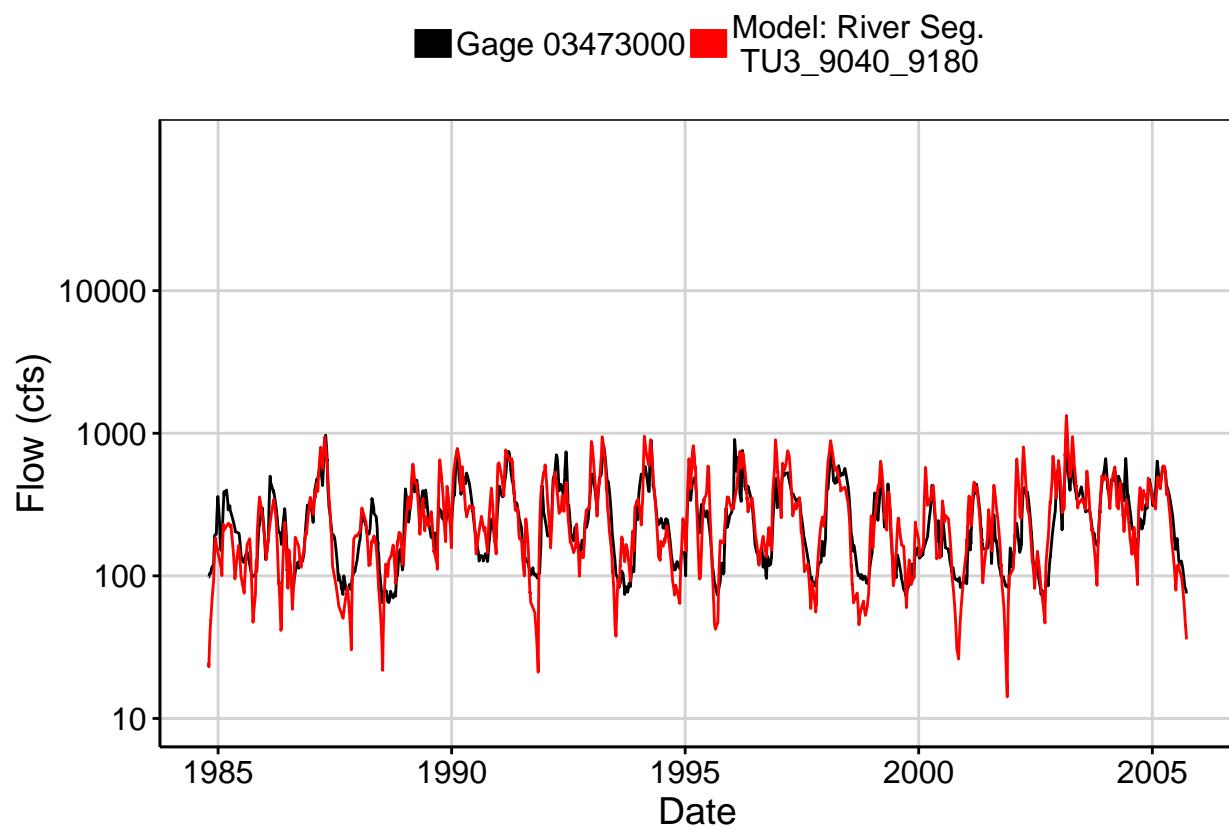


Fig. 5: Combined Baseflow

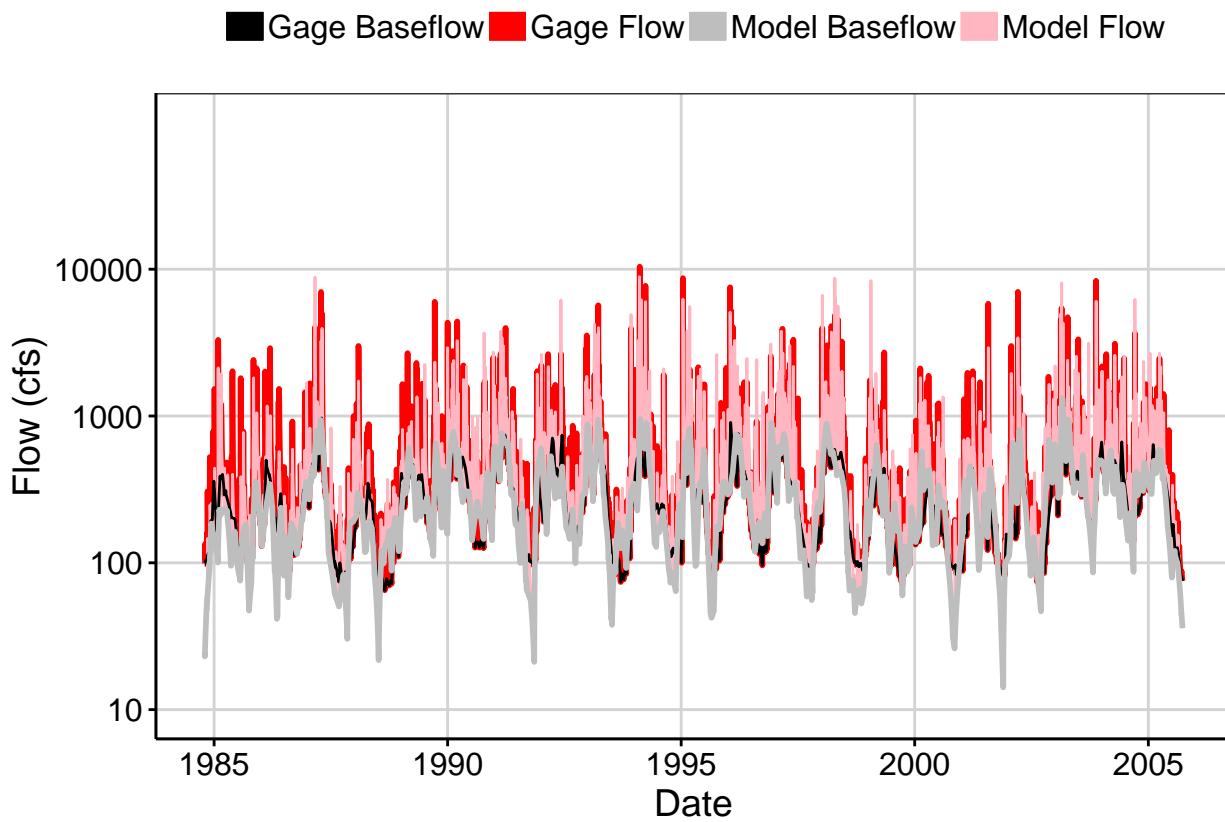


Fig. 6: Largest Error Segment

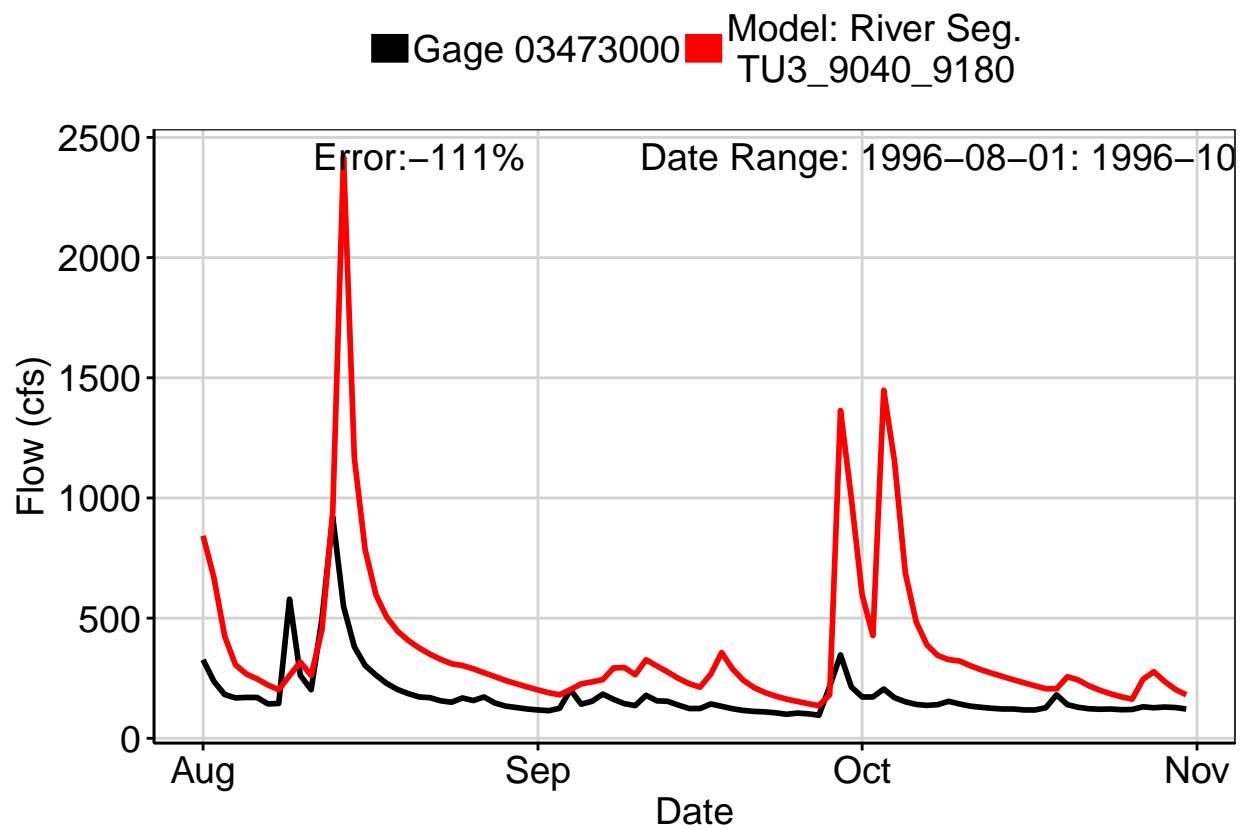


Fig. 7: Second Largest Error Segment

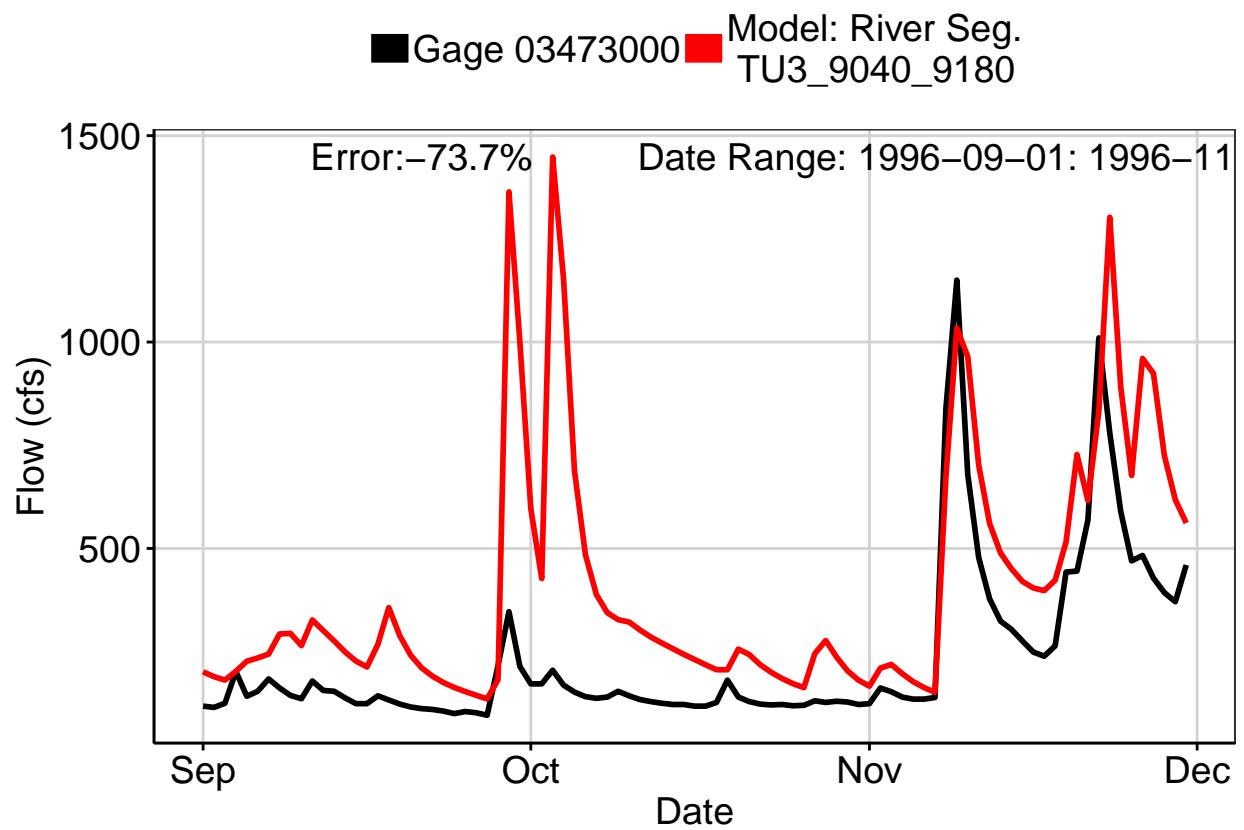


Fig. 8: Third Largest Error Segment

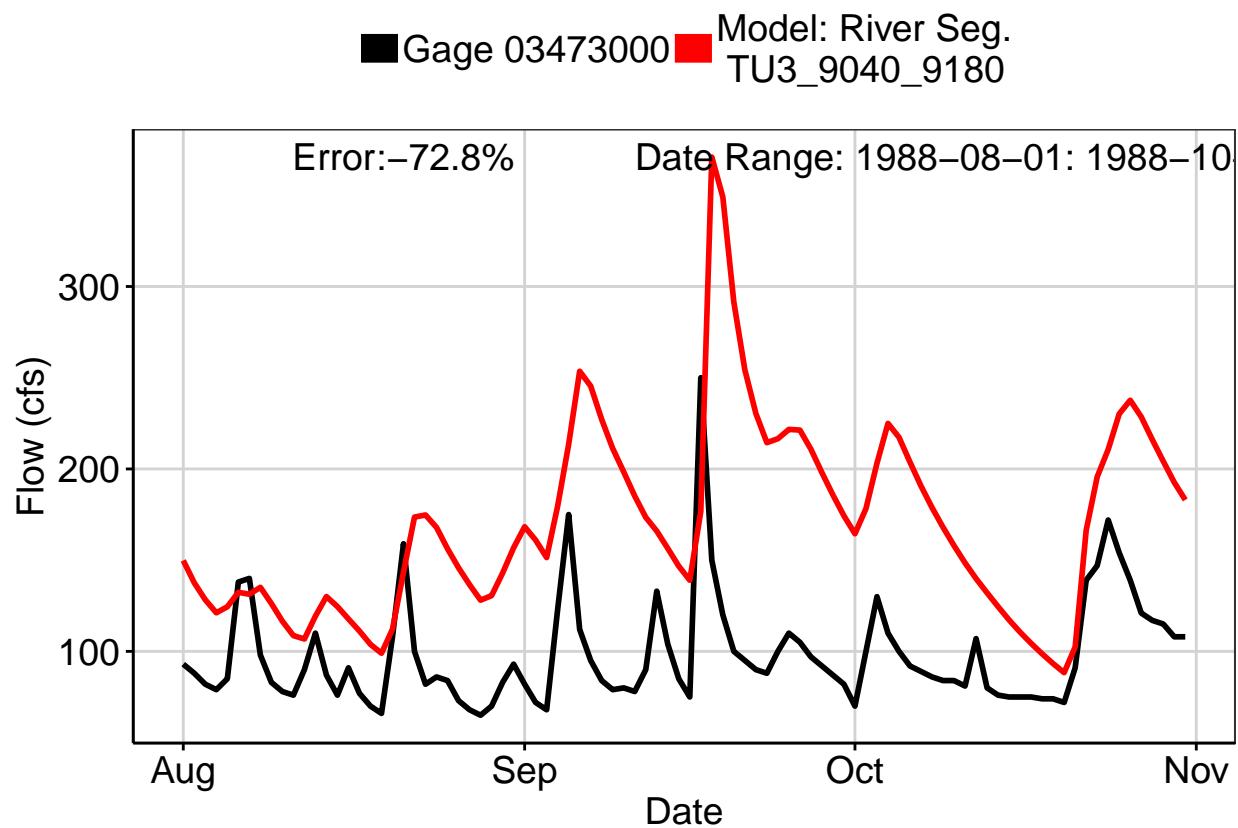
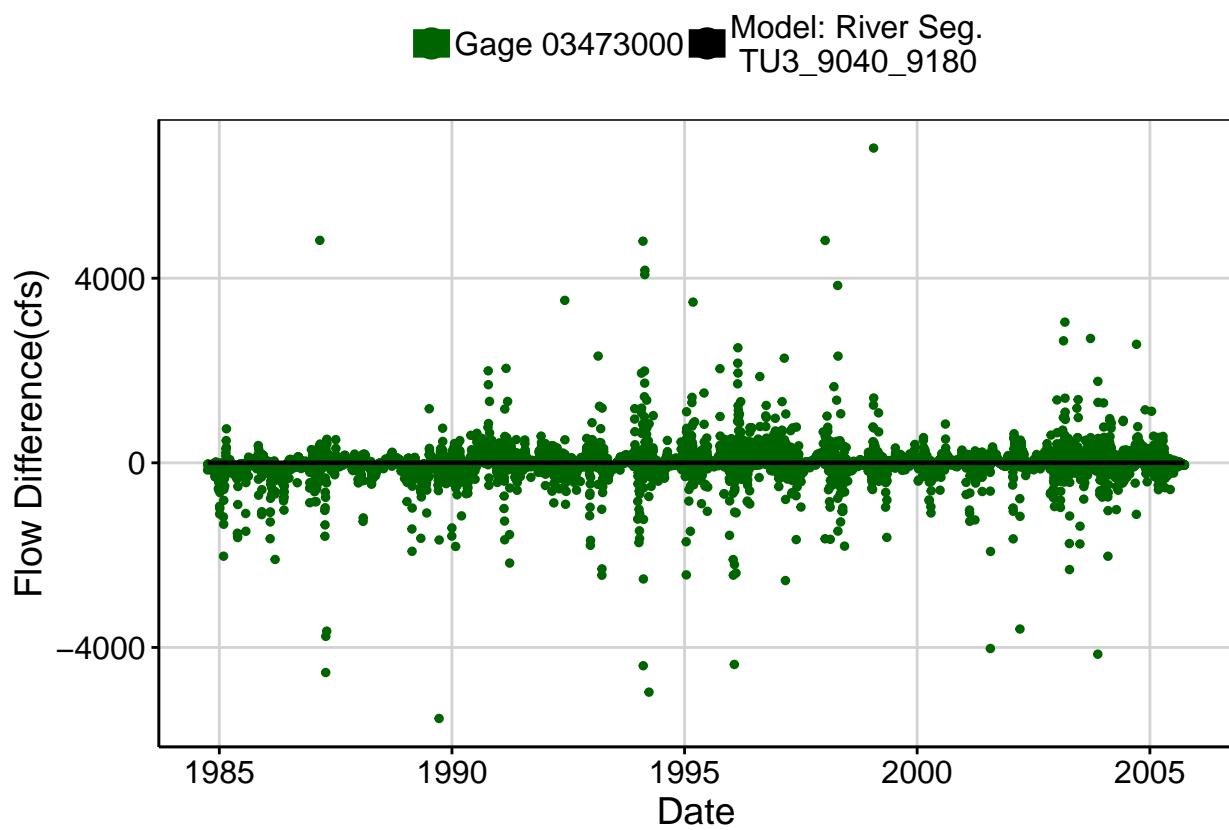
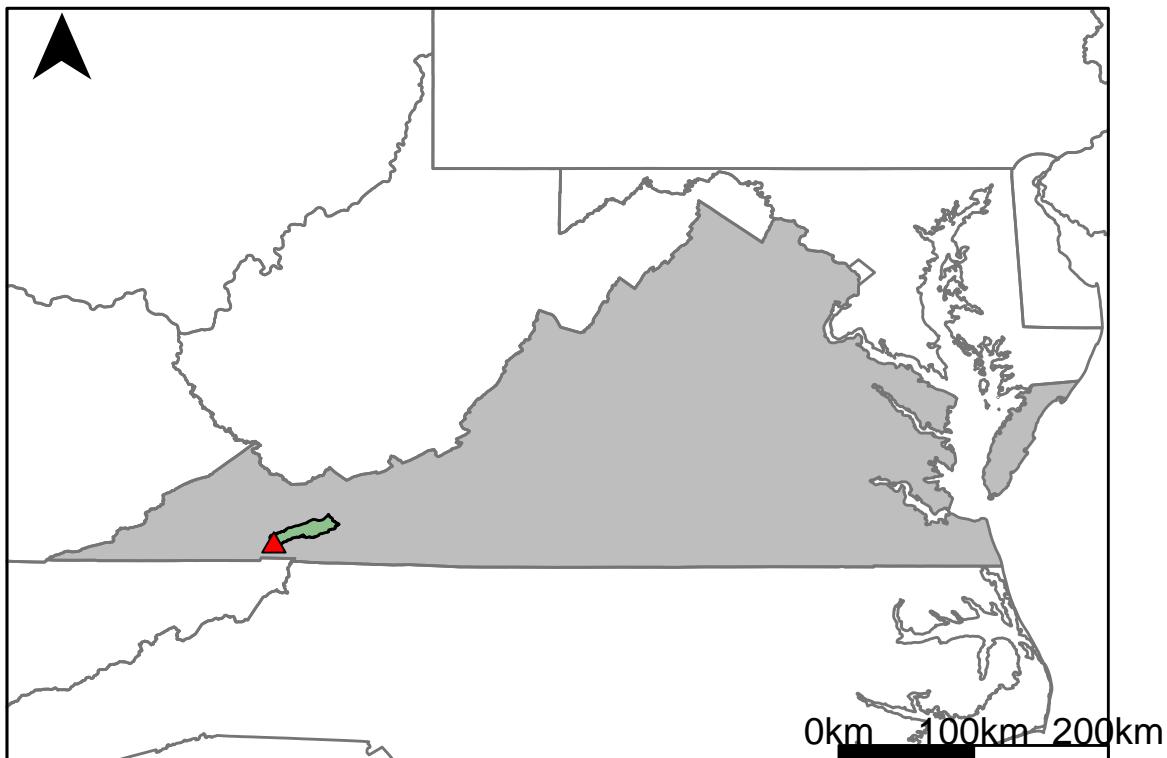


Fig. 9: Residuals Plot



## Appendix D.3: USGS Gage 03475000 vs. TU2\_8790\_9070



This river segment follows part of the flow of the Middle Fork of the Houston River, a tributary of the Tennessee River. The gage is located in Washington County, VA (Lat 36°42'47", Long 81°49'08") approximately 22 miles northeast of Bristol, VA. Drainage area is 206 sq. miles. This gage started taking data in 1931 and is still taking data. The Edmondson Power Company Dam was located 0.9 miles upstream of this gage but was decommissioned and removed in 1982. The average daily discharge error between the model and gage data for the 20 year timespan was 0%, with 34.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	62	43.5	29.8
Feb. Low Flow	62	61.3	1.13
Mar. Low Flow	94	87.8	6.6
Apr. Low Flow	117	140	-19.7
May Low Flow	196	214	-9.18
Jun. Low Flow	218	231	-5.96
Jul. Low Flow	198	172	13.1
Aug. Low Flow	144	127	11.8
Sep. Low Flow	116	101	12.9
Oct. Low Flow	83	66	20.5
Nov. Low Flow	80	58.3	27.1
Dec. Low Flow	67	51.3	23.4

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	253	253	0
Jan. Mean Flow	321	343	-6.85
Feb. Mean Flow	470	481	-2.34
Mar. Mean Flow	472	476	-0.85
Apr. Mean Flow	380	367	3.42
May Mean Flow	296	252	14.9
Jun. Mean Flow	224	204	8.93
Jul. Mean Flow	173	146	15.6
Aug. Mean Flow	134	135	-0.75
Sep. Mean Flow	107	117	-9.35
Oct. Mean Flow	99.8	123	-23.2
Nov. Mean Flow	144	166	-15.3
Dec. Mean Flow	228	243	-6.58

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	118	113	4.24
Feb. High Flow	222	239	-7.66
Mar. High Flow	792	367	53.7
Apr. High Flow	965	1080	-11.9
May High Flow	1430	1060	25.9
Jun. High Flow	1250	1430	-14.4
Jul. High Flow	663	650	1.96
Aug. High Flow	733	540	26.3
Sep. High Flow	399	315	21.1
Oct. High Flow	281	250	11
Nov. High Flow	228	184	19.3
Dec. High Flow	168	151	10.1

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	39	8.17	79.1
Med. 1 Day Min	56	22.7	59.5
Min. 3 Day Min	40	8.82	78
Med. 3 Day Min	56.7	24.1	57.5
Min. 7 Day Min	40.7	9.73	76.1
Med. 7 Day Min	58.7	26.4	55
Min. 30 Day Min	49.6	13.3	73.2
Med. 30 Day Min	65.8	42	36.2
Min. 90 Day Min	53.2	37.3	29.9
Med. 90 Day Min	84.1	77.7	7.61
7Q10	47.1	12.6	73.2
Year of 90-Day Min. Flow	1988	1985	100
Drought Year Mean	119	253	-113
Mean Baseflow	149	155	-4.03

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	7040	5960	15.3
Med. 1 Day Max	2810	2580	8.19
Max. 3 Day Max	4180	4020	3.83
Med. 3 Day Max	1880	1750	6.91
Max. 7 Day Max	2690	2450	8.92
Med. 7 Day Max	1220	1080	11.5
Max. 30 Day Max	1170	1400	-19.7
Med. 30 Day Max	653	641	1.84
Max. 90 Day Max	789	932	-18.1
Med. 90 Day Max	444	539	-21.4

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	49	17.9	63.5
5% Non-Exceedance	60	35.1	41.5
50% Non-Exceedance	152	167	-9.87
95% Non-Exceedance	731	678	7.25
99% Non-Exceedance	1500	1480	1.33
Sept. 10% Non-Exceedance	32.2	32.2	0

**Fig. 1: Hydrograph**

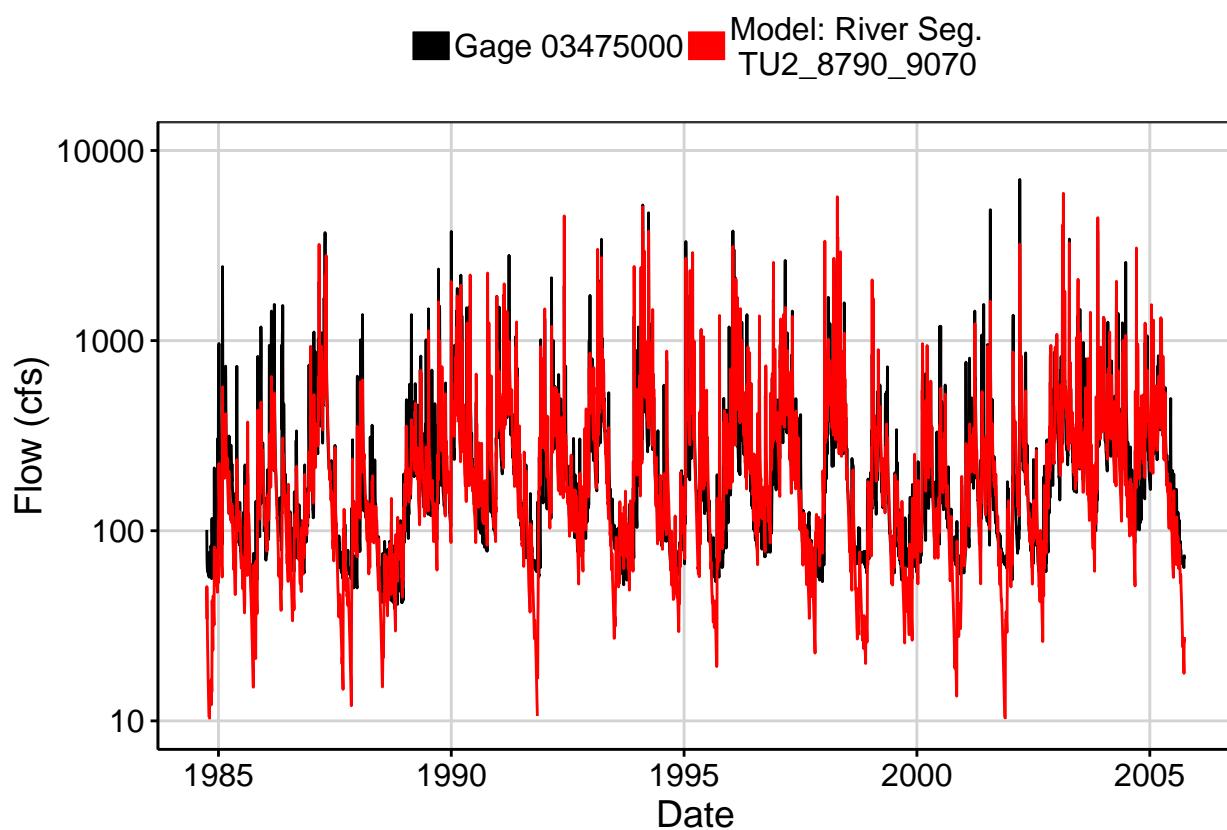


Fig. 2: Zoomed Hydrograph

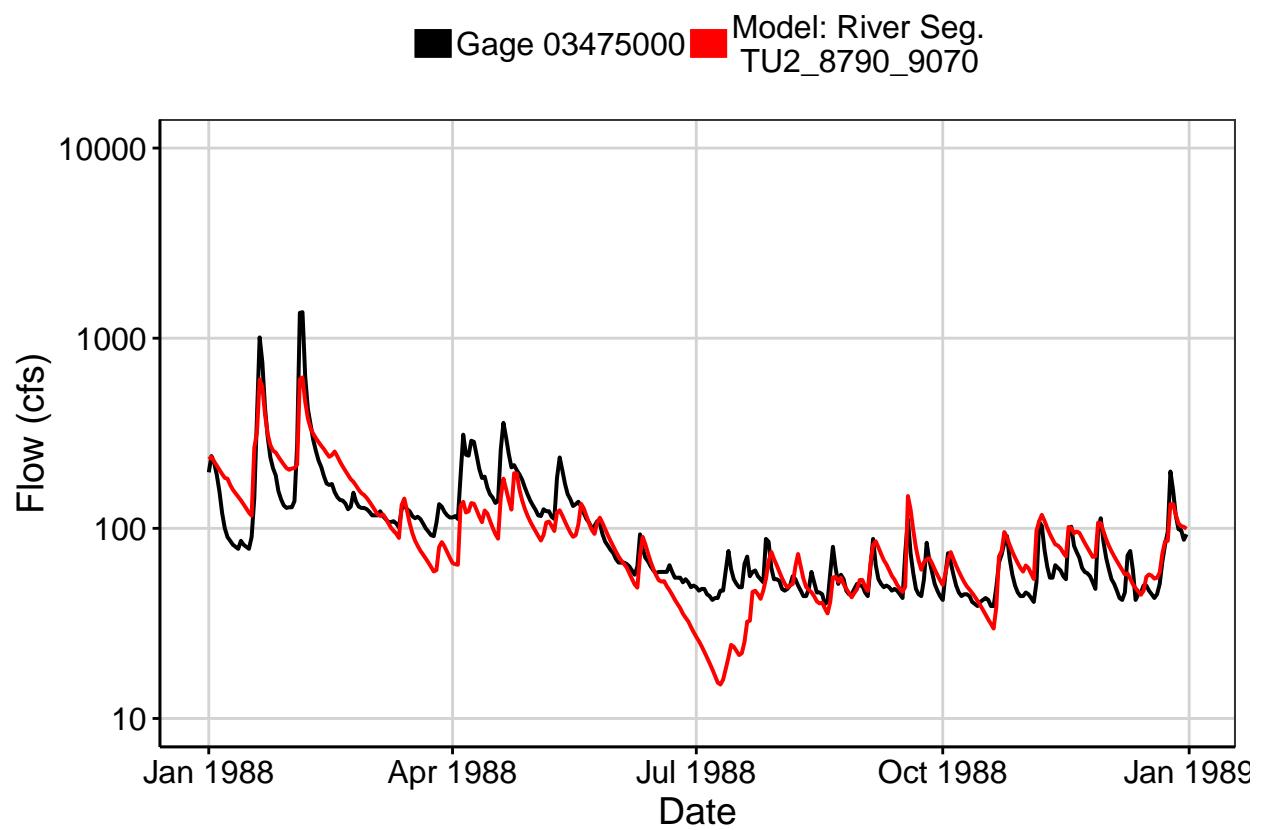


Fig. 3: Flow Exceedance

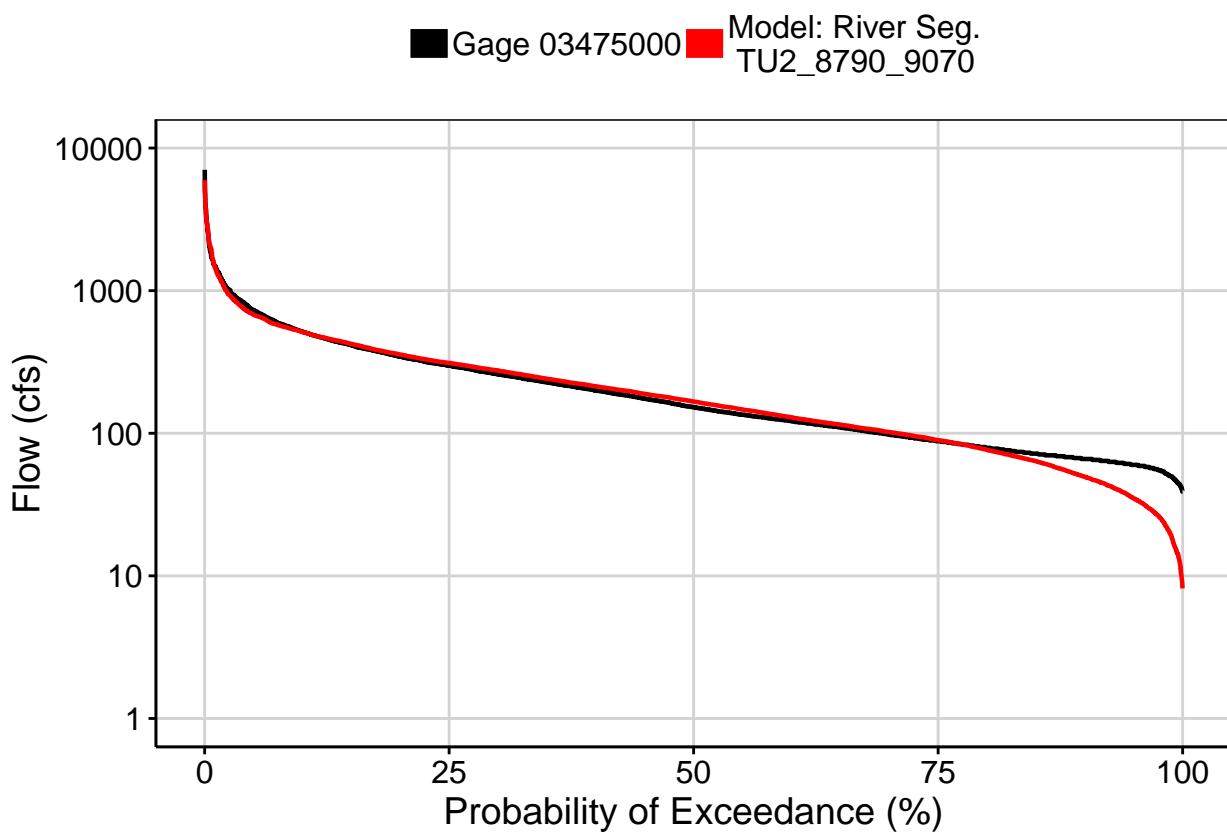


Fig. 4: Baseflow

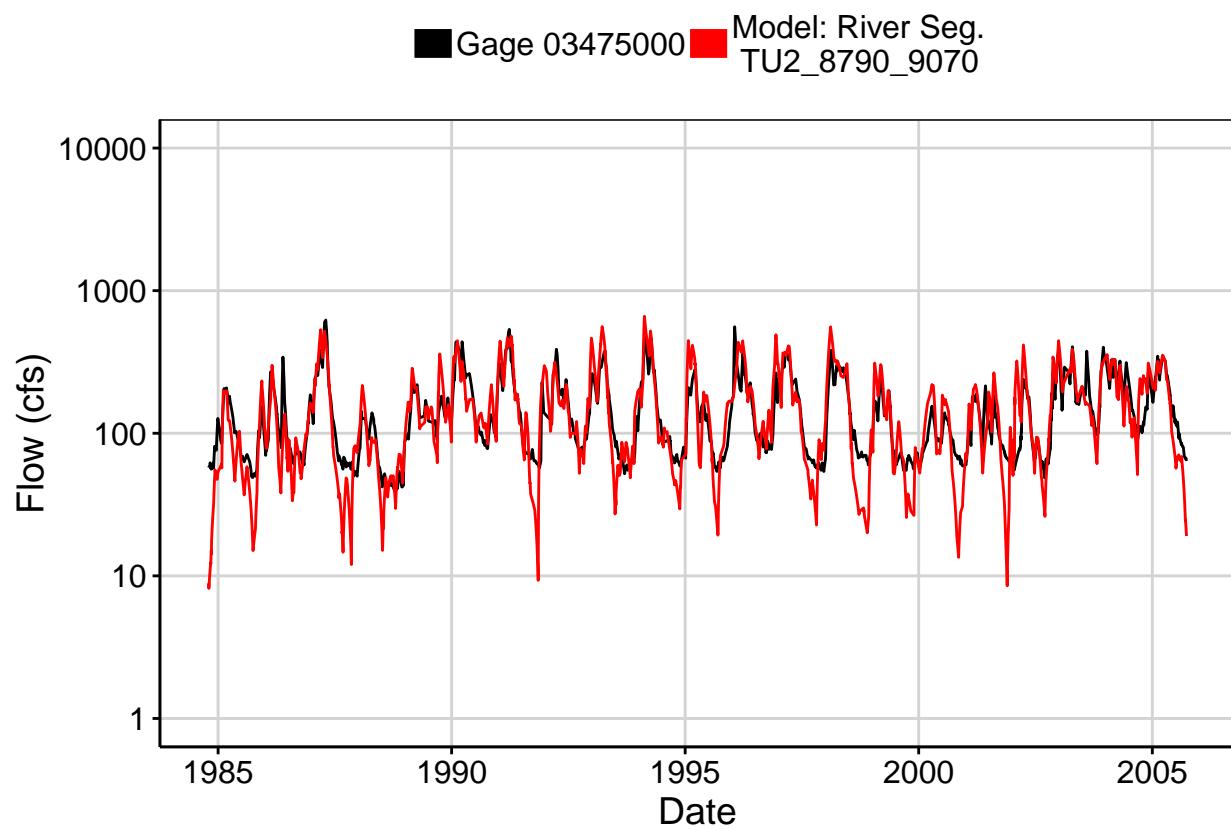


Fig. 5: Combined Baseflow

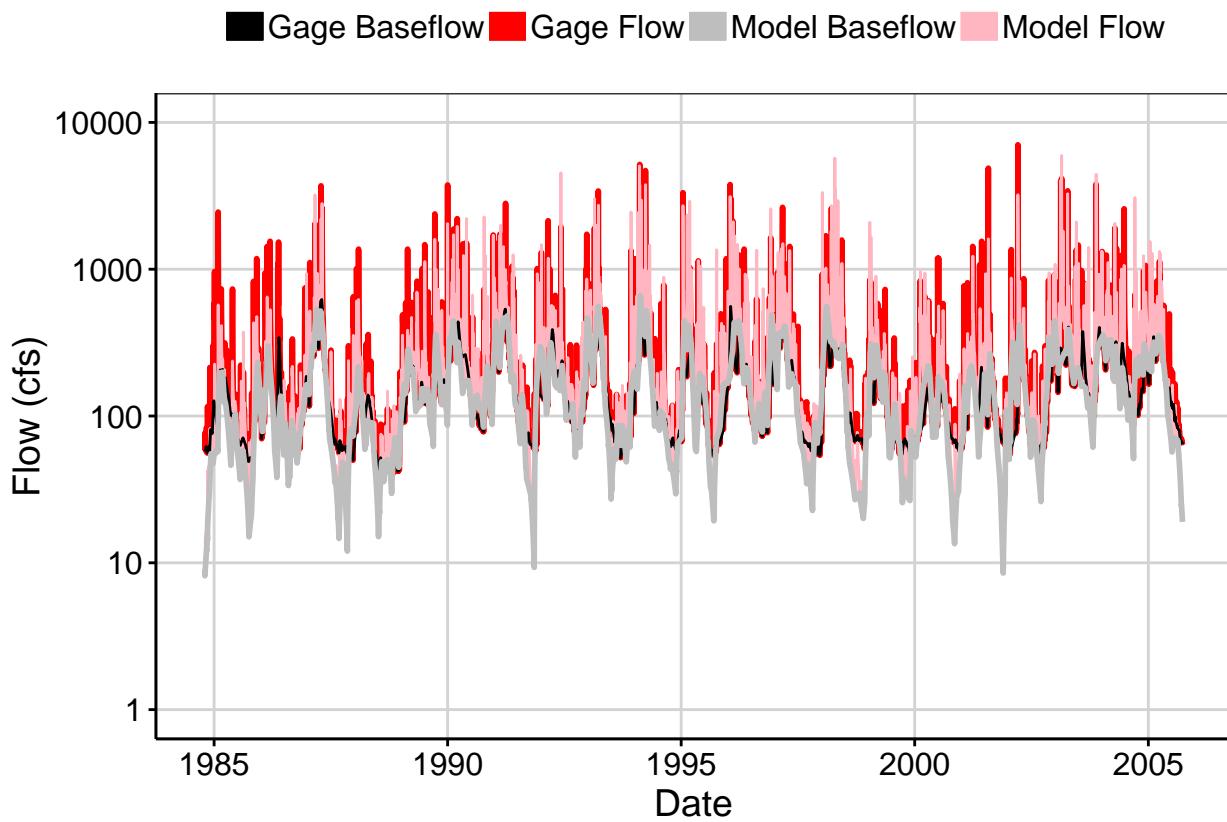


Fig. 6: Largest Error Segment

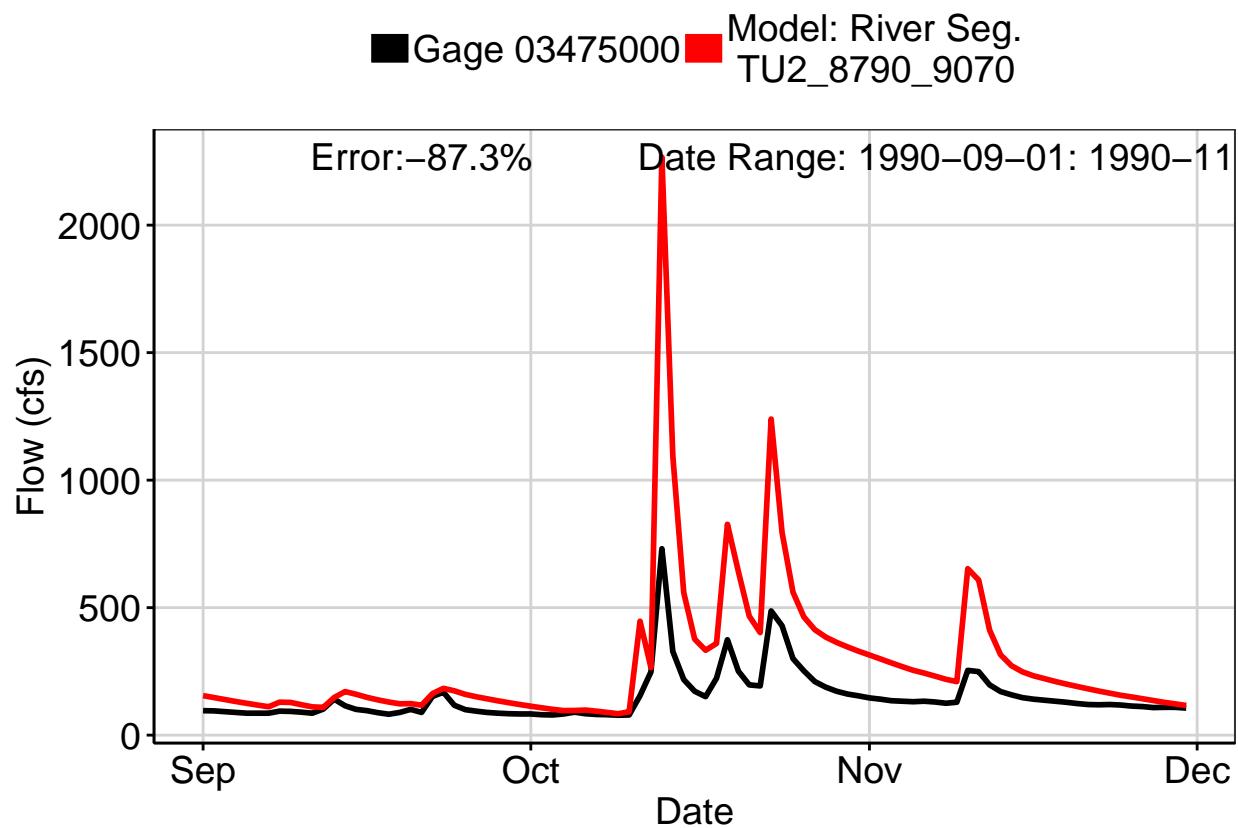


Fig. 7: Second Largest Error Segment

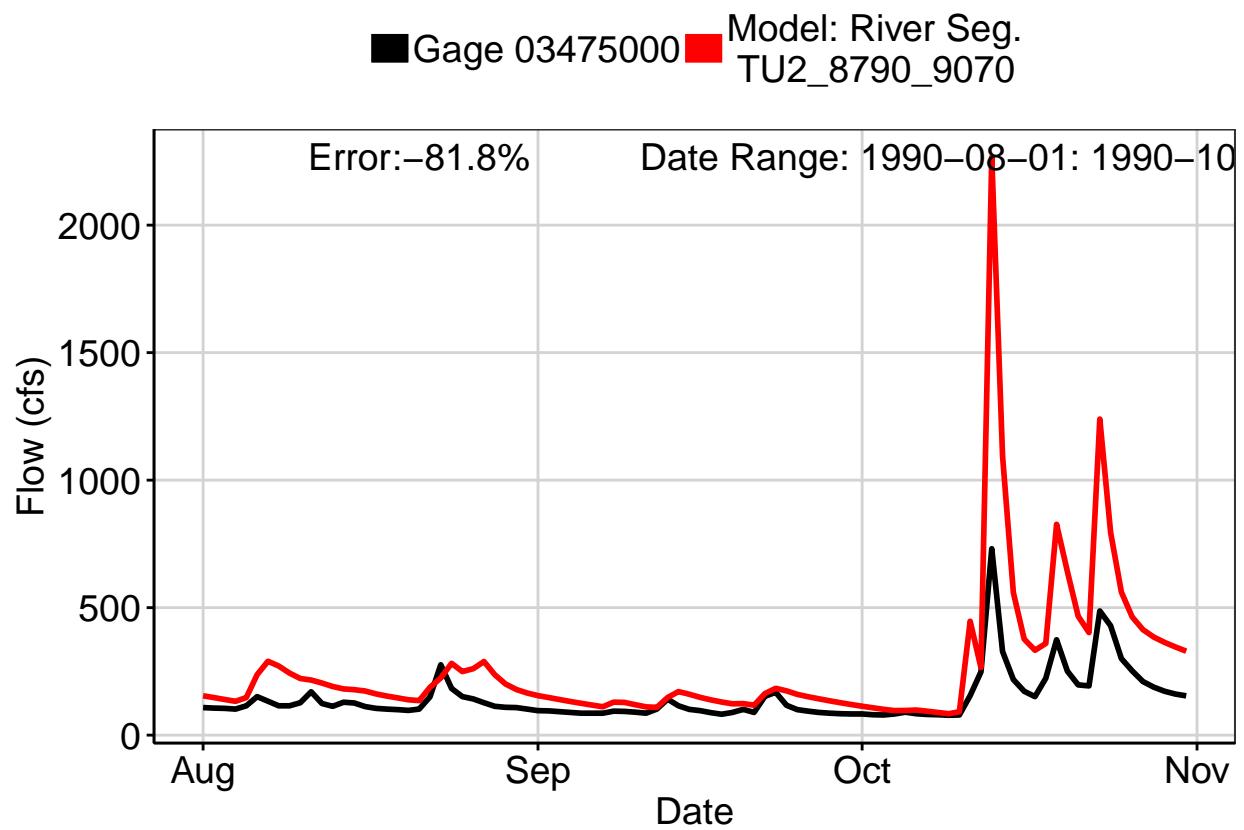


Fig. 8: Third Largest Error Segment

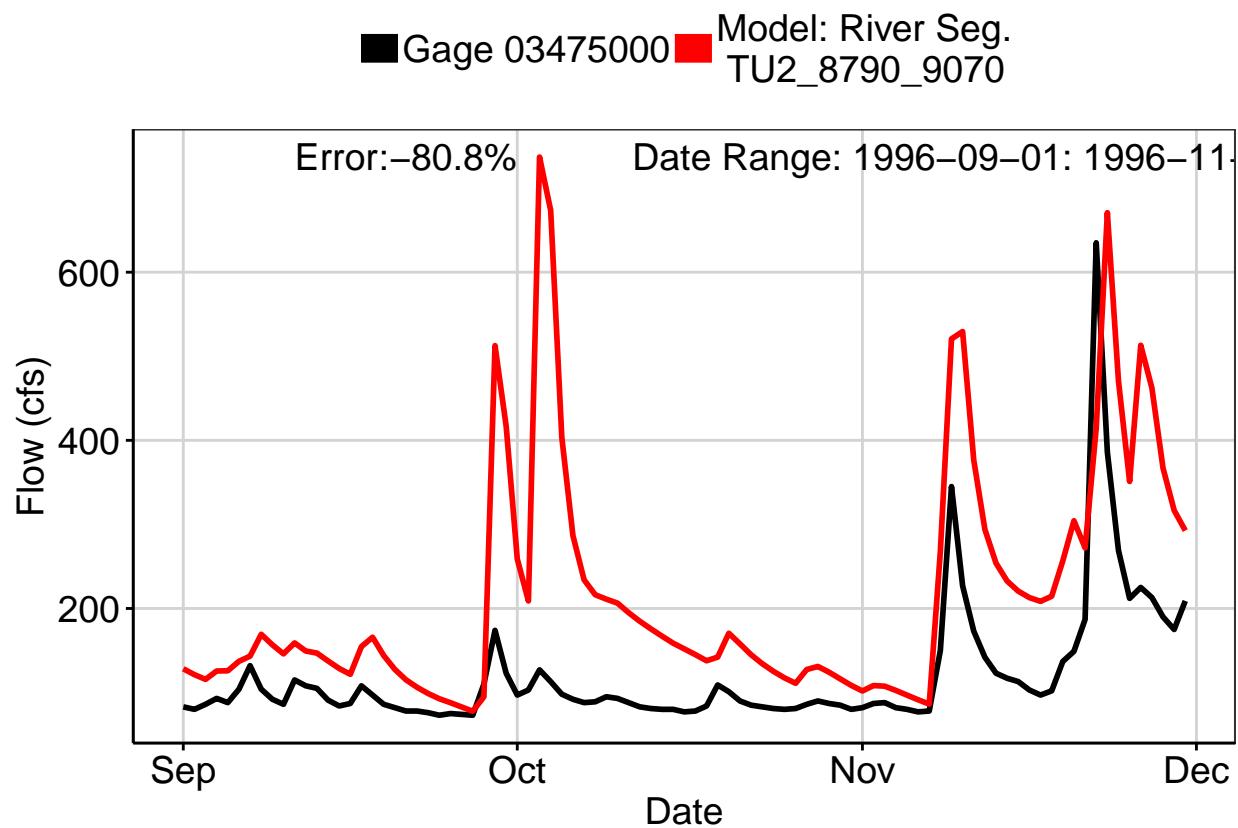
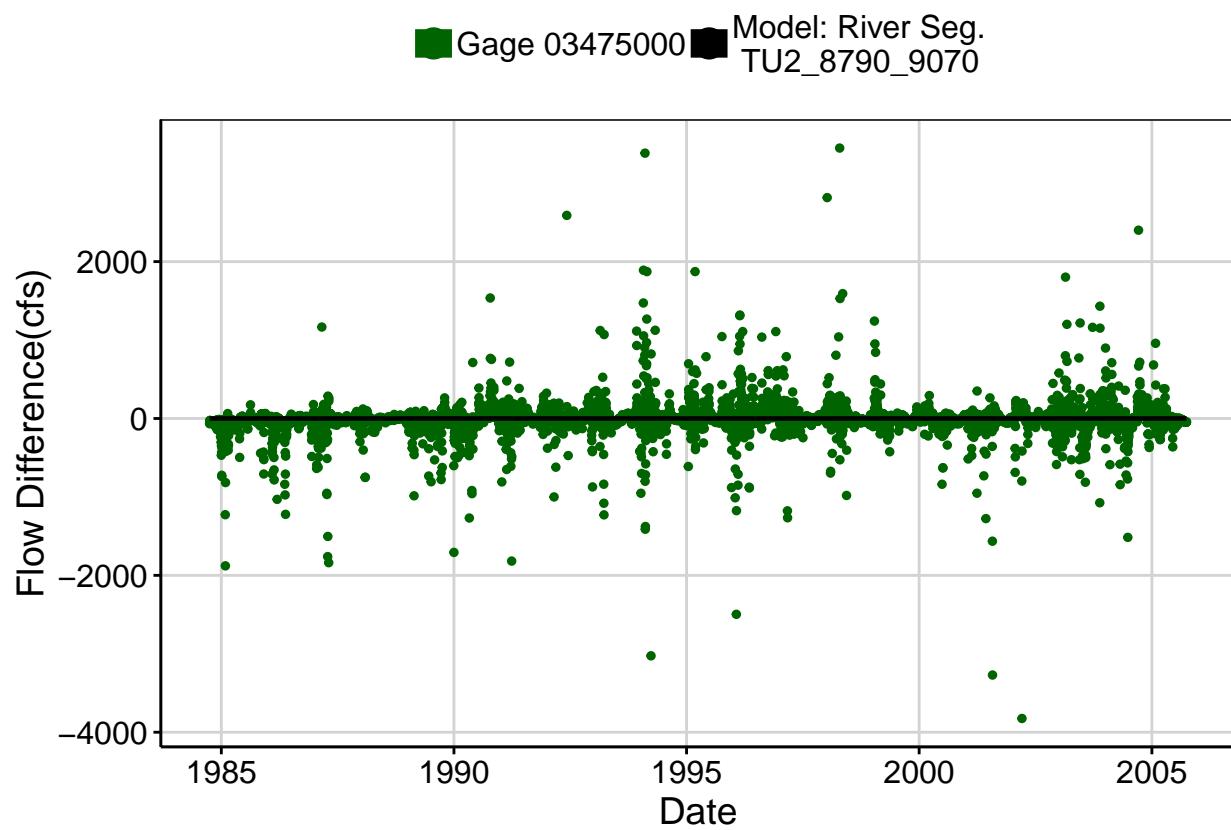
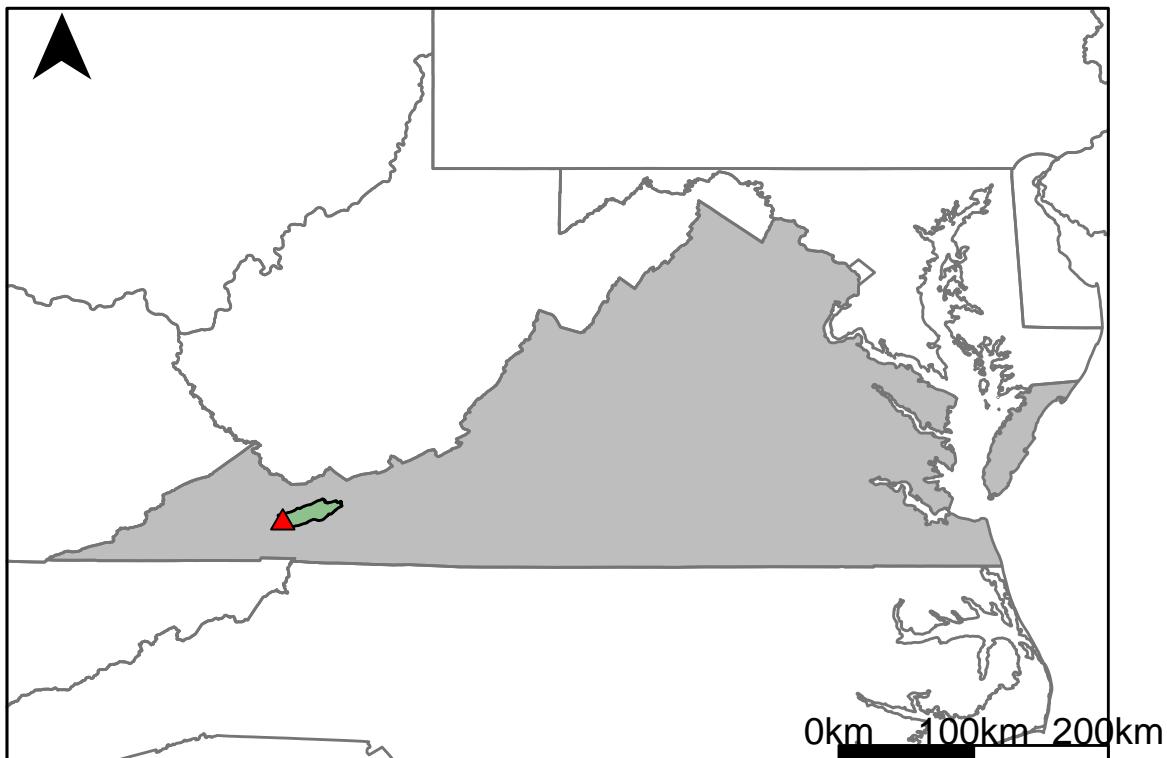


Fig. 9: Residuals Plot



## Appendix D.4: USGS Gage 03488000 vs. TU3\_8650\_8800



This river segment follows part of the flow of the North Fork of the Holston River, a tributary of the Tennessee River. The gage is located in Smyth County, VA (Lat 36°53'48", Long 81°44'47") approximately 32 miles northeast of Bristol, VA. Drainage area is 221 sq. miles. This gage started taking data in 1907 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 1.36%, with 42.9% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	35	36	-2.86
Feb. Low Flow	39	75.9	-94.6
Mar. Low Flow	72	94.1	-30.7
Apr. Low Flow	118	148	-25.4
May Low Flow	173	213	-23.1
Jun. Low Flow	207	242	-16.9
Jul. Low Flow	206	172	16.5
Aug. Low Flow	121	117	3.31
Sep. Low Flow	78.7	65.7	16.5
Oct. Low Flow	55	37.3	32.2
Nov. Low Flow	44	46.5	-5.68
Dec. Low Flow	37	37.1	-0.27

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	294	290	1.36
Jan. Mean Flow	427	409	4.22
Feb. Mean Flow	562	561	0.18
Mar. Mean Flow	566	545	3.71
Apr. Mean Flow	449	401	10.7
May Mean Flow	372	292	21.5
Jun. Mean Flow	230	223	3.04
Jul. Mean Flow	152	144	5.26
Aug. Mean Flow	115	137	-19.1
Sep. Mean Flow	89.2	138	-54.7
Oct. Mean Flow	92.2	149	-61.6
Nov. Mean Flow	184	201	-9.24
Dec. Mean Flow	304	296	2.63

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	94	128	-36.2
Feb. High Flow	319	359	-12.5
Mar. High Flow	1210	435	64
Apr. High Flow	1560	1330	14.7
May High Flow	1870	1320	29.4
Jun. High Flow	1580	1630	-3.16
Jul. High Flow	928	848	8.62
Aug. High Flow	1210	633	47.7
Sep. High Flow	410	435	-6.1
Oct. High Flow	274	197	28.1
Nov. High Flow	226	211	6.64
Dec. High Flow	129	155	-20.2

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	17	5.07	70.2
Med. 1 Day Min	26	16.3	37.3
Min. 3 Day Min	18	5.41	69.9
Med. 3 Day Min	27	18	33.3
Min. 7 Day Min	21	6.17	70.6
Med. 7 Day Min	27.7	20.4	26.4
Min. 30 Day Min	25.1	14.2	43.4
Med. 30 Day Min	35.3	36.6	-3.68
Min. 90 Day Min	31.5	31.7	-0.64
Med. 90 Day Min	62.8	76.2	-21.3
7Q10	22.5	8.61	61.7
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	135	290	-115
Mean Baseflow	134	160	-19.4

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	12700	5950	53.1
Med. 1 Day Max	4370	3130	28.4
Max. 3 Day Max	5840	4550	22.1
Med. 3 Day Max	2760	2160	21.7
Max. 7 Day Max	3040	2470	18.8
Med. 7 Day Max	1830	1370	25.1
Max. 30 Day Max	1330	1590	-19.5
Med. 30 Day Max	880	729	17.2
Max. 90 Day Max	951	1030	-8.31
Med. 90 Day Max	572	574	-0.35

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	26	13.2	49.2
5% Non-Exceedance	32	27.2	15
50% Non-Exceedance	156	181	-16
95% Non-Exceedance	945	850	10.1
99% Non-Exceedance	2240	1970	12.1
Sept. 10% Non-Exceedance	21.2	21.2	0

**Fig. 1: Hydrograph**

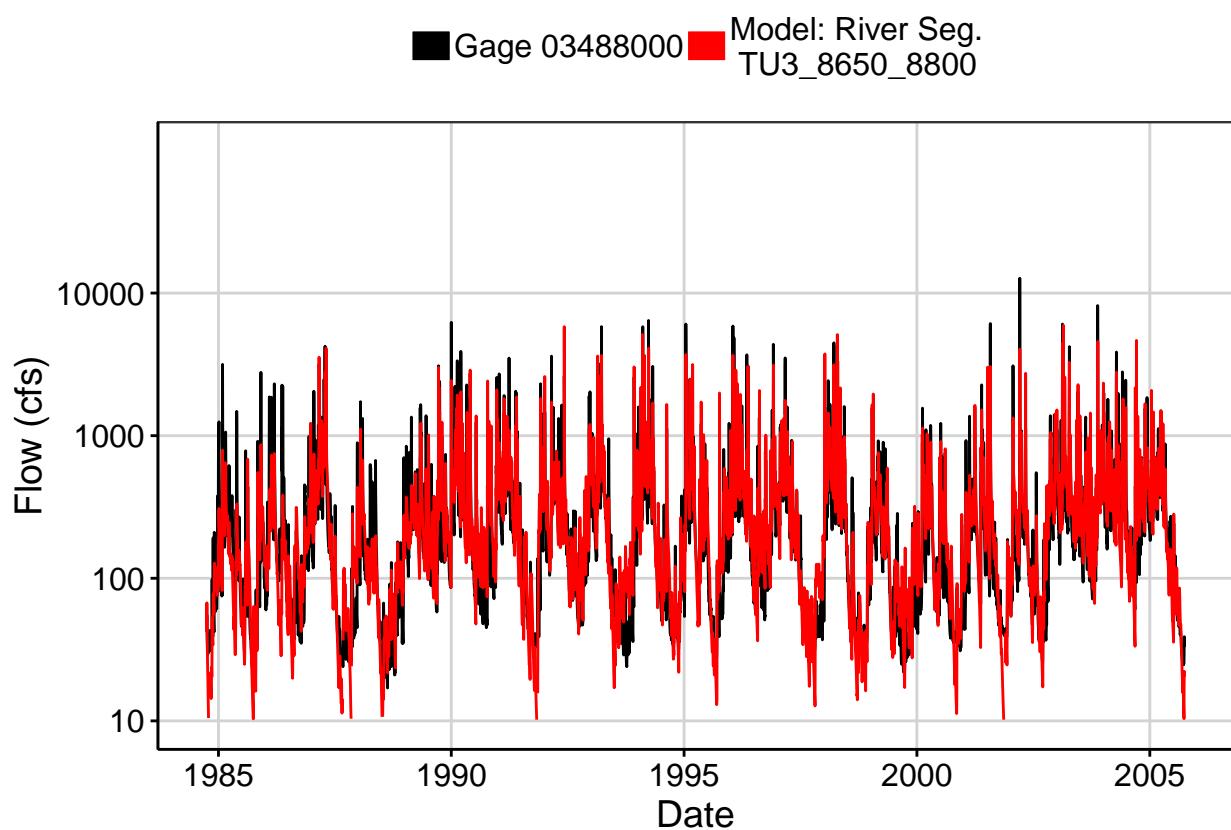


Fig. 2: Zoomed Hydrograph

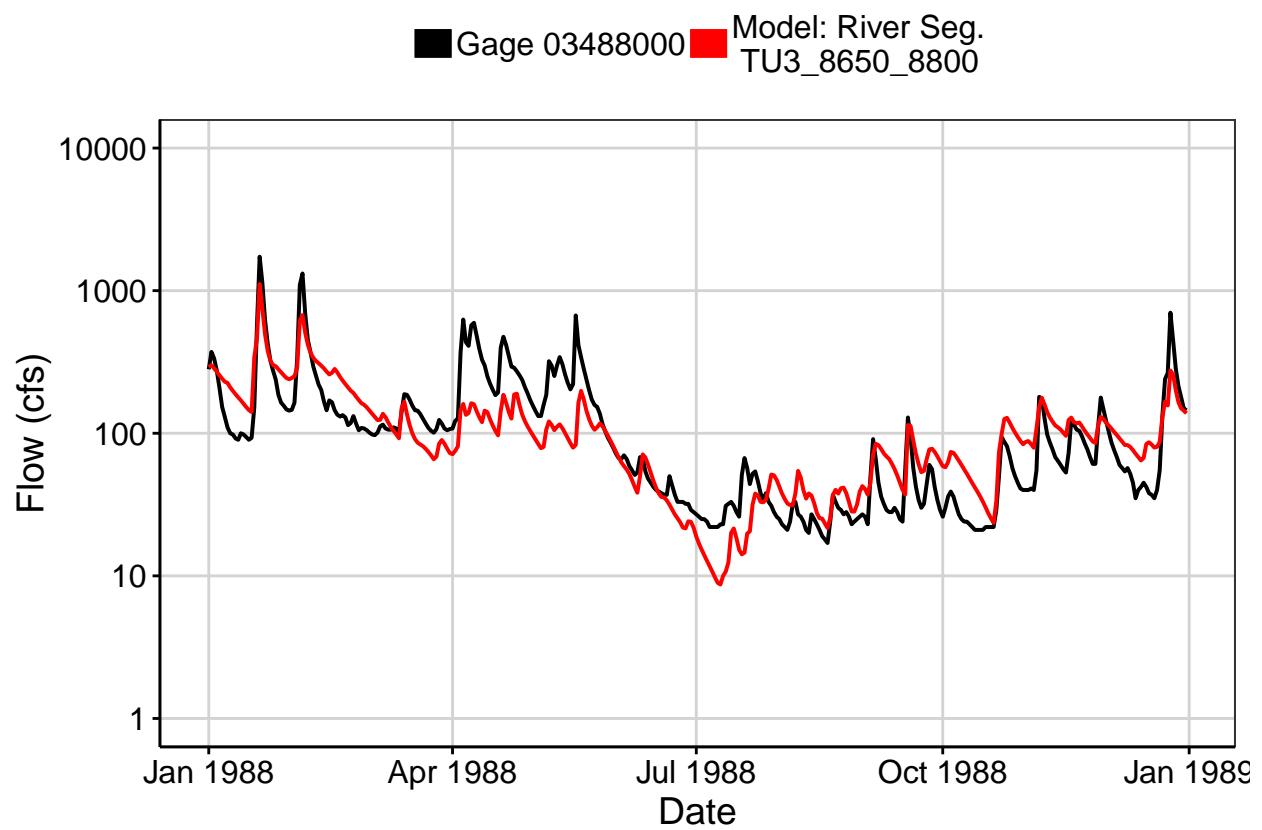


Fig. 3: Flow Exceedance

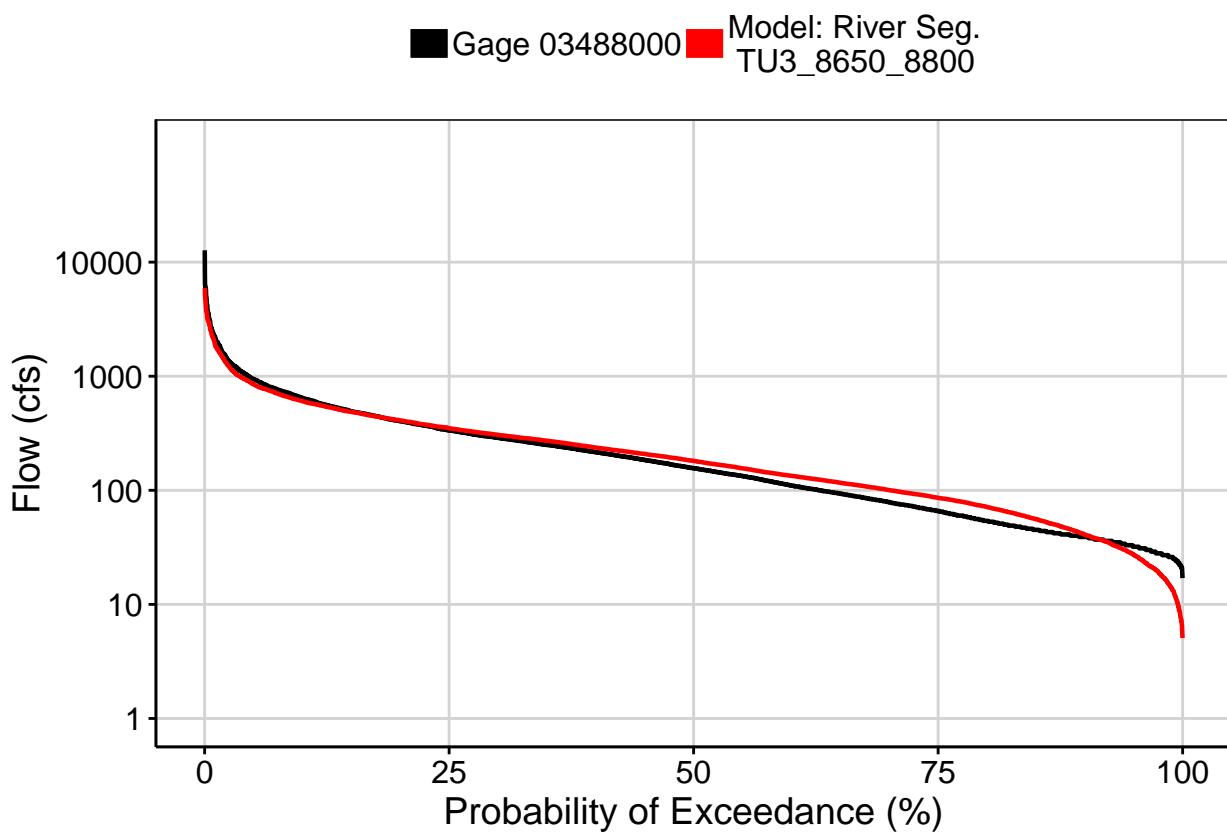


Fig. 4: Baseflow

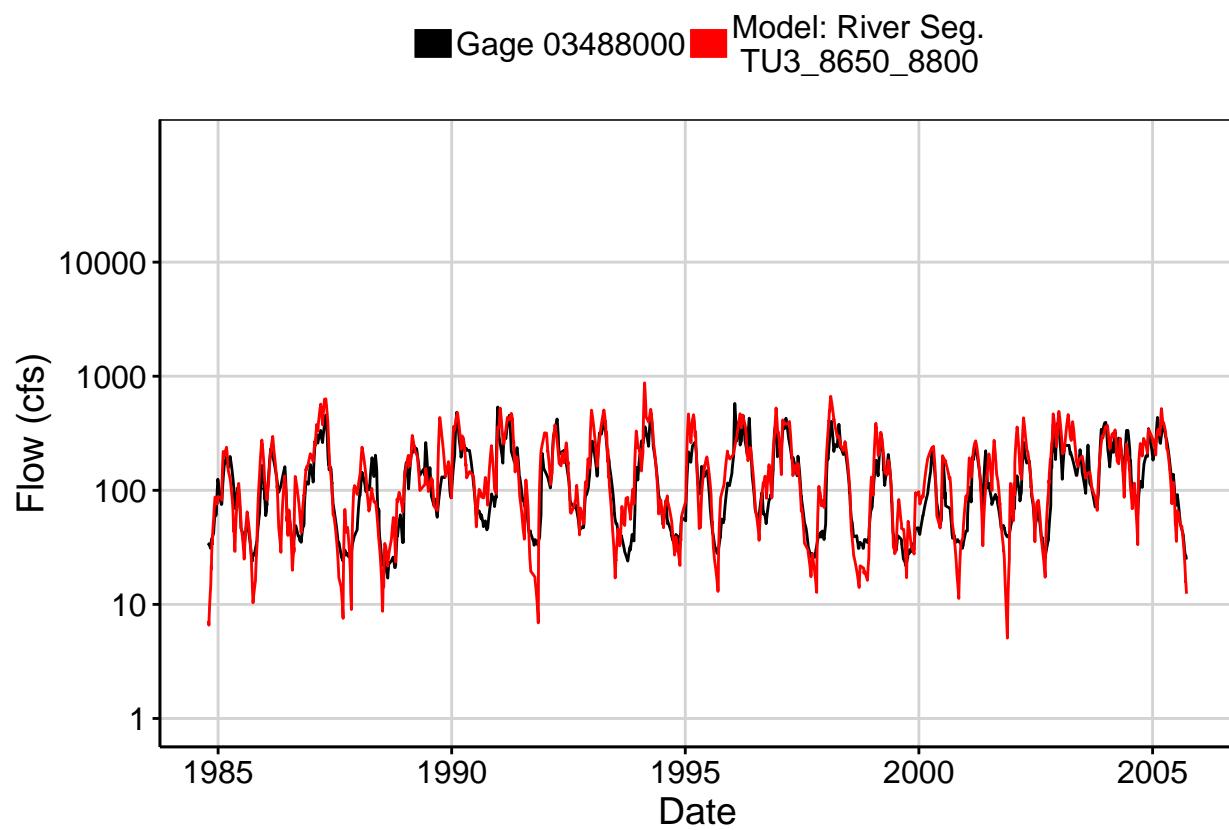


Fig. 5: Combined Baseflow

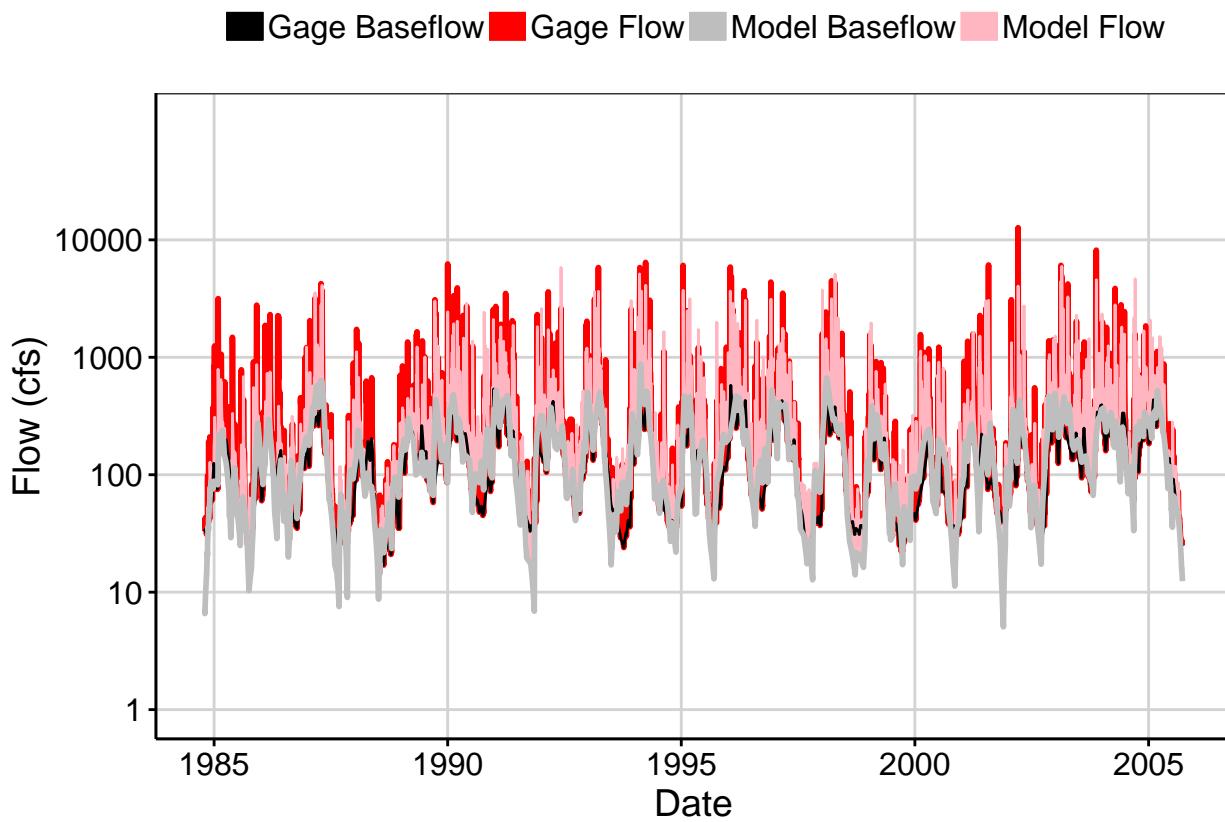


Fig. 6: Largest Error Segment

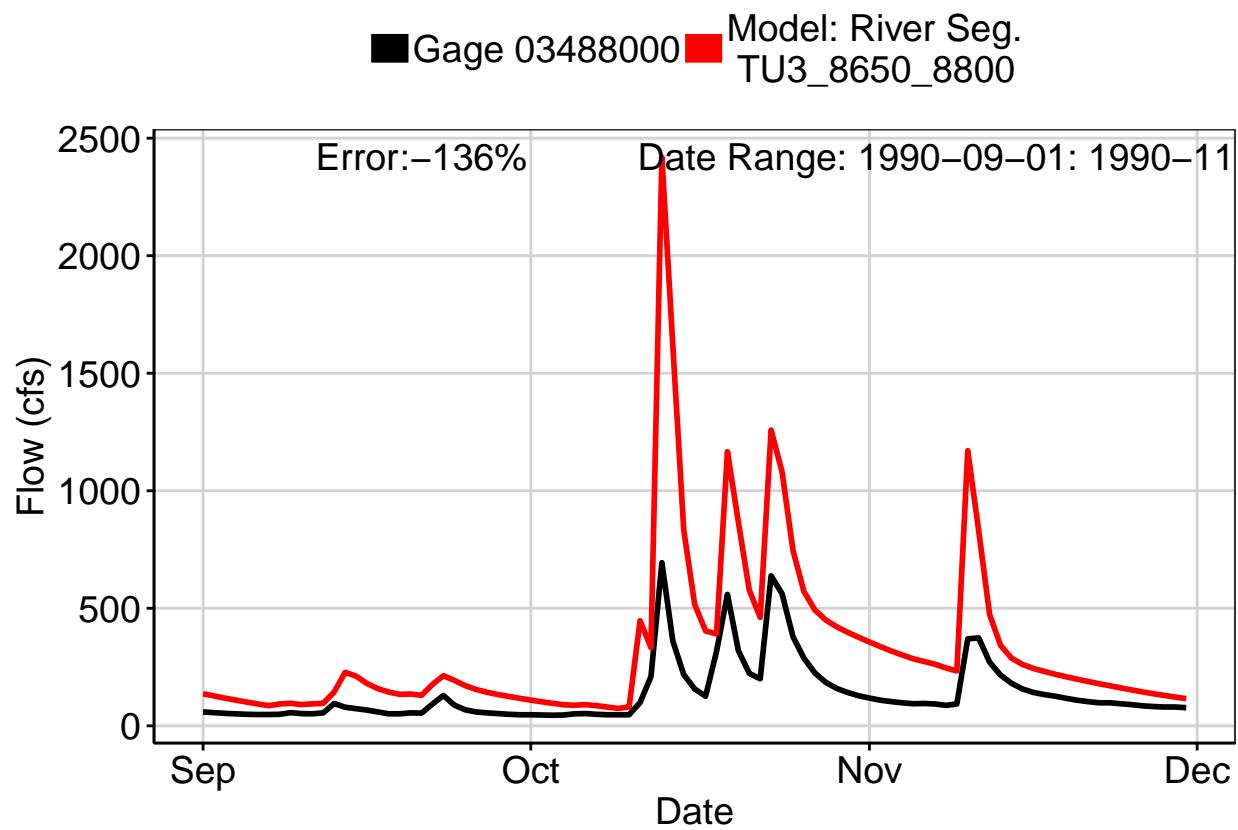


Fig. 7: Second Largest Error Segment

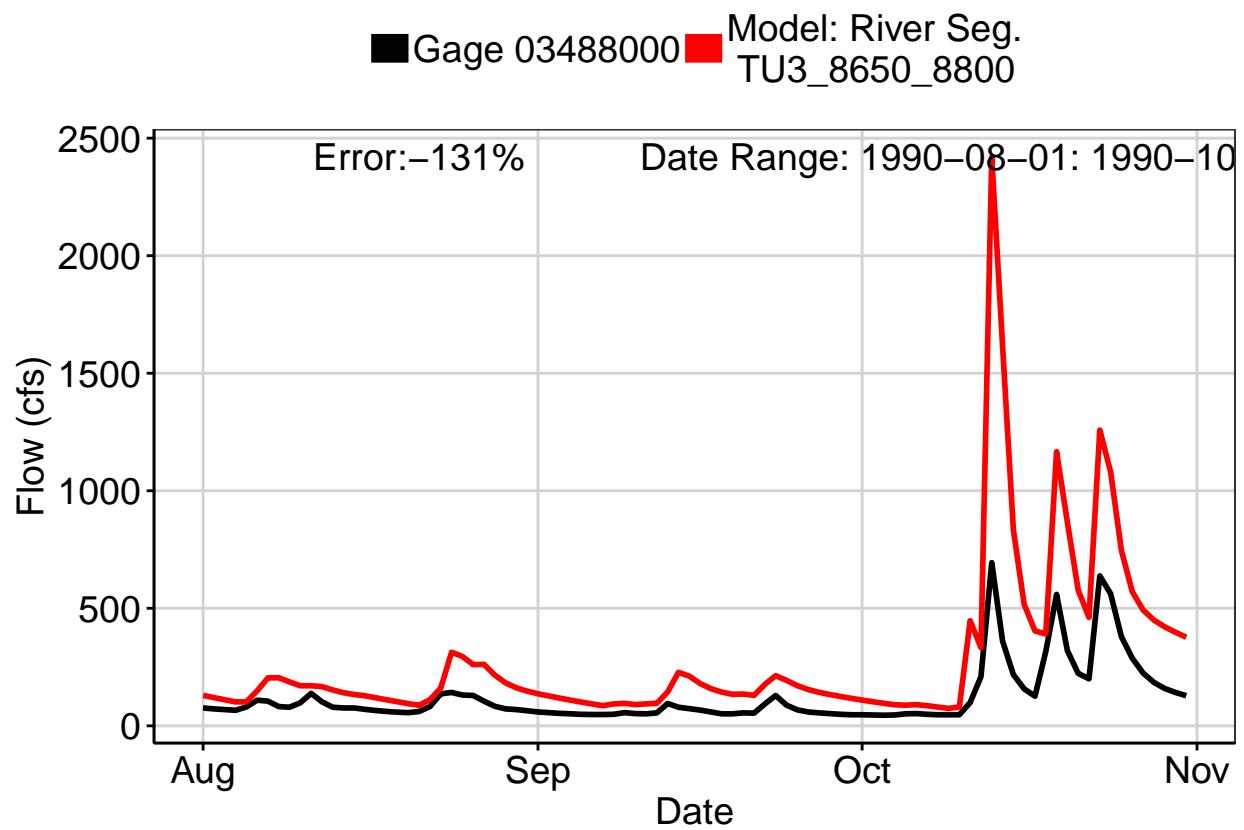


Fig. 8: Third Largest Error Segment

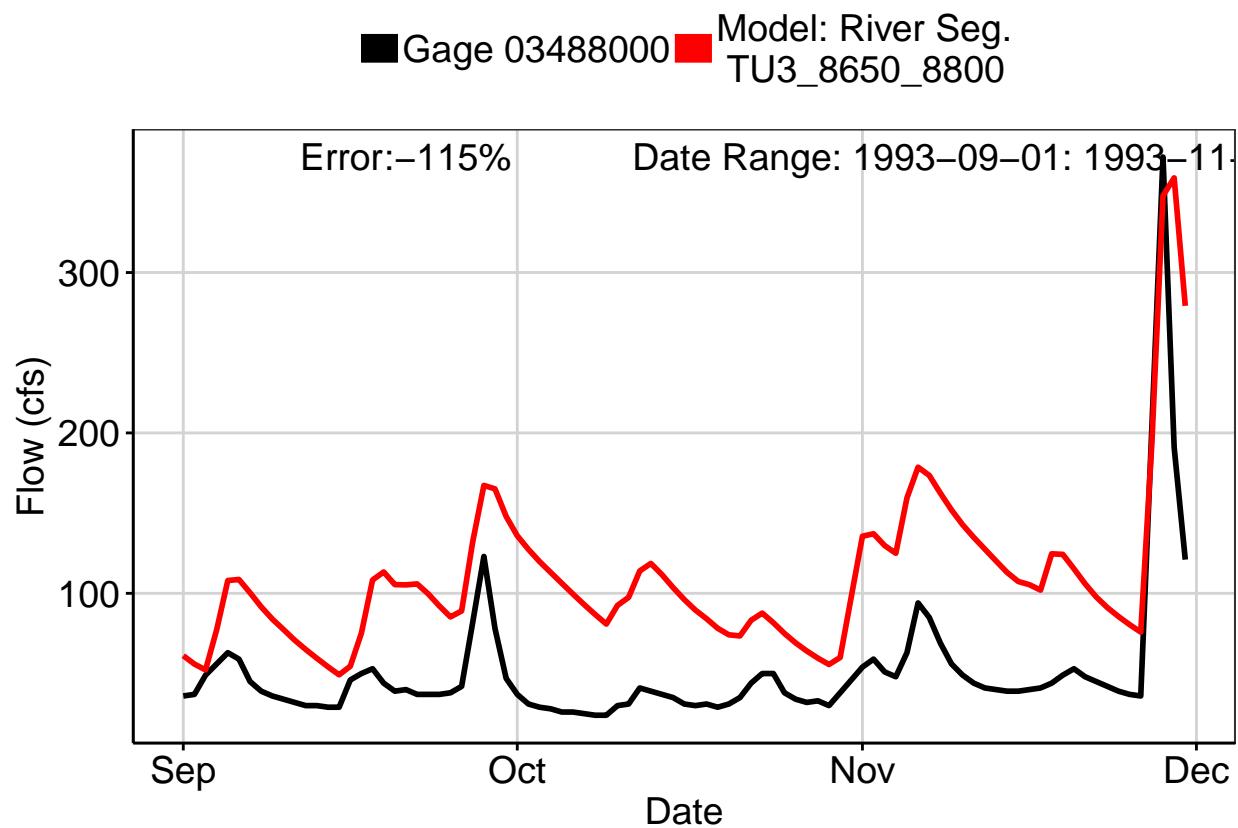
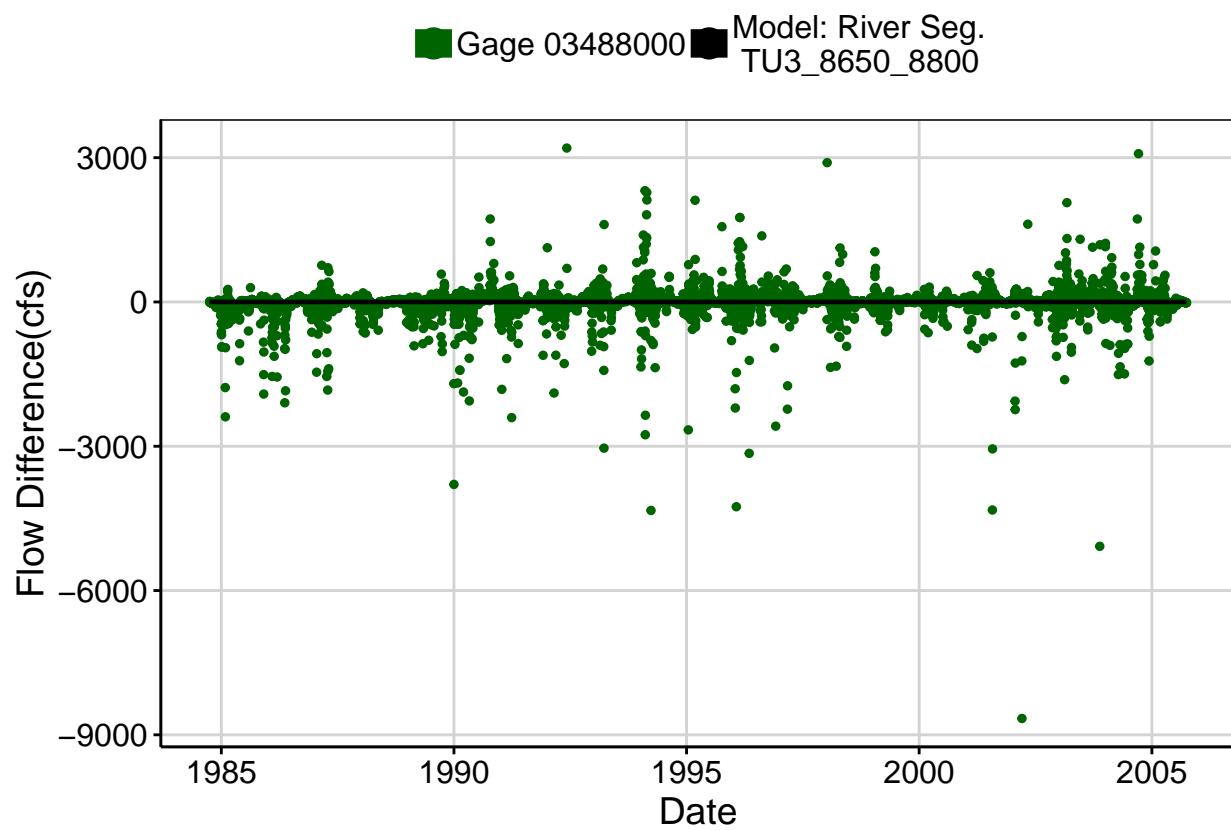
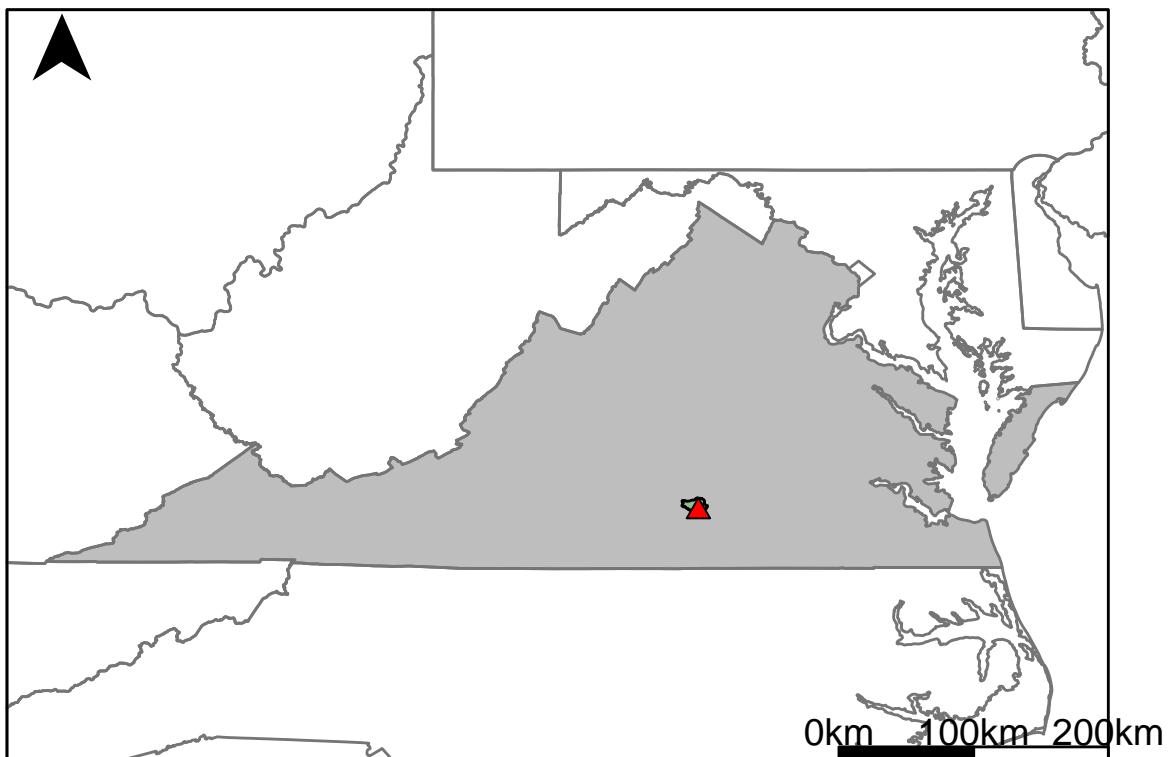


Fig. 9: Residuals Plot



## Appendix E: Meherrin River Gages

### Appendix E.1: USGS Gage 02051000 vs. MN1\_7990\_8100



This river segment follows part of the flow of the North Meherrin River. The gage is located in Lunenburg County, VA (Lat 36°59'50", Long 78°21'00") approximately 62 miles southwest of Richmond, VA. Drainage area is 56 sq. miles. This gage started taking data in 1910 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was -4.02%, with 66.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	3.9	2.86	26.7
Feb. Low Flow	10	8.29	17.1
Mar. Low Flow	14	12.1	13.6
Apr. Low Flow	17	18.7	-10
May Low Flow	29	31.7	-9.31
Jun. Low Flow	27.8	29.5	-6.12
Jul. Low Flow	24.7	19.5	21.1
Aug. Low Flow	12.2	11.6	4.92
Sep. Low Flow	6.93	6.41	7.5
Oct. Low Flow	3.2	3.1	3.13
Nov. Low Flow	2.1	2.4	-14.3
Dec. Low Flow	1.52	2.54	-67.1

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	44.8	46.6	-4.02
Jan. Mean Flow	60.9	62.7	-2.96
Feb. Mean Flow	72.3	82	-13.4
Mar. Mean Flow	85.4	103	-20.6
Apr. Mean Flow	67	71.4	-6.57
May Mean Flow	45	41.7	7.33
Jun. Mean Flow	27.5	26.7	2.91
Jul. Mean Flow	18.5	13.6	26.5
Aug. Mean Flow	22.3	19.2	13.9
Sep. Mean Flow	33.6	40.2	-19.6
Oct. Mean Flow	16.1	22.6	-40.4
Nov. Mean Flow	47.3	36.6	22.6
Dec. Mean Flow	44.6	42.4	4.93

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	49.9	29.3	41.3
Feb. High Flow	178	98.5	44.7
Mar. High Flow	242	94.7	60.9
Apr. High Flow	299	184	38.5
May High Flow	243	191	21.4
Jun. High Flow	350	441	-26
Jul. High Flow	241	192	20.3
Aug. High Flow	224	82.3	63.3
Sep. High Flow	86	24.3	71.7
Oct. High Flow	40	31.5	21.2
Nov. High Flow	75	27.1	63.9
Dec. High Flow	22	23.4	-6.36

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	0.00	8.00e-02	-Inf
Med. 1 Day Min	1.00	1.72	-7.20e+01
Min. 3 Day Min	0.00	8.00e-02	3.88e+14
Med. 3 Day Min	1.10	1.77	-6.09e+01
Min. 7 Day Min	1.00e-02	1.00e-01	-8.79e+02
Med. 7 Day Min	1.24	2.05	-6.53e+01
Min. 30 Day Min	6.00e-02	3.20e-01	-4.37e+02
Med. 30 Day Min	2.76	3.71	-3.44e+01
Min. 90 Day Min	1.52	2.08	-3.68e+01
Med. 90 Day Min	9.90	6.93	3.00e+01
7Q10	1.50e-01	2.80e-01	-8.09e+01
Year of 90-Day Min. Flow	2.00e+03	2.00e+03	0.00
Drought Year Mean	1.00e+01	4.66e+01	-3.66e+02
Mean Baseflow	1.55e+01	2.01e+01	-2.97e+01

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	3010	3290	-9.3
Med. 1 Day Max	840	1240	-47.6
Max. 3 Day Max	1390	1580	-13.7
Med. 3 Day Max	503	671	-33.4
Max. 7 Day Max	842	952	-13.1
Med. 7 Day Max	258	357	-38.4
Max. 30 Day Max	299	328	-9.7
Med. 30 Day Max	125	145	-16
Max. 90 Day Max	187	220	-17.6
Med. 90 Day Max	84.8	88.5	-4.36

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	0.36	0.56	-54.2
5% Non-Exceedance	1.6	2.08	-30
50% Non-Exceedance	19	20.9	-10
95% Non-Exceedance	153	143	6.54
99% Non-Exceedance	446	473	-6.05
Sept. 10% Non-Exceedance	1.66	1.62	2.41

**Fig. 1: Hydrograph**

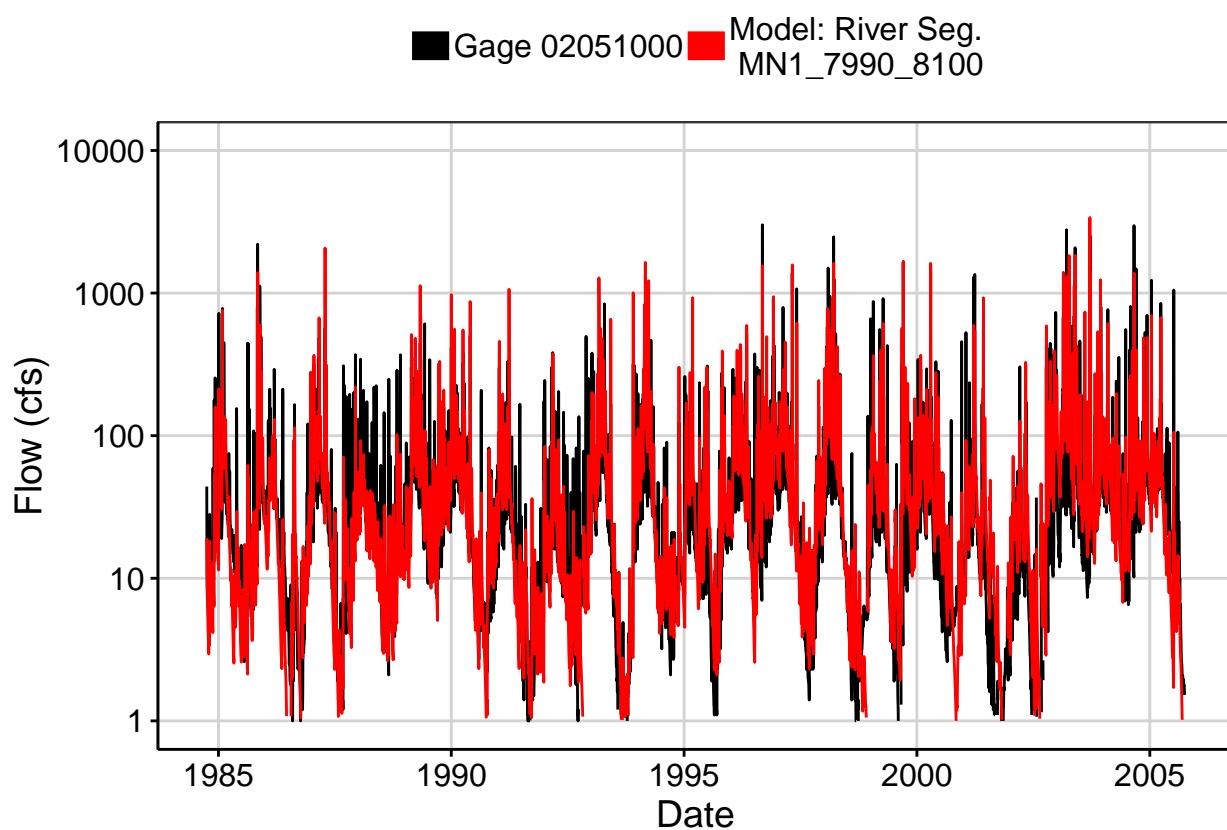


Fig. 2: Zoomed Hydrograph

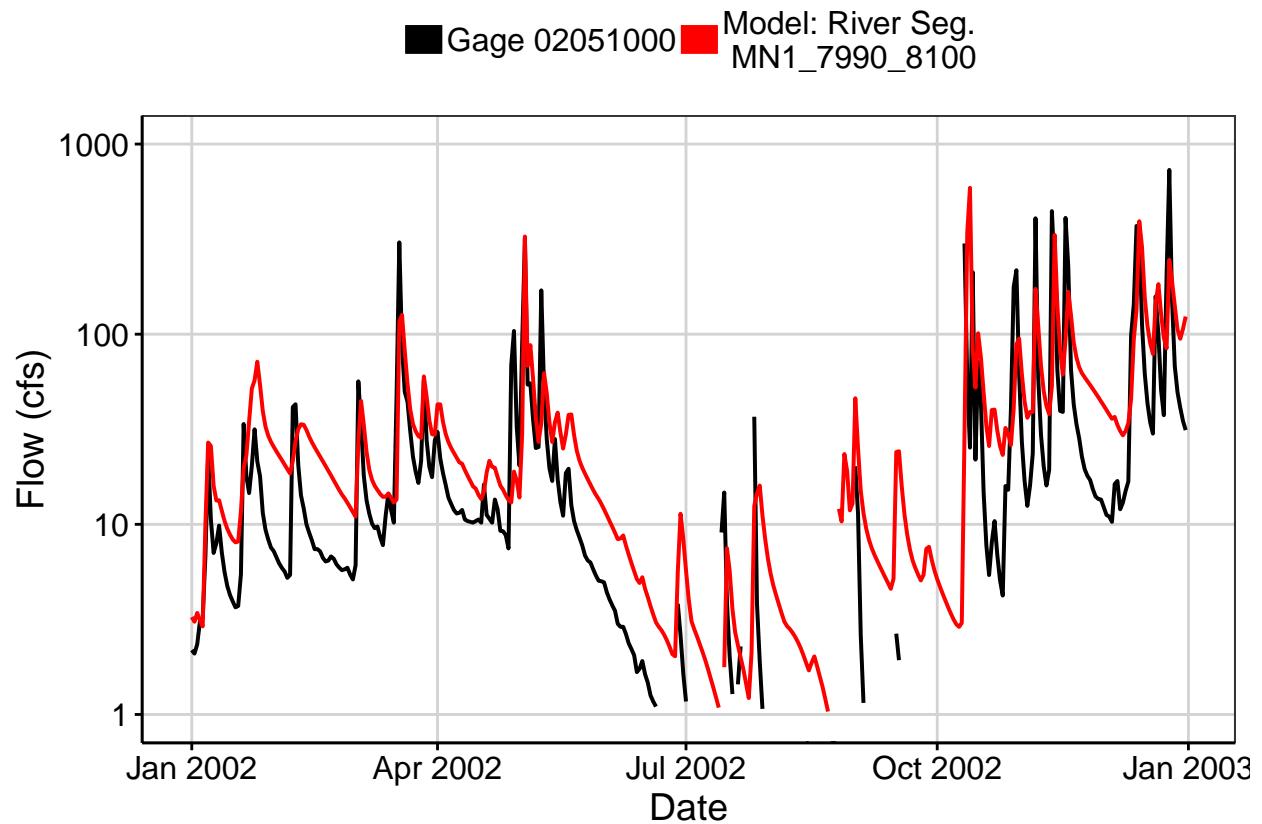


Fig. 3: Flow Exceedance

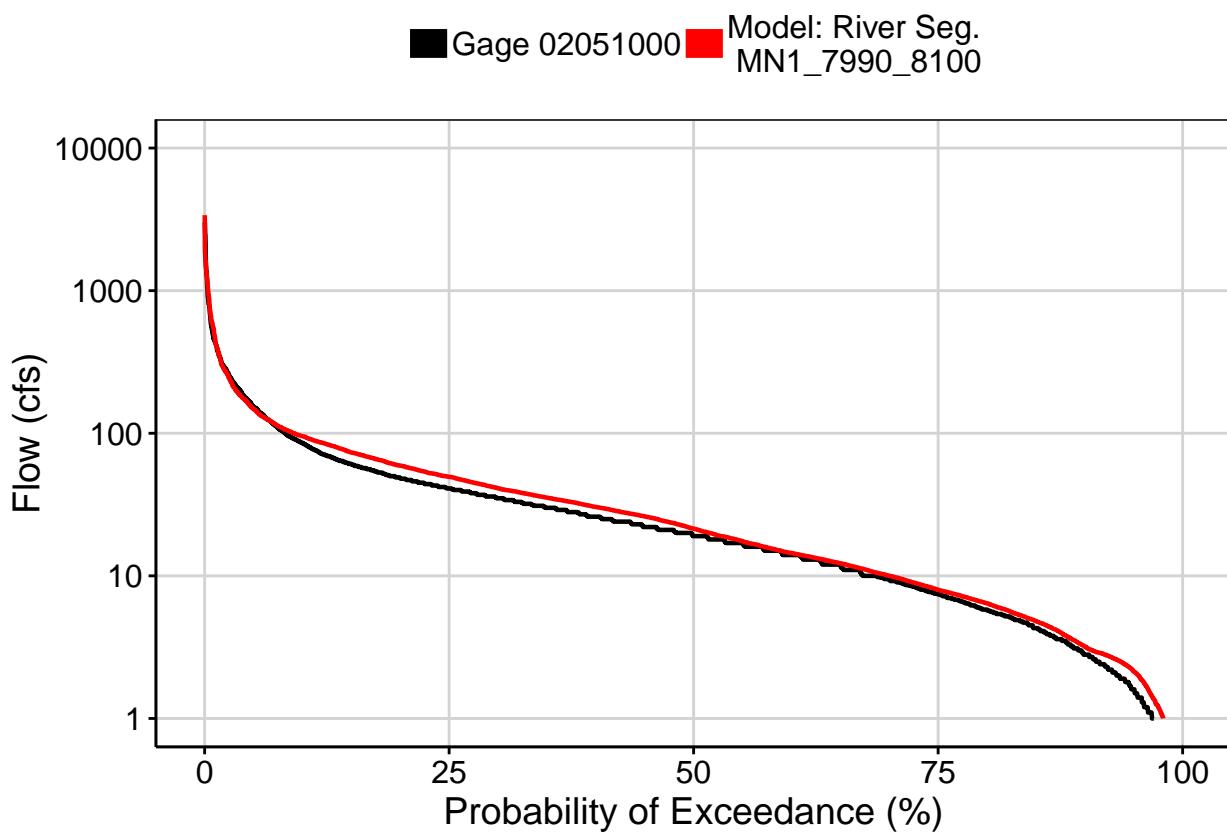


Fig. 4: Baseflow

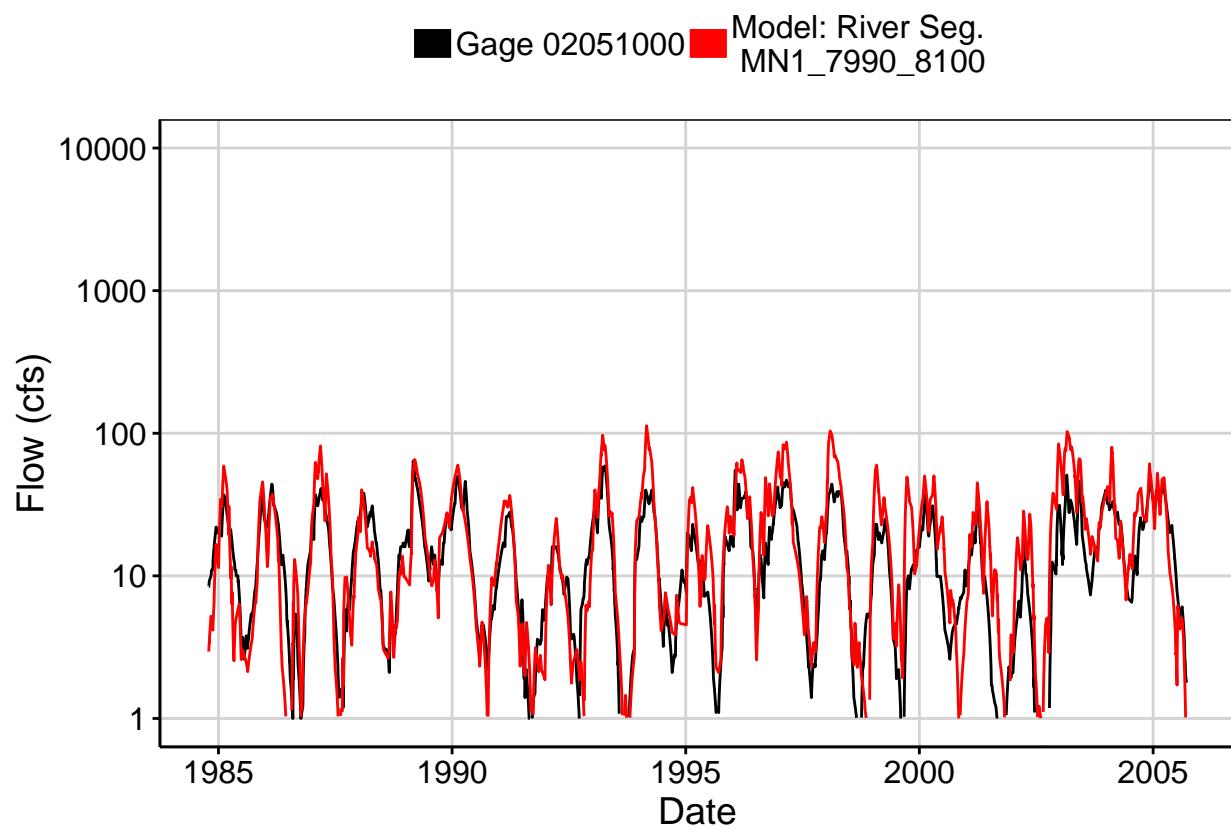


Fig. 5: Combined Baseflow

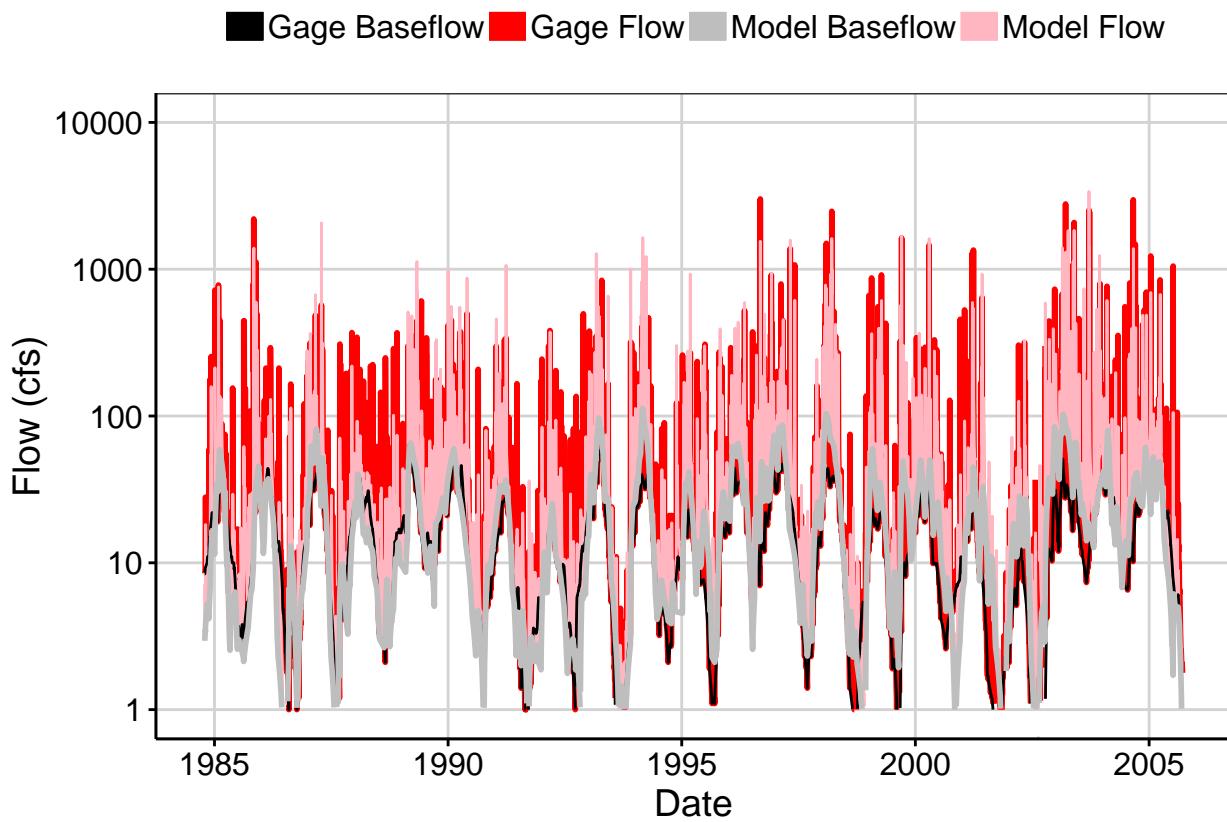


Fig. 6: Largest Error Segment

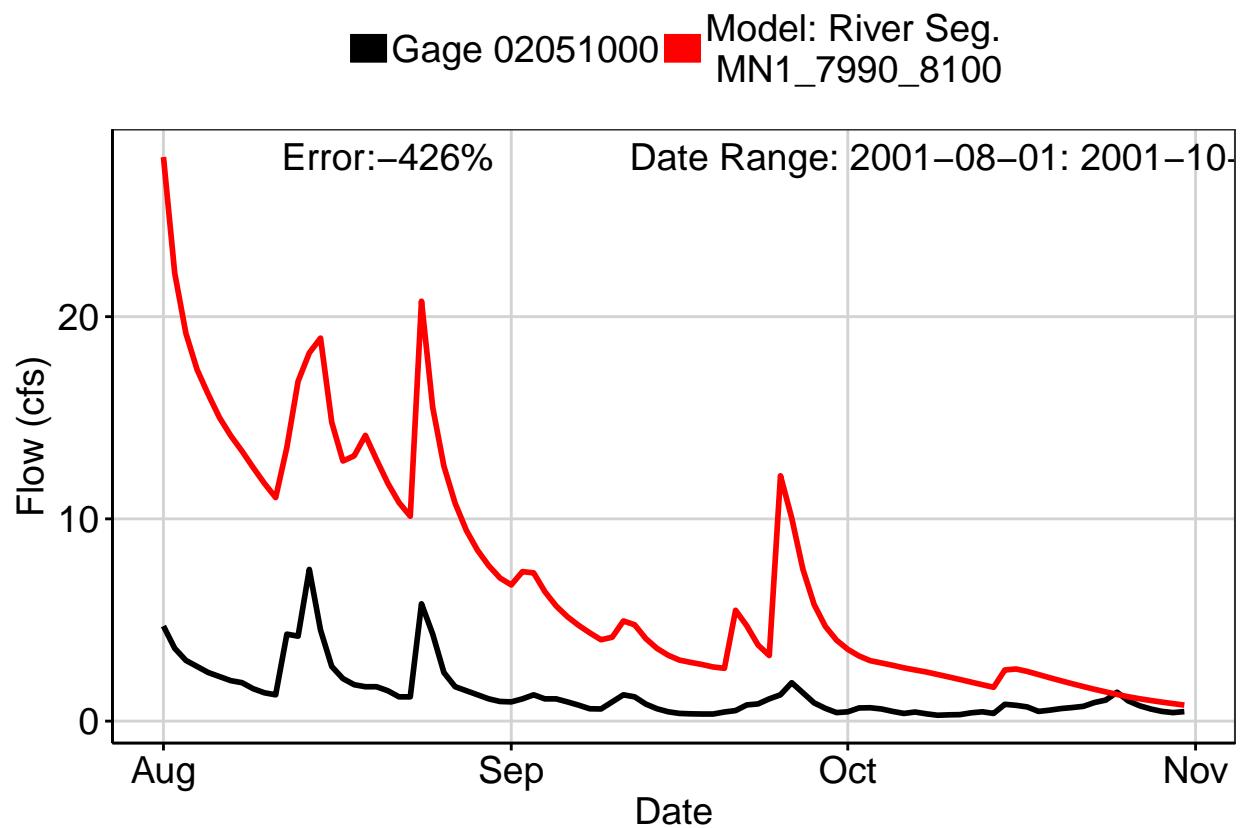


Fig. 7: Second Largest Error Segment

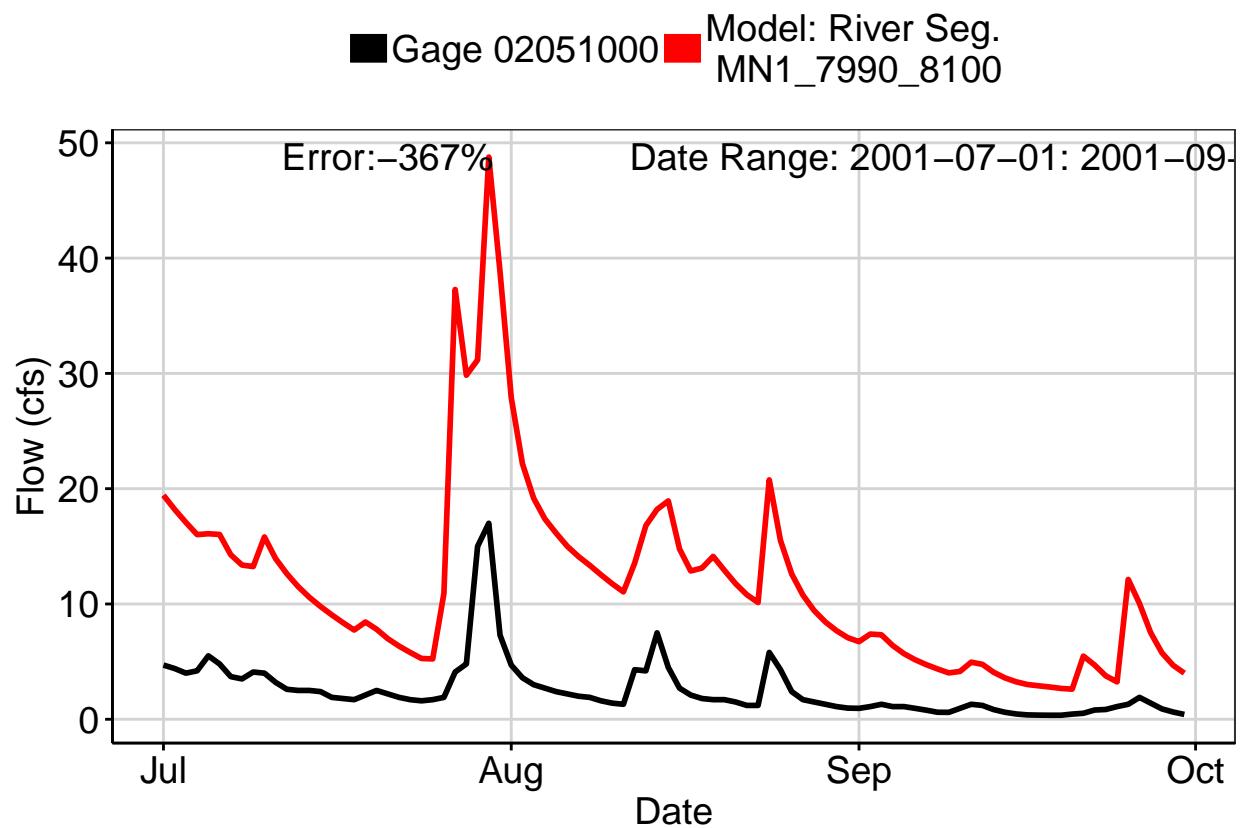


Fig. 8: Third Largest Error Segment

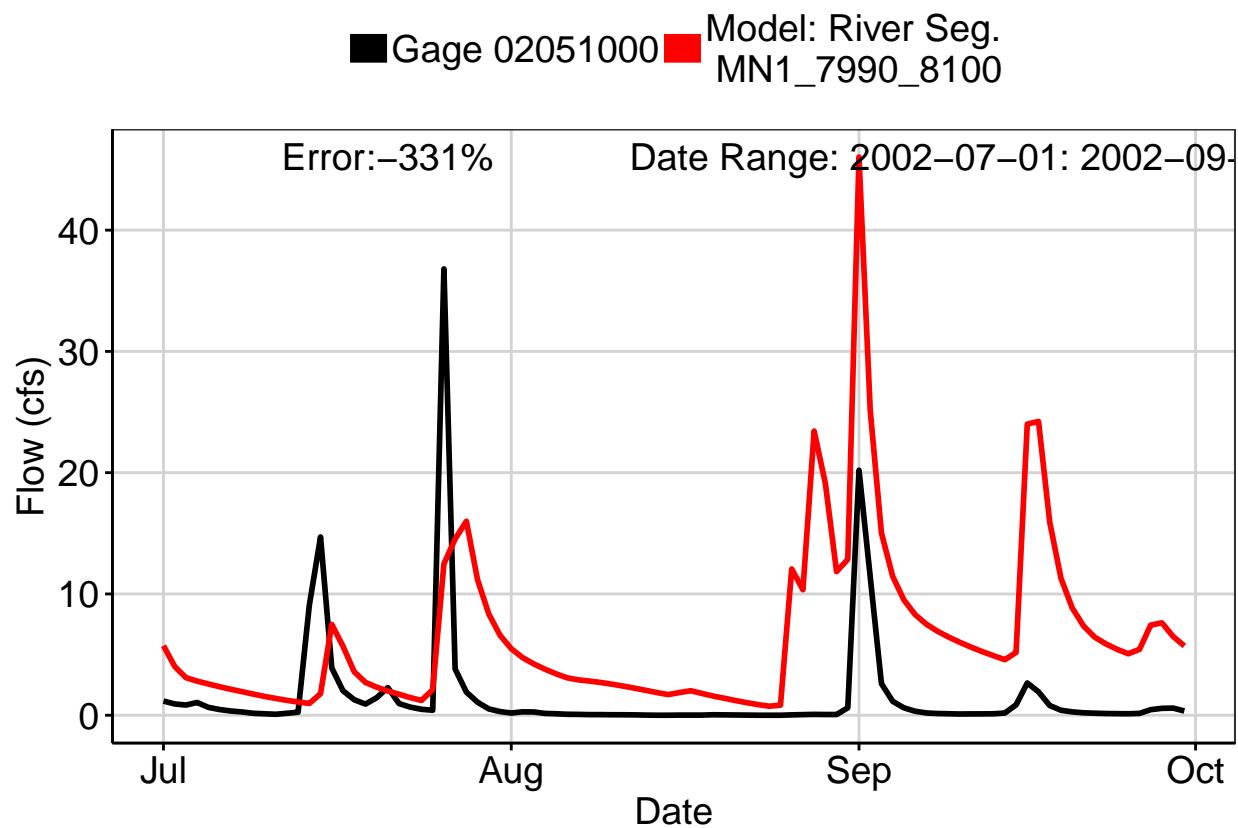
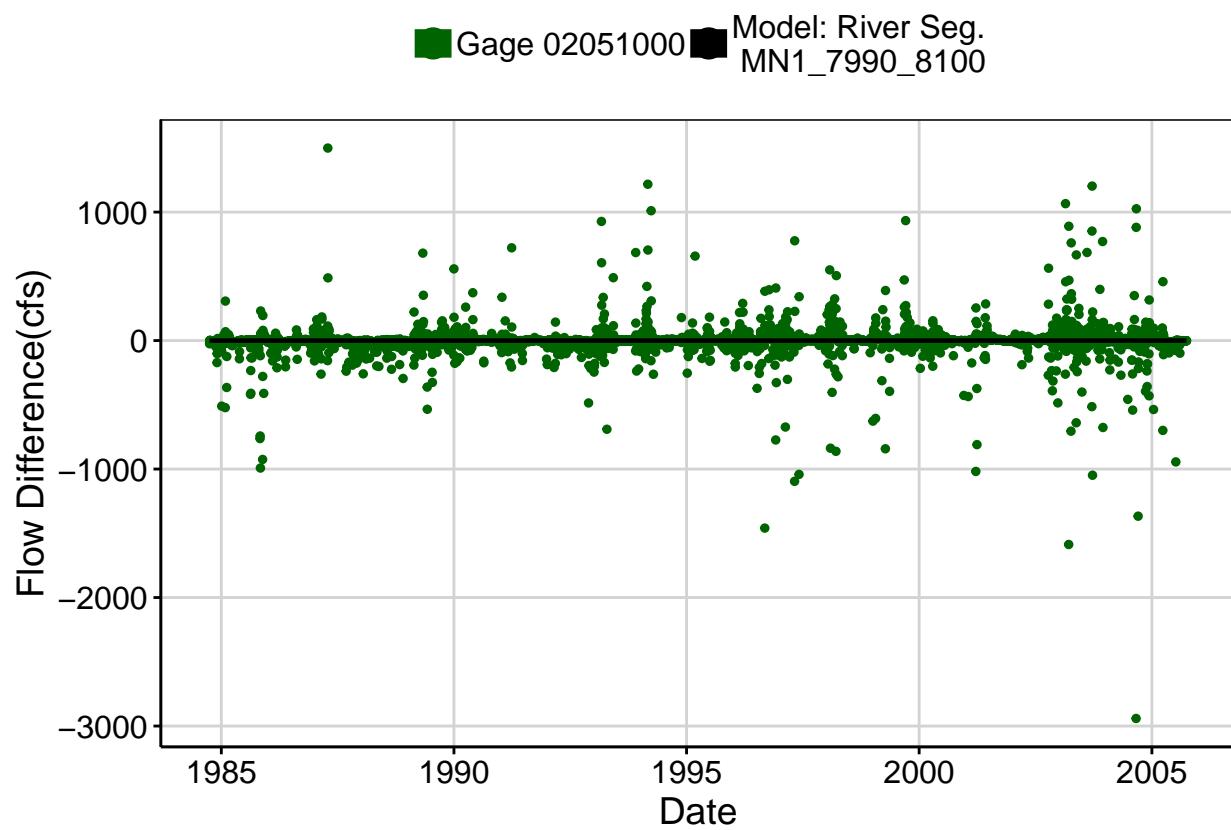
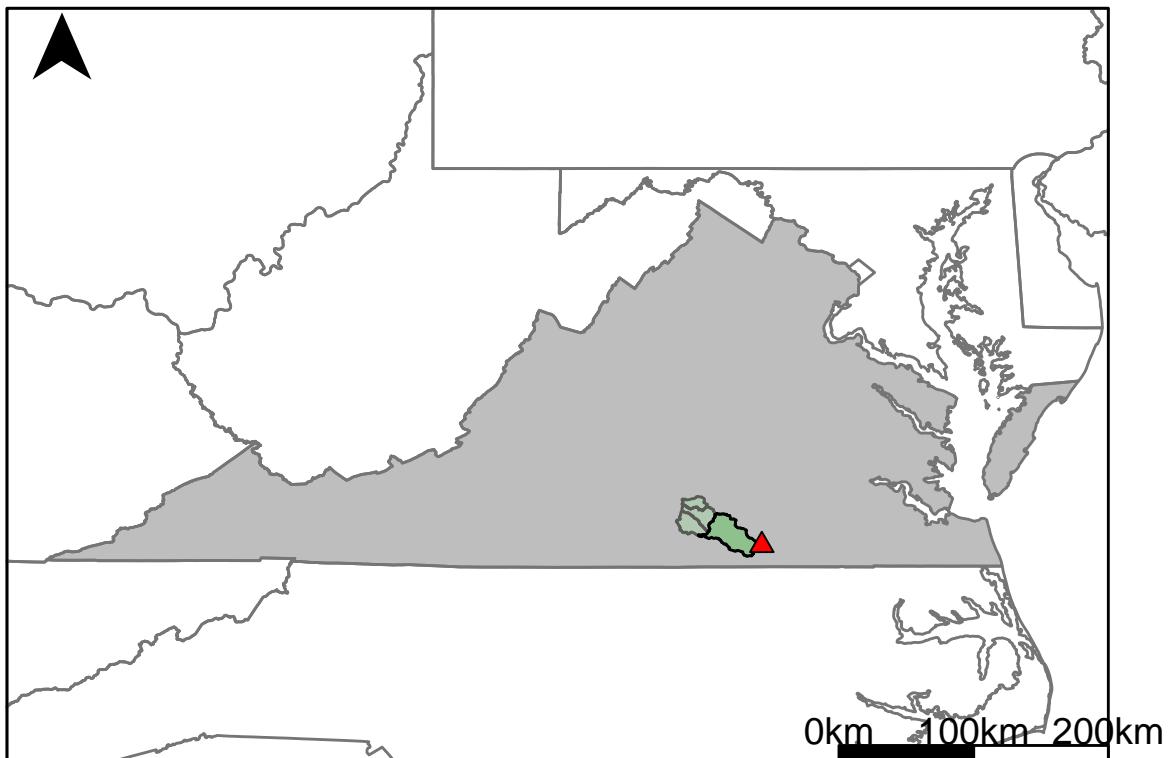


Fig. 9: Residuals Plot



## Appendix E.2: USGS Gage 02051500 vs. MN3\_8190\_8260



This river segment follows part of the flow of the Meherrin River. The gage is located in Brunswick County, VA (Lat 3643'0", Long 7749'55") approximately 16 miles west of Emporia, VA. Drainage area is 552 sq. miles. This gage started taking data in 1929 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 1.57%, with 45.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	56	51.7	7.68
Feb. Low Flow	124	95.4	23.1
Mar. Low Flow	153	136	11.1
Apr. Low Flow	212	226	-6.6
May Low Flow	349	334	4.3
Jun. Low Flow	336	304	9.52
Jul. Low Flow	283	219	22.6
Aug. Low Flow	152	134	11.8
Sep. Low Flow	99	89	10.1
Oct. Low Flow	56	61.4	-9.64
Nov. Low Flow	52	47.8	8.08
Dec. Low Flow	48	51.6	-7.5

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	511	503	1.57
Jan. Mean Flow	708	663	6.36
Feb. Mean Flow	786	839	-6.74
Mar. Mean Flow	1030	1050	-1.94
Apr. Mean Flow	771	771	0
May Mean Flow	500	450	10
Jun. Mean Flow	335	302	9.85
Jul. Mean Flow	207	175	15.5
Aug. Mean Flow	235	237	-0.85
Sep. Mean Flow	437	464	-6.18
Oct. Mean Flow	216	264	-22.2
Nov. Mean Flow	450	385	14.4
Dec. Mean Flow	477	458	3.98

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	551	314	43
Feb. High Flow	1220	1100	9.84
Mar. High Flow	1870	1150	38.5
Apr. High Flow	2890	1680	41.9
May High Flow	2980	1530	48.7
Jun. High Flow	3370	2660	21.1
Jul. High Flow	3330	2520	24.3
Aug. High Flow	1260	695	44.8
Sep. High Flow	592	265	55.2
Oct. High Flow	465	314	32.5
Nov. High Flow	609	437	28.2
Dec. High Flow	274	311	-13.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	2.19	8.26	-277
Med. 1 Day Min	30	32.9	-9.67
Min. 3 Day Min	2.22	8.36	-277
Med. 3 Day Min	33	34.7	-5.15
Min. 7 Day Min	2.57	8.83	-244
Med. 7 Day Min	36.5	38.5	-5.48
Min. 30 Day Min	10.2	12	-17.6
Med. 30 Day Min	62.3	57.2	8.19
Min. 90 Day Min	23	28.6	-24.3
Med. 90 Day Min	125	91.9	26.5
7Q10	11.3	13.9	-23
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	111	503	-353
Mean Baseflow	208	233	-12

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	15400	15400	0
Med. 1 Day Max	7580	6320	16.6
Max. 3 Day Max	12300	12700	-3.25
Med. 3 Day Max	6400	5220	18.4
Max. 7 Day Max	7830	8970	-14.6
Med. 7 Day Max	3380	3410	-0.89
Max. 30 Day Max	2990	3210	-7.36
Med. 30 Day Max	1470	1410	4.08
Max. 90 Day Max	2110	2170	-2.84
Med. 90 Day Max	973	953	2.06

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	17.2	17.1	0.58
5% Non-Exceedance	39	37.9	2.82
50% Non-Exceedance	252	249	1.19
95% Non-Exceedance	1690	1700	-0.59
99% Non-Exceedance	5340	4380	18
Sept. 10% Non-Exceedance	33.2	32.6	1.81

**Fig. 1: Hydrograph**

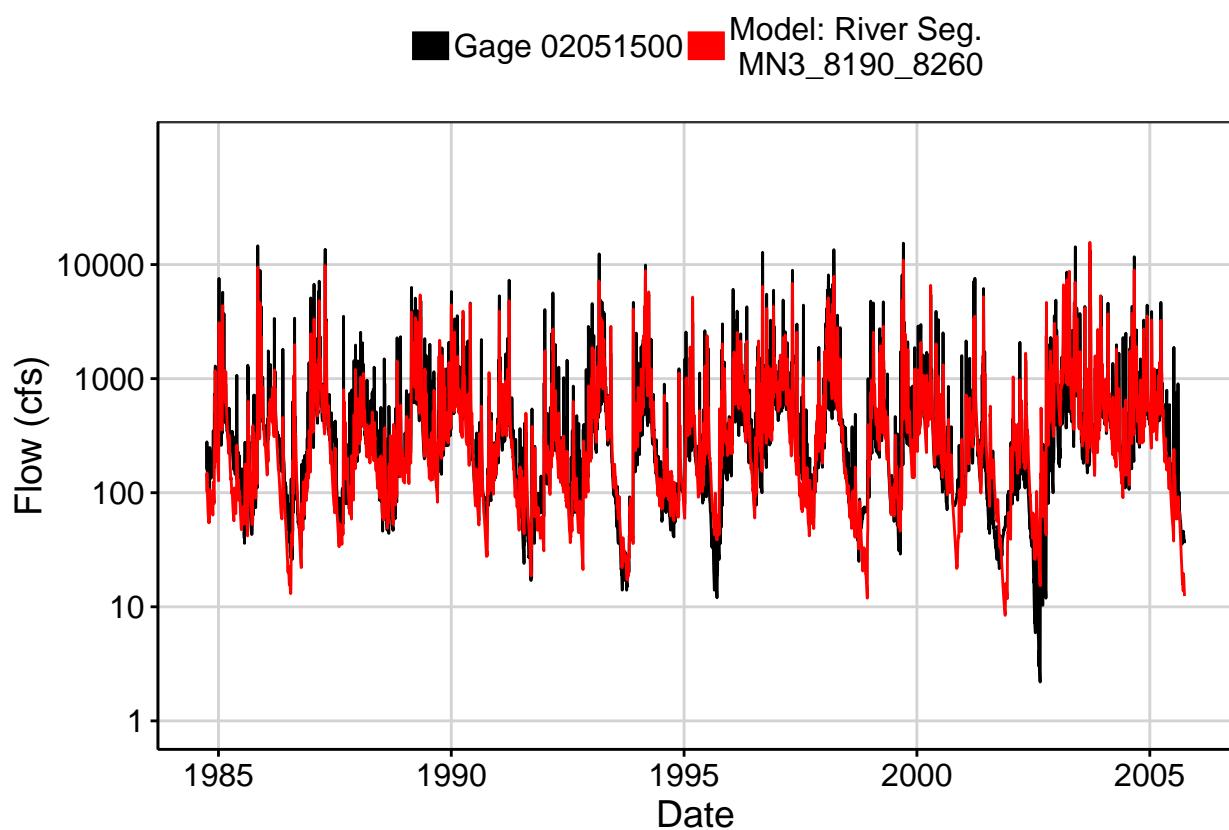


Fig. 2: Zoomed Hydrograph

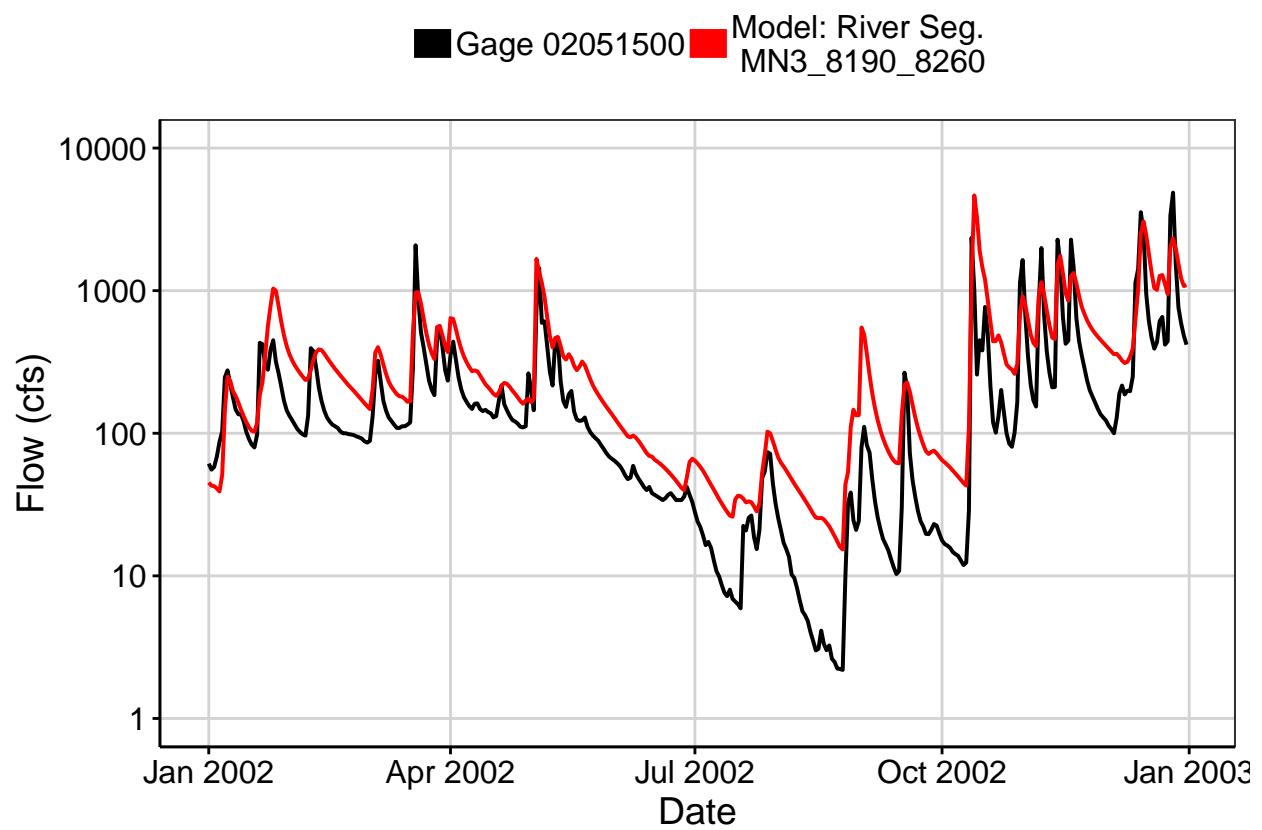


Fig. 3: Flow Exceedance

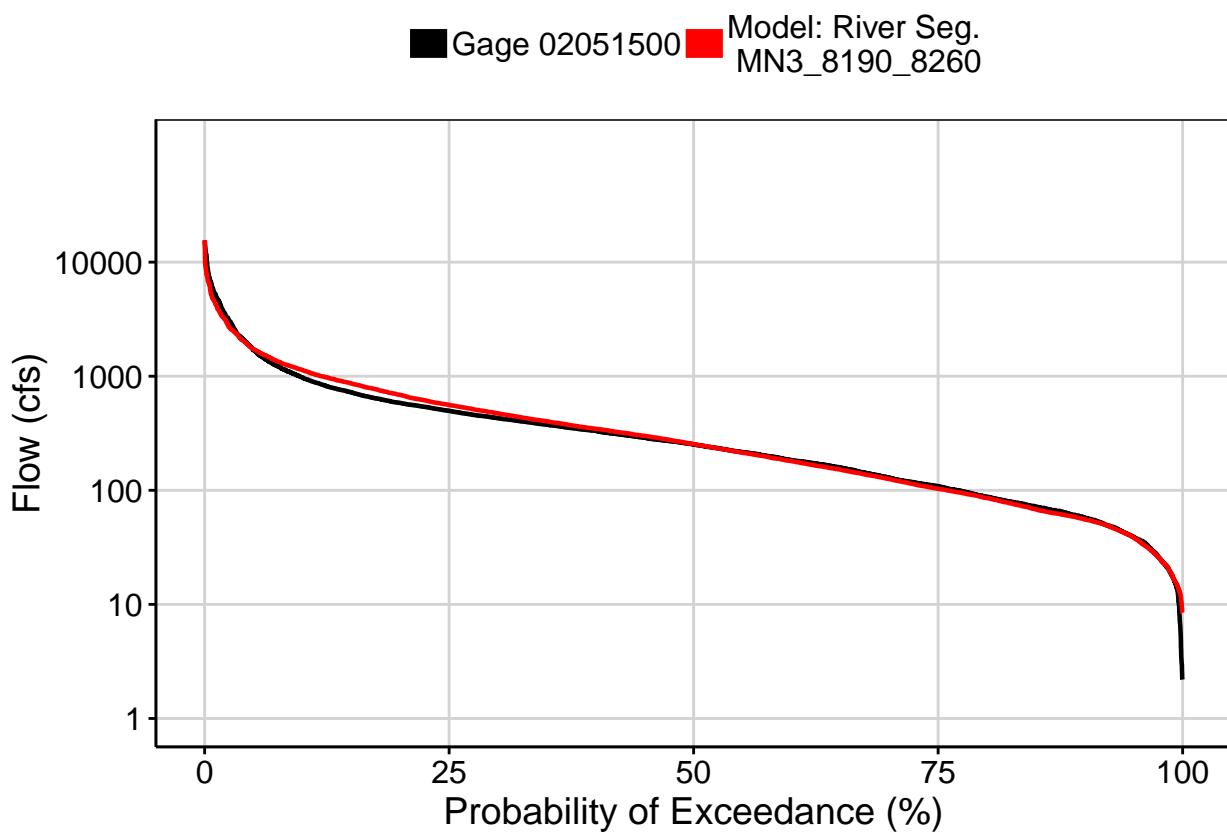
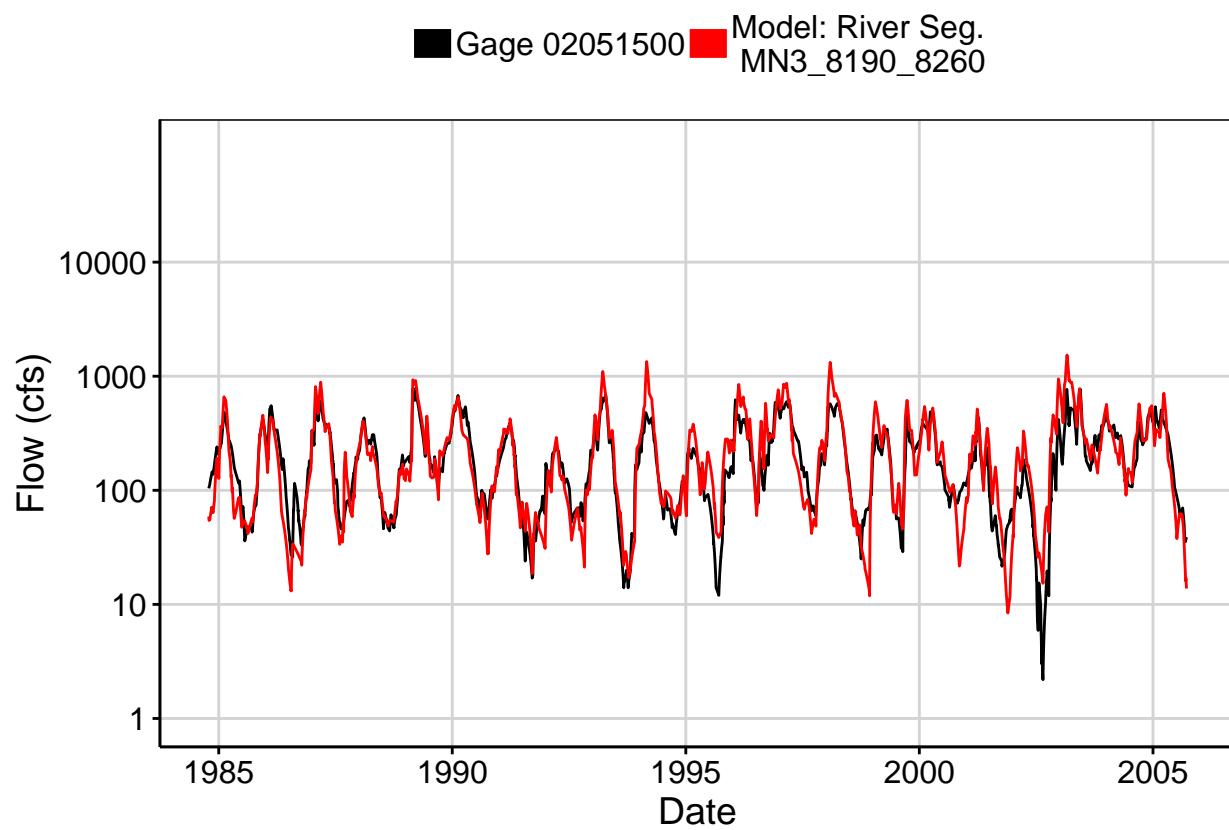


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

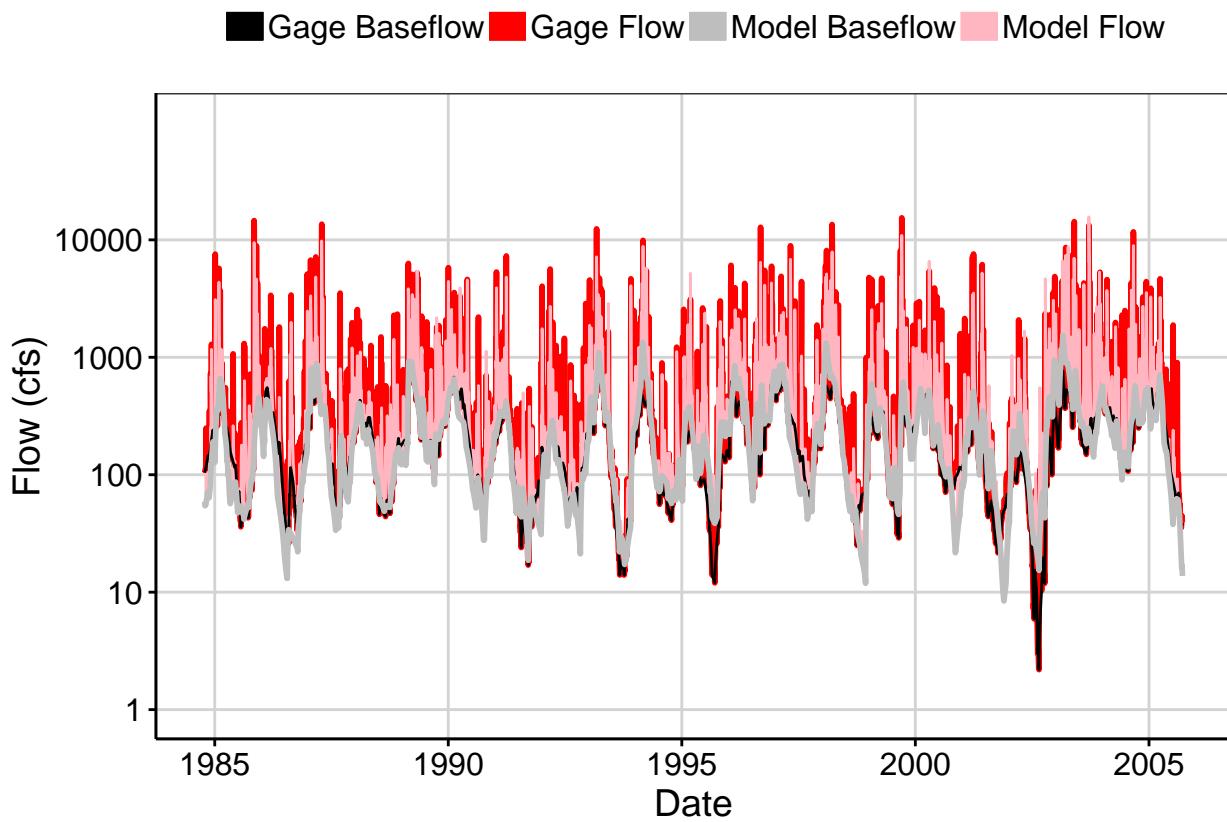


Fig. 6: Largest Error Segment

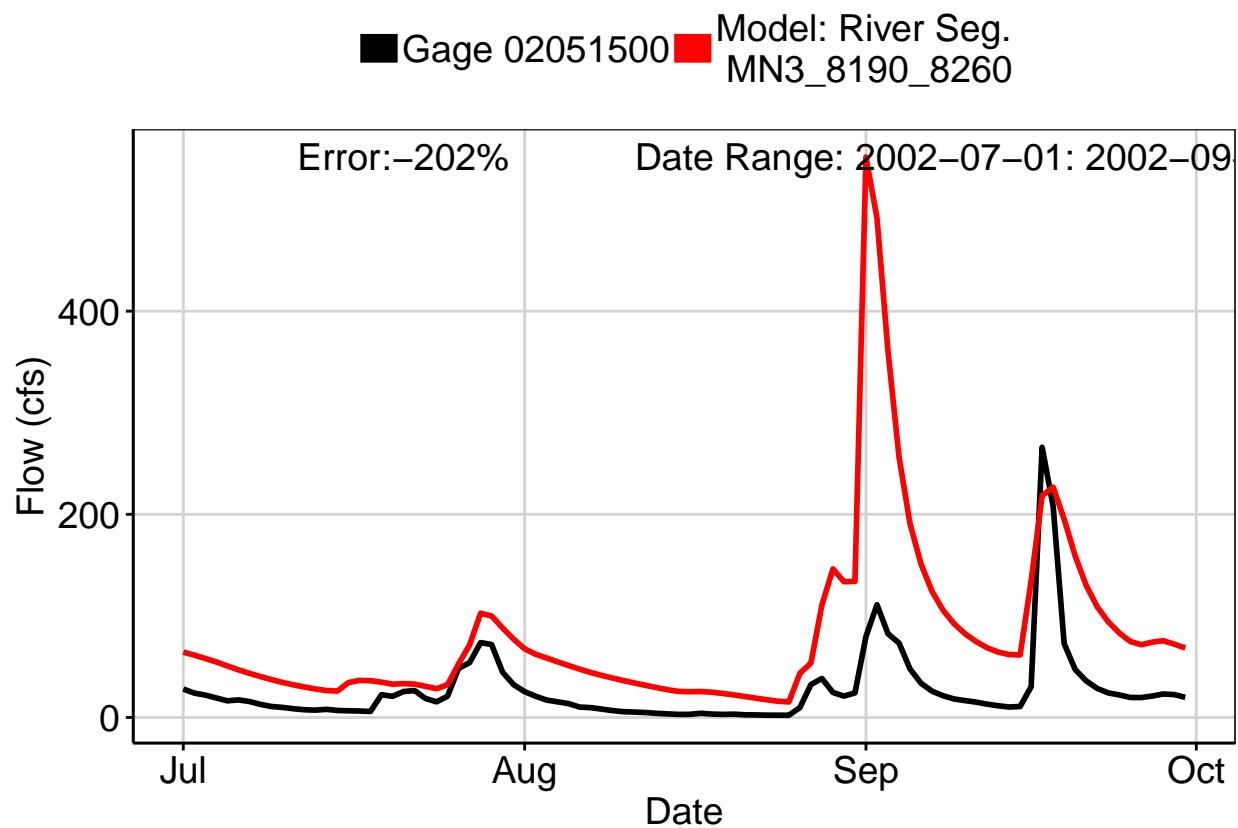


Fig. 7: Second Largest Error Segment

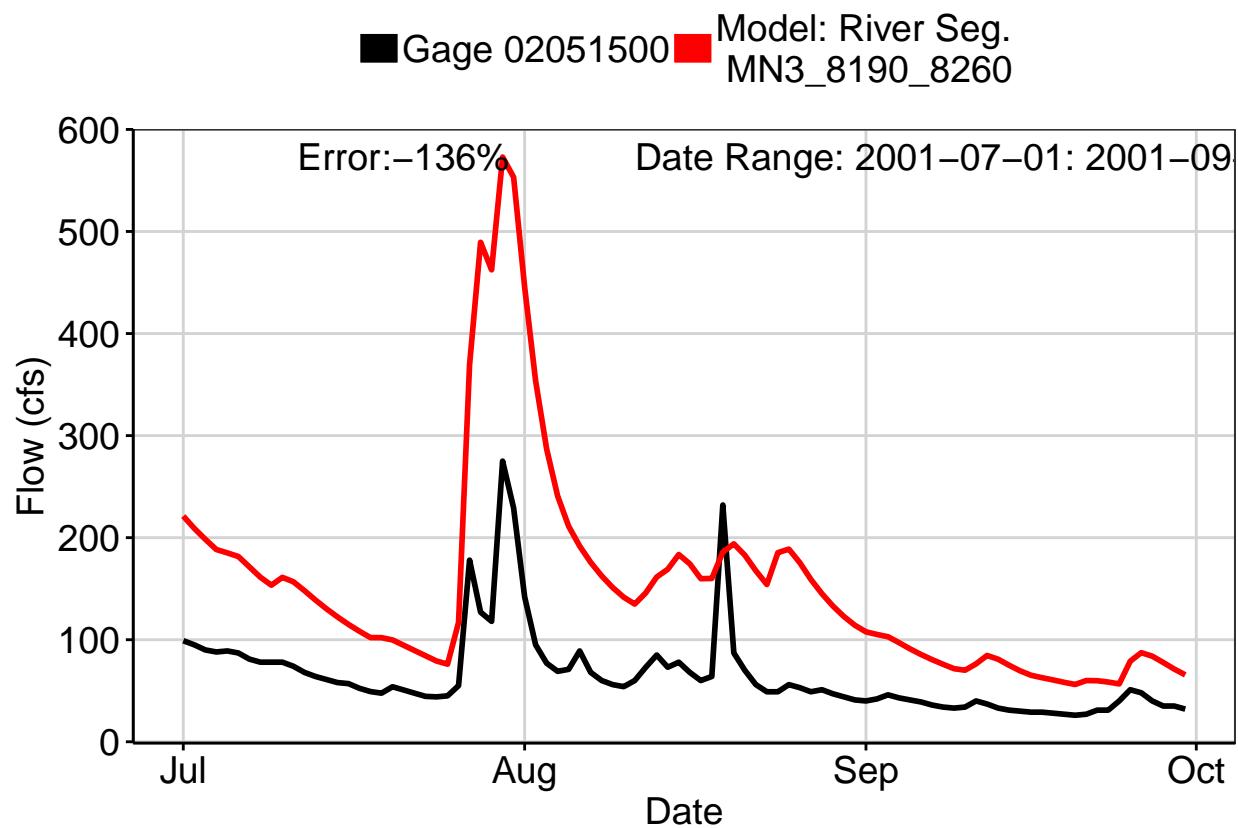


Fig. 8: Third Largest Error Segment

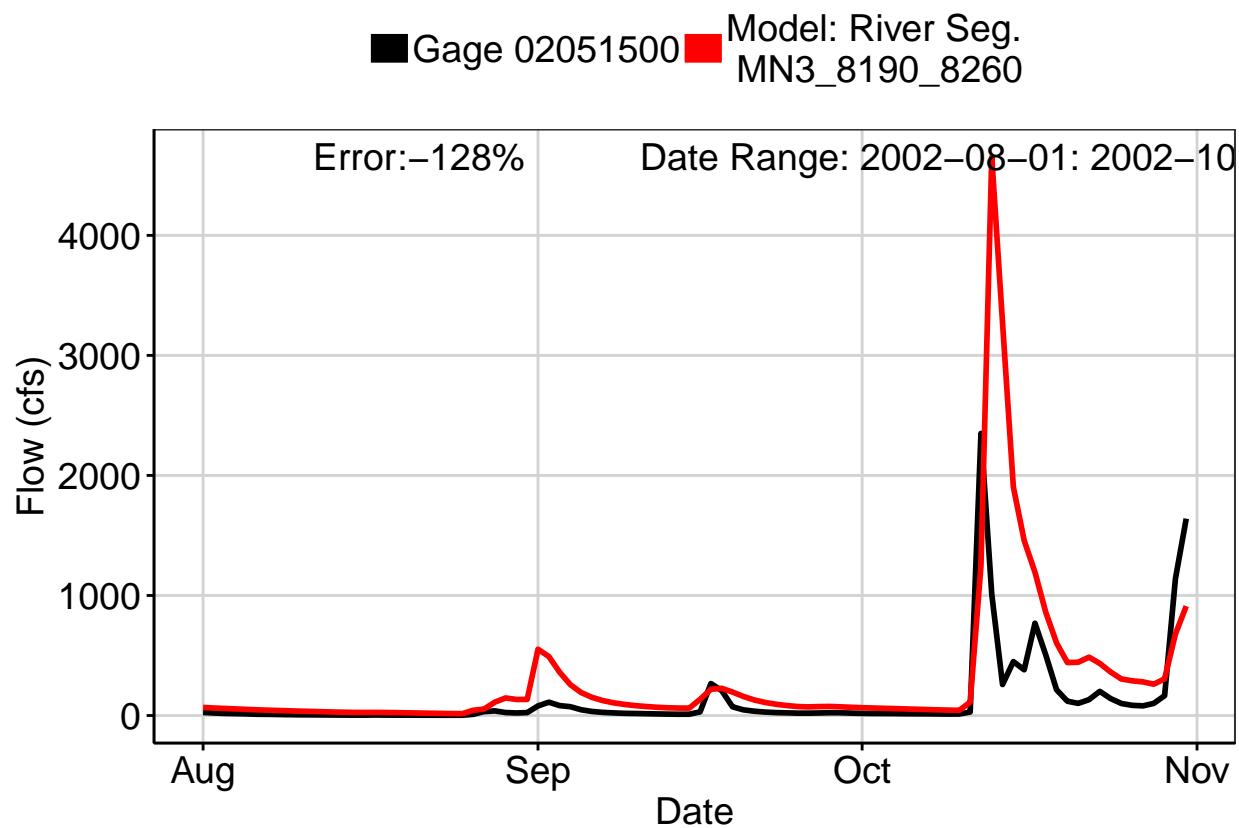
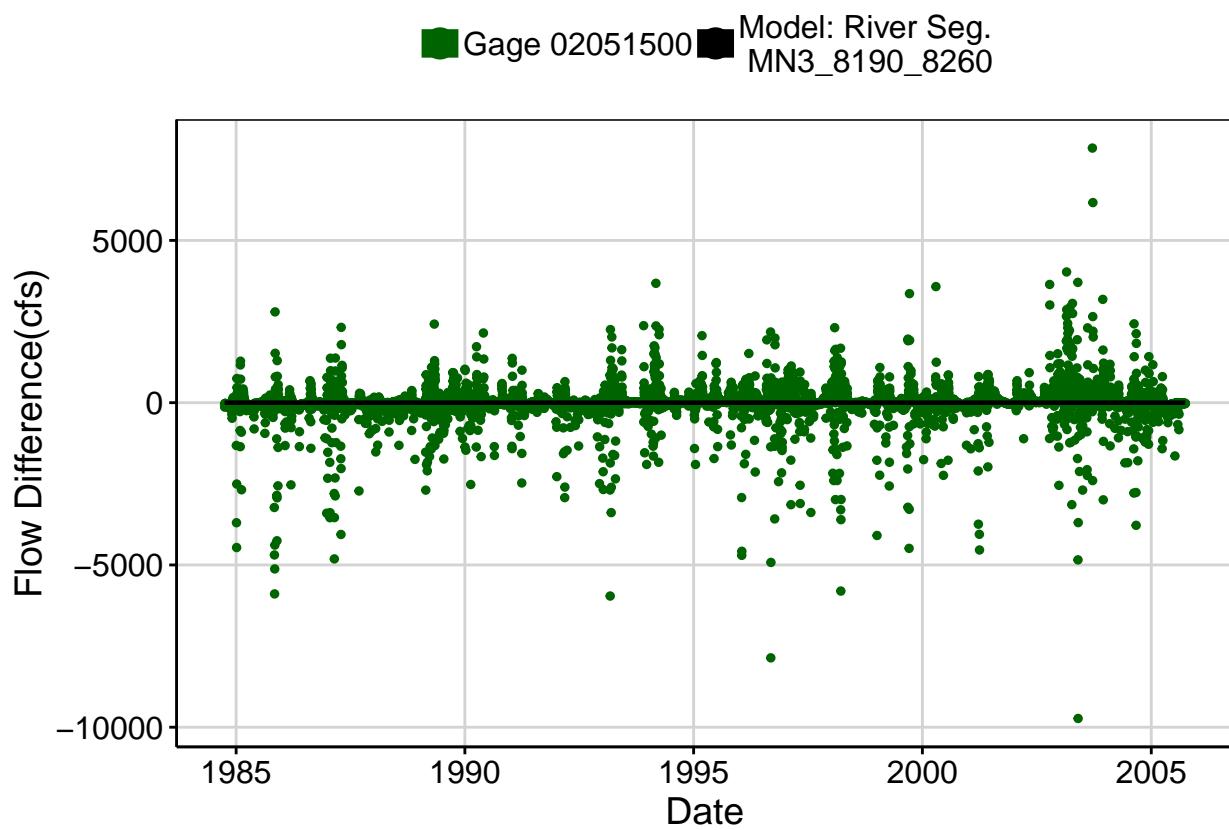
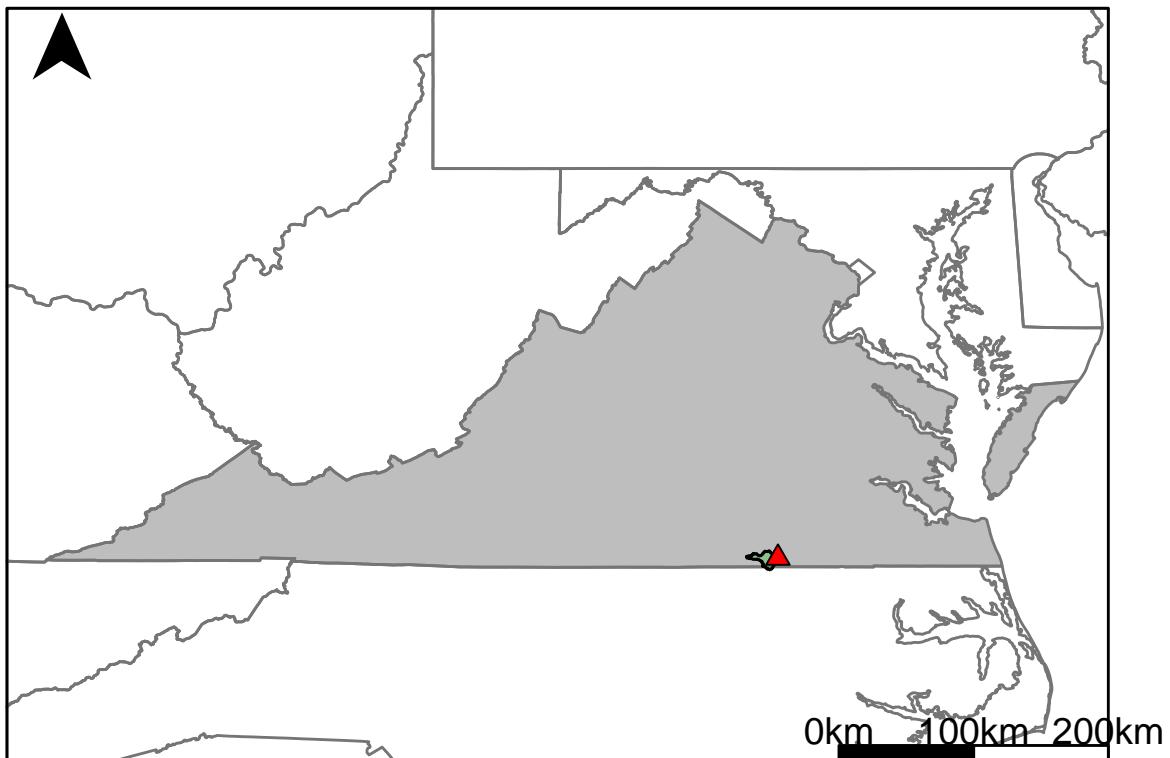


Fig. 9: Residuals Plot



## Appendix E.3: USGS Gage 02052500 vs. MN2\_8530\_8510



This river segment follows part of the flow of the Fountains Creek, a tributary of the Meherrin River. The gage is located in Greensville County, VA (Lat 36°36'55", Long 77°42'00") approximately 10 miles southeast of Emporia, VA. Drainage area is 68.7 sq. miles. This gage started taking data in 1953 and was decommissioned in 1997. For this reason the analysis was run from 1984-10-01 to 1996-09-30. There are no known anthropogenic alterations that would affect the flow of this area. The average daily discharge error between the model and gage data for the 20 year timespan was -14.2%, with 47.7% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	1.35	3.25	-141
Feb. Low Flow	4.1	12.9	-215
Mar. Low Flow	10.5	18.5	-76.2
Apr. Low Flow	27.5	29.3	-6.55
May Low Flow	42	43.4	-3.33
Jun. Low Flow	36	30.3	15.8
Jul. Low Flow	22.5	19.7	12.4
Aug. Low Flow	11.5	9.82	14.6
Sep. Low Flow	3.3	6.41	-94.2
Oct. Low Flow	1.07	3.97	-271
Nov. Low Flow	1.55	3.55	-129
Dec. Low Flow	1.6	2.98	-86.2

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	59	67.4	-14.2
Jan. Mean Flow	108	97.9	9.35
Feb. Mean Flow	110	112	-1.82
Mar. Mean Flow	160	145	9.38
Apr. Mean Flow	87.5	95.2	-8.8
May Mean Flow	45.6	49.6	-8.77
Jun. Mean Flow	22.6	29.3	-29.6
Jul. Mean Flow	16.8	26.9	-60.1
Aug. Mean Flow	32.7	42.9	-31.2
Sep. Mean Flow	21.4	68.4	-220
Oct. Mean Flow	9.77	32.6	-234
Nov. Mean Flow	55.2	48.8	11.6
Dec. Mean Flow	41.6	63	-51.4

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	48	33.2	30.8
Feb. High Flow	96	120	-25
Mar. High Flow	123	121	1.63
Apr. High Flow	441	369	16.3
May High Flow	336	401	-19.3
Jun. High Flow	994	478	51.9
Jul. High Flow	174	273	-56.9
Aug. High Flow	112	126	-12.5
Sep. High Flow	71	57.2	19.4
Oct. High Flow	77	32.1	58.3
Nov. High Flow	78	93.7	-20.1
Dec. High Flow	30.5	39.8	-30.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	0	0.03	-Inf
Med. 1 Day Min	0.13	1.91	-1370
Min. 3 Day Min	0	0.03	-Inf
Med. 3 Day Min	0.16	2.02	-1190
Min. 7 Day Min	0	0.05	-Inf
Med. 7 Day Min	0.28	2.29	-730
Min. 30 Day Min	0.01	0.52	-8120
Med. 30 Day Min	1.5	3.34	-123
Min. 90 Day Min	1.7	2.32	-36.5
Med. 90 Day Min	9.36	9.88	-5.56
7Q10	0	0.21	-213000
Year of 90-Day Min. Flow	1987	2002	100
Drought Year Mean	97.2	67.4	30.7
Mean Baseflow	18.5	24.3	-31.4

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	3010	7860	-161
Med. 1 Day Max	1550	1670	-7.74
Max. 3 Day Max	1820	3310	-81.9
Med. 3 Day Max	847	873	-3.07
Max. 7 Day Max	948	1540	-62.4
Med. 7 Day Max	434	467	-7.6
Max. 30 Day Max	452	544	-20.4
Med. 30 Day Max	182	190	-4.4
Max. 90 Day Max	270	257	4.81
Med. 90 Day Max	133	144	-8.27

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	0	0.63	-Inf
5% Non-Exceedance	0.53	2.49	-369
50% Non-Exceedance	20	27.2	-36
95% Non-Exceedance	202	229	-13.4
99% Non-Exceedance	761	685	9.99
Sept. 10% Non-Exceedance	2.6	2.52	3.08

**Fig. 1: Hydrograph**

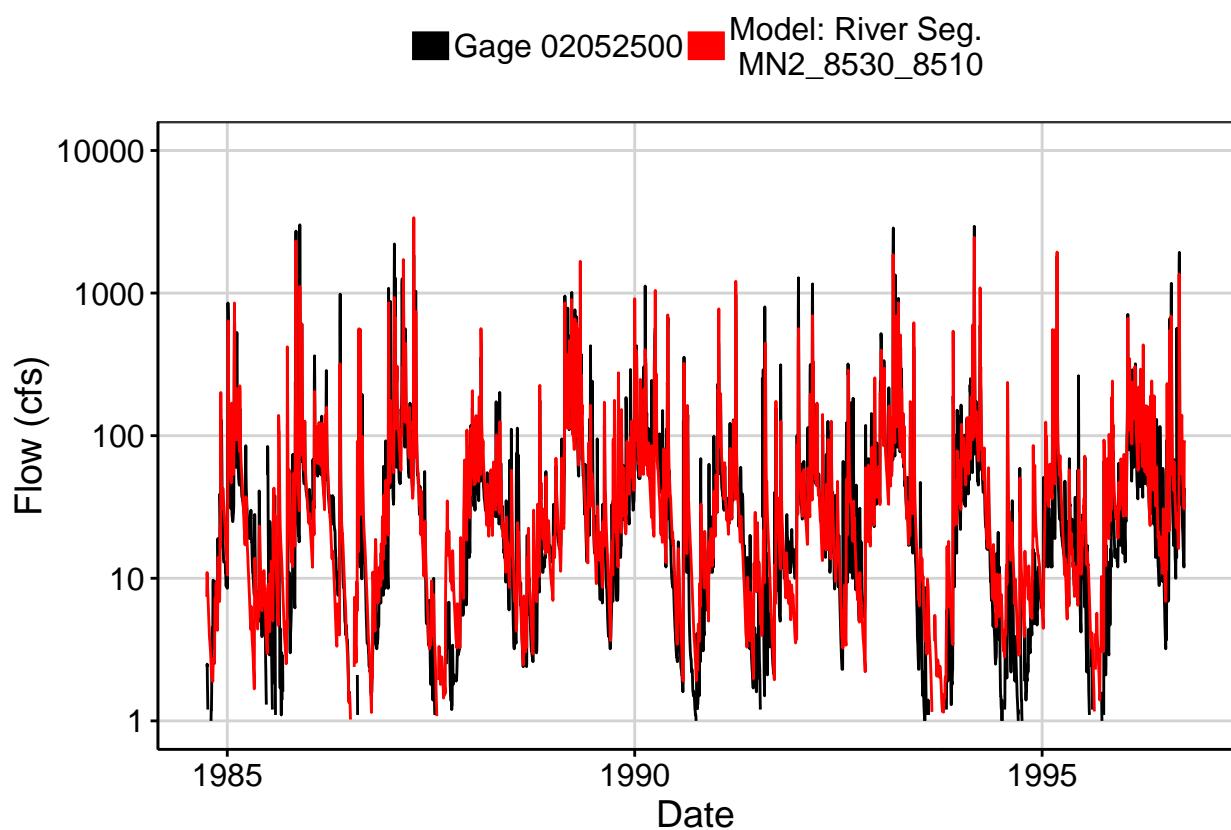


Fig. 2: Zoomed Hydrograph

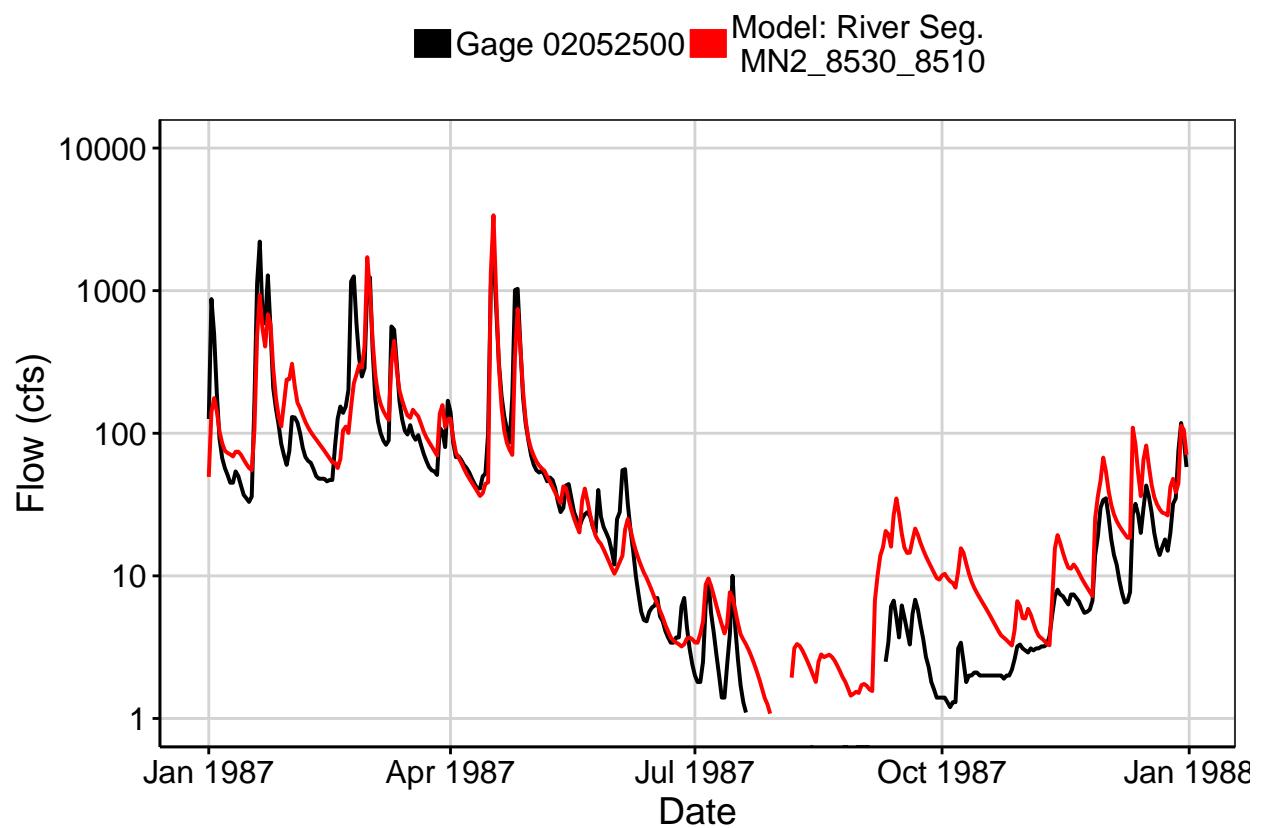


Fig. 3: Flow Exceedance

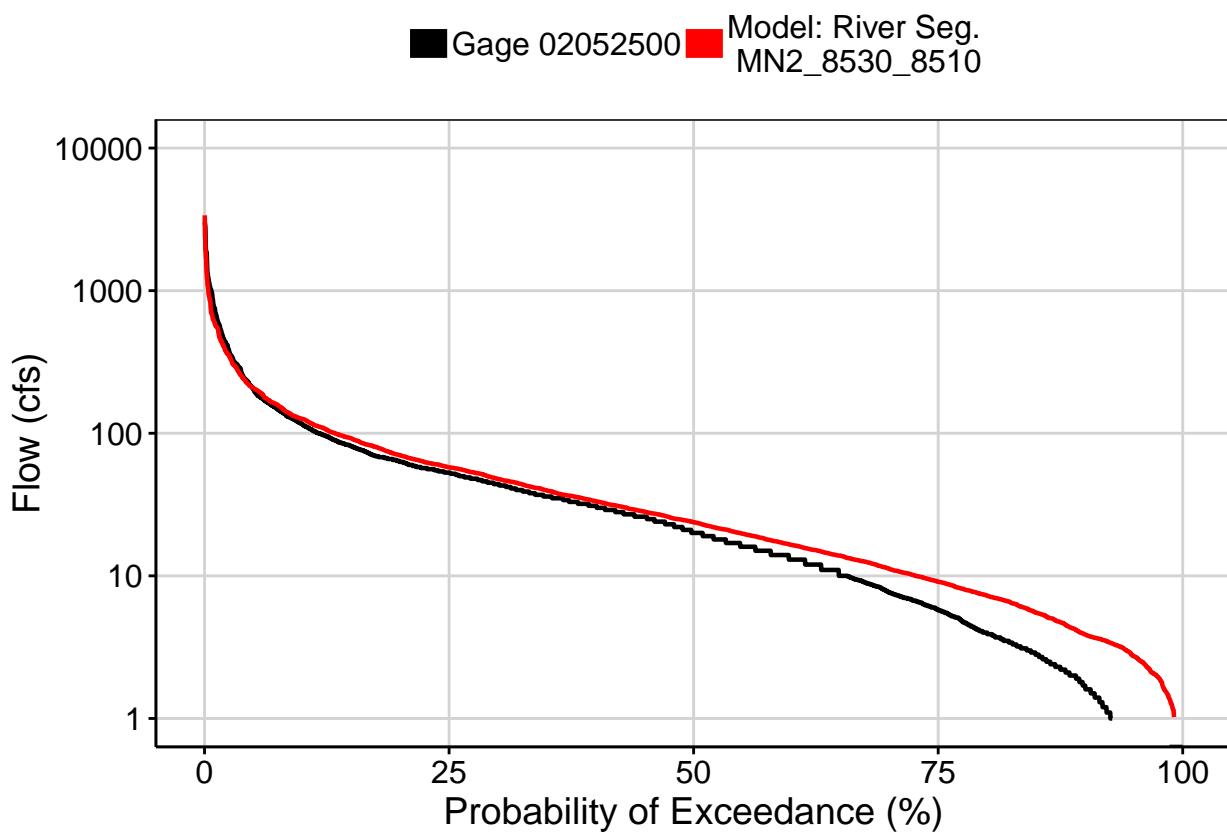


Fig. 4: Baseflow

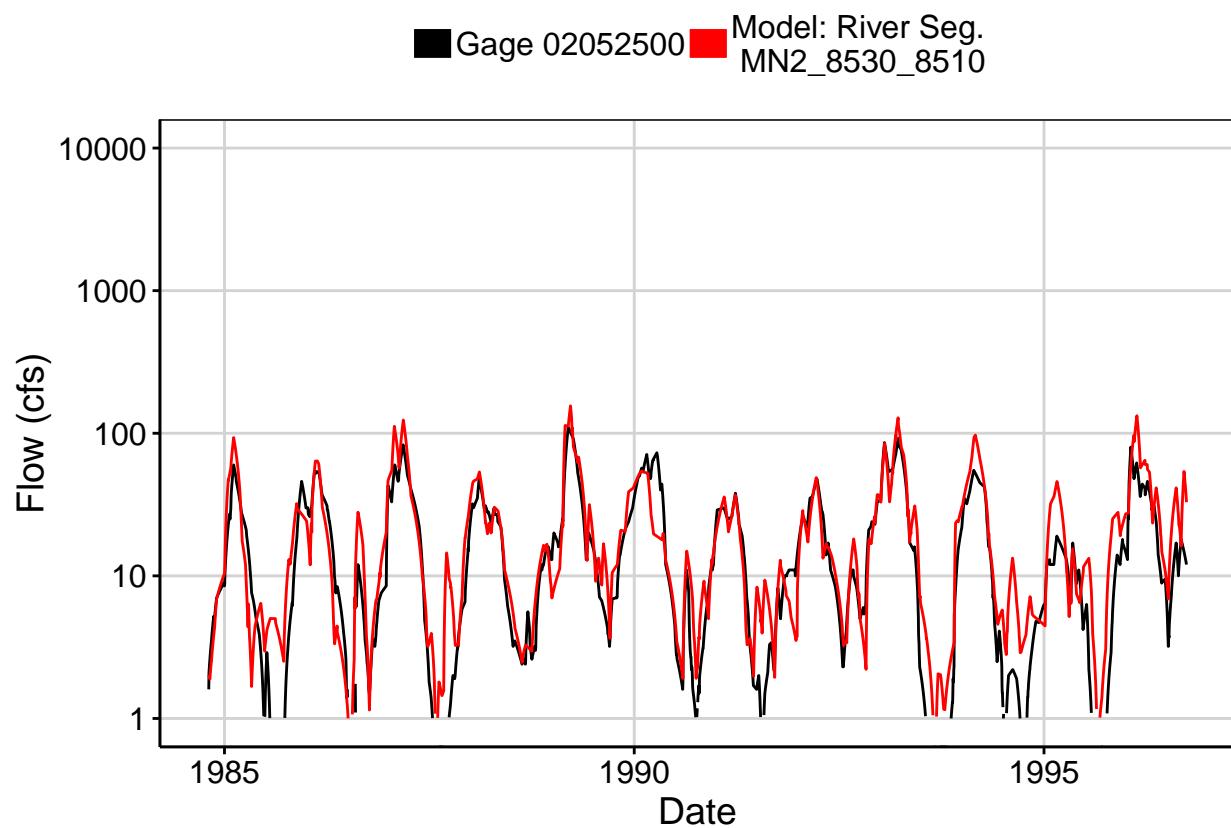


Fig. 5: Combined Baseflow

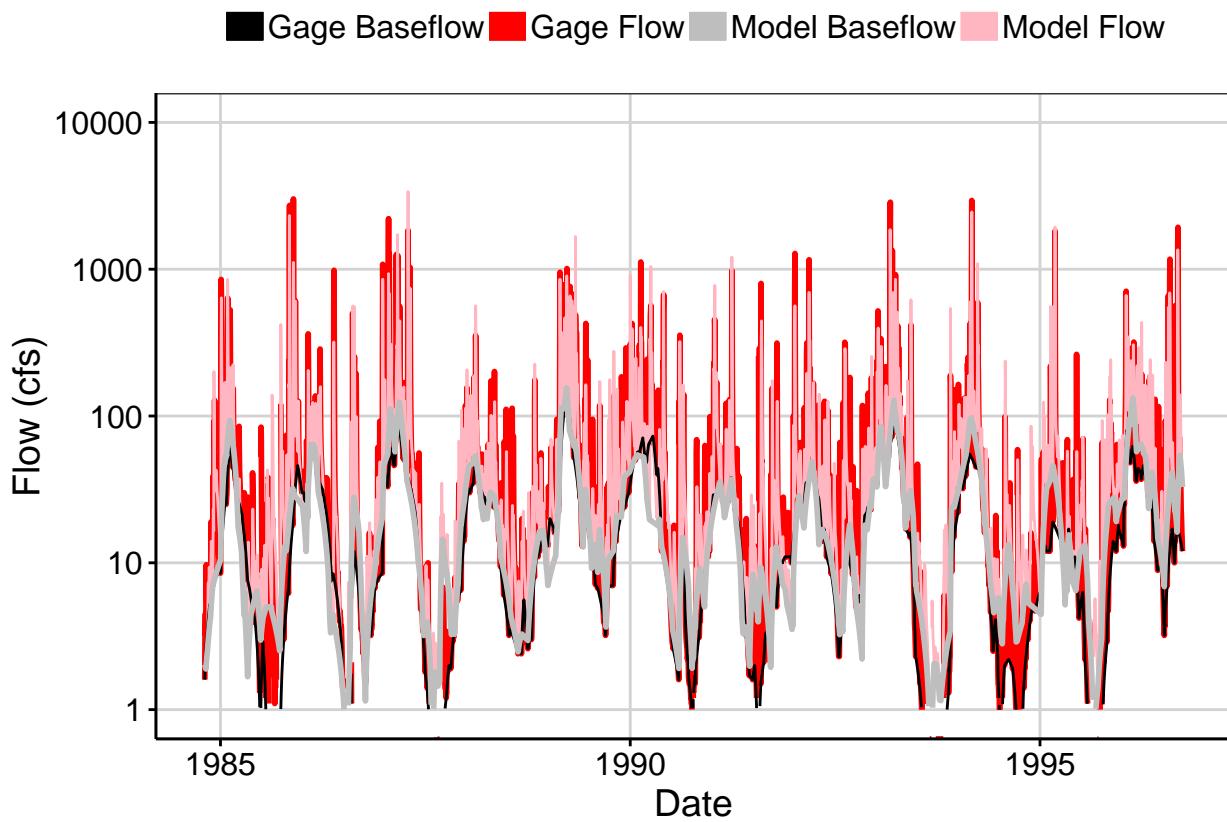


Fig. 6: Largest Error Segment

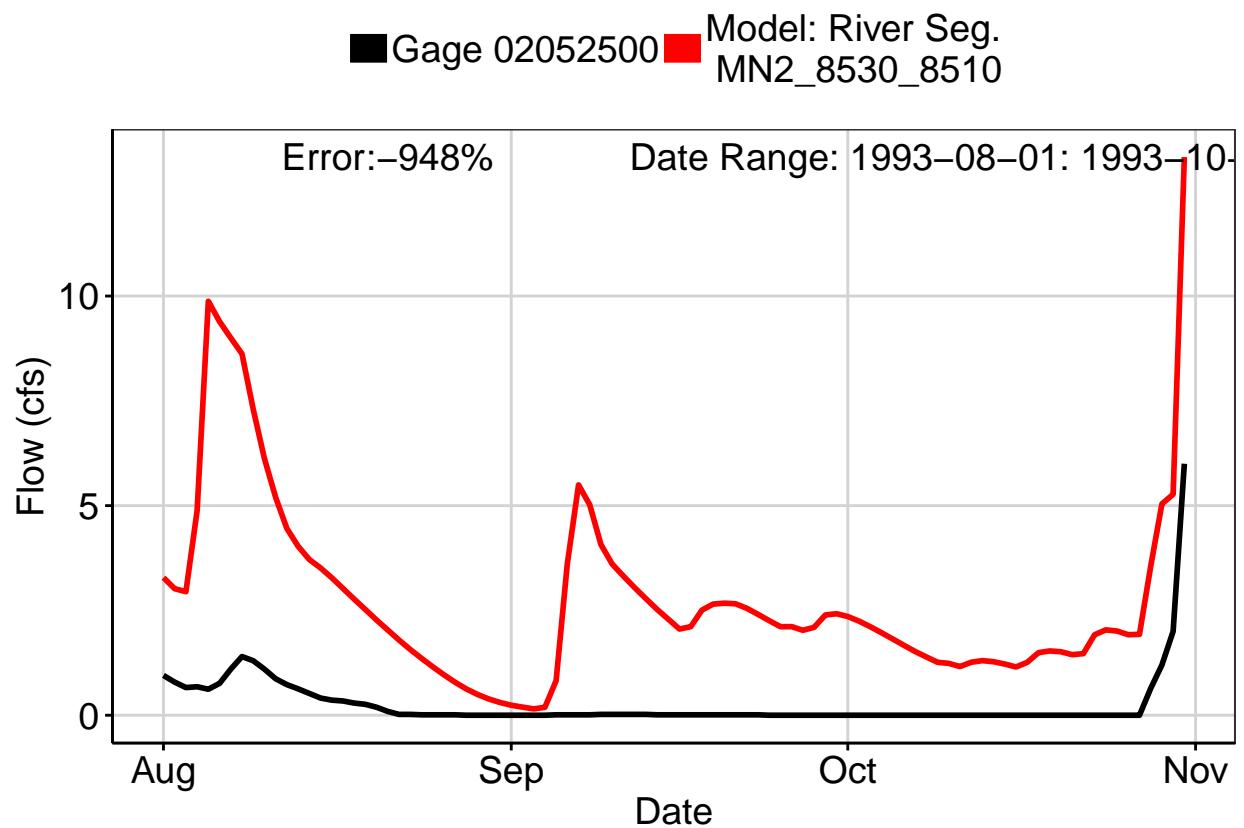


Fig. 7: Second Largest Error Segment

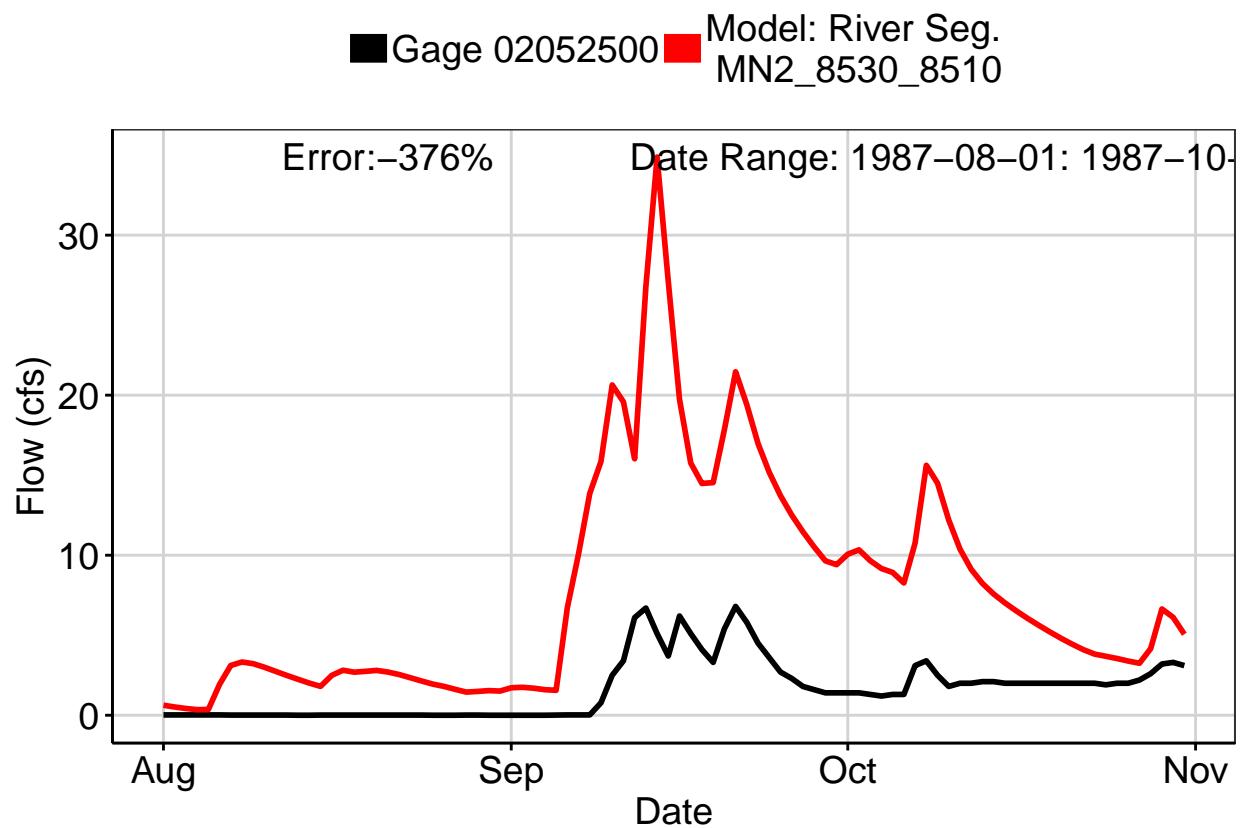


Fig. 8: Third Largest Error Segment

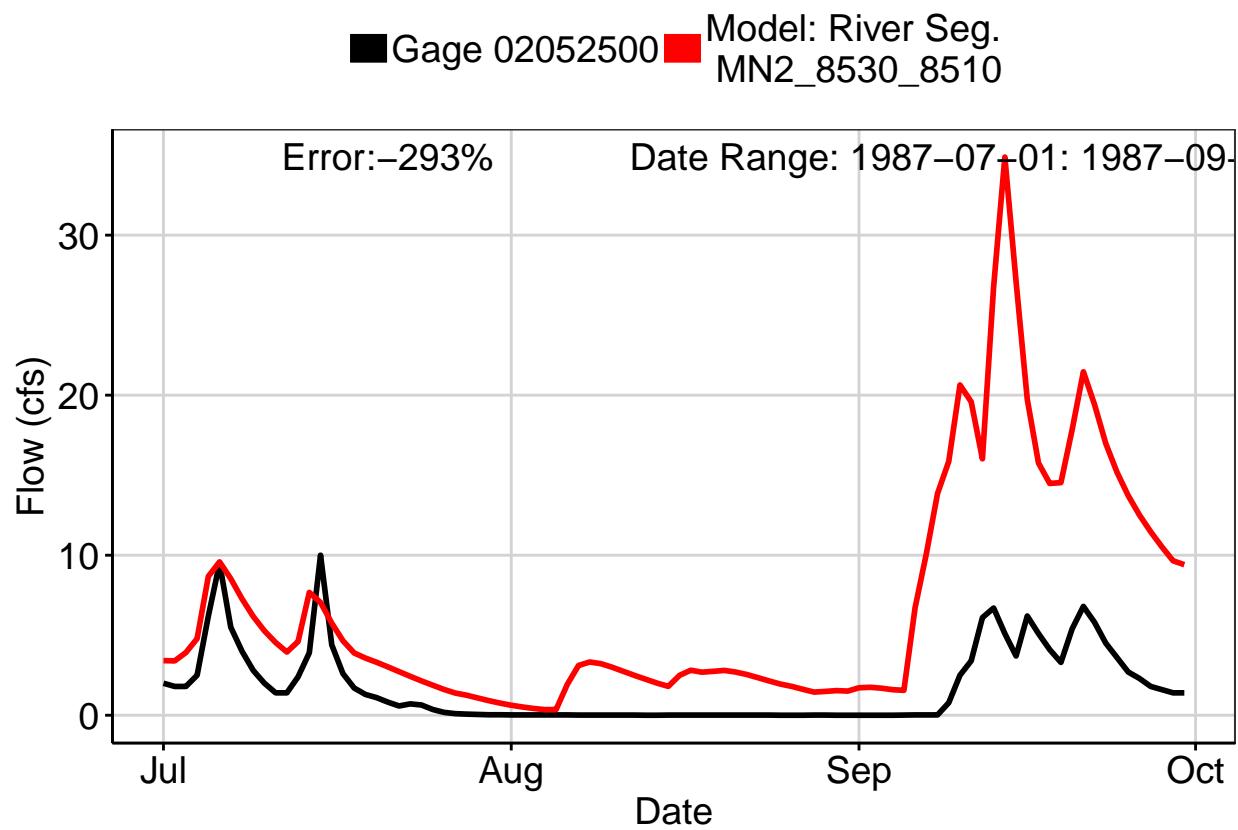
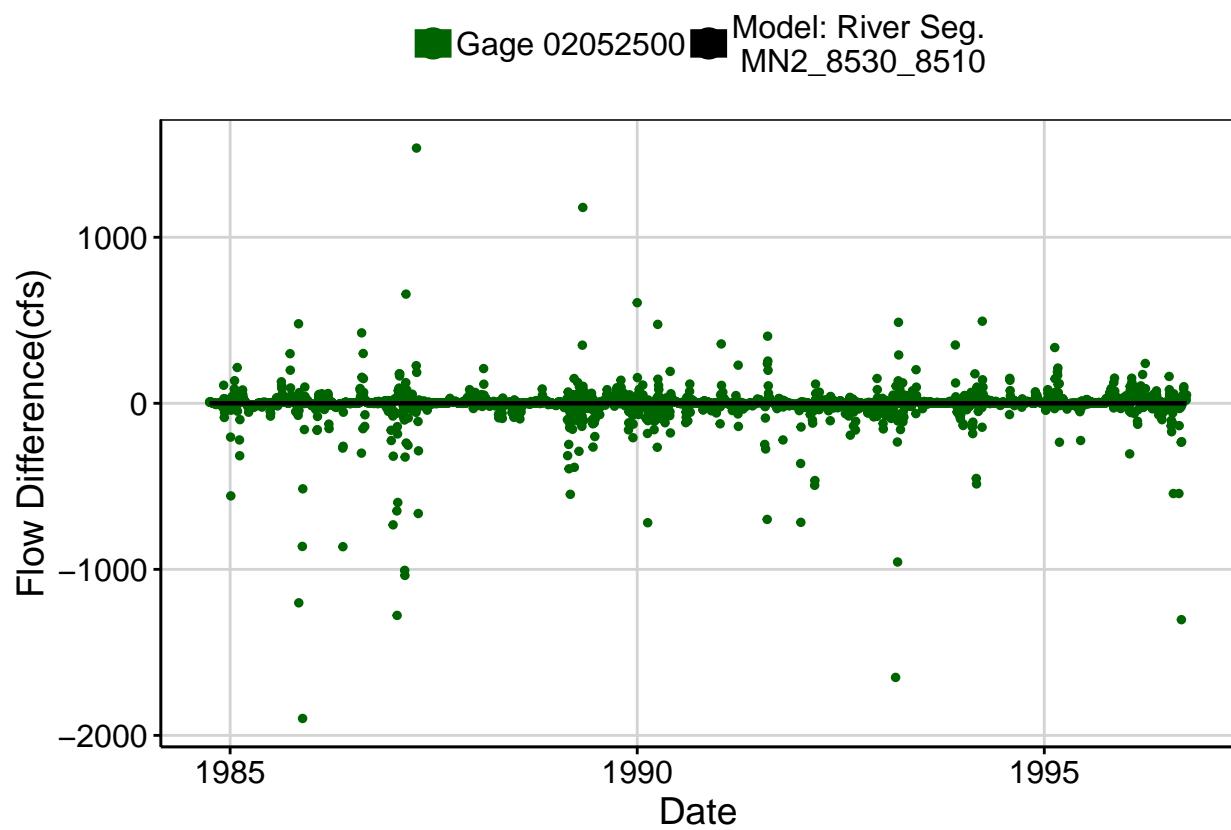
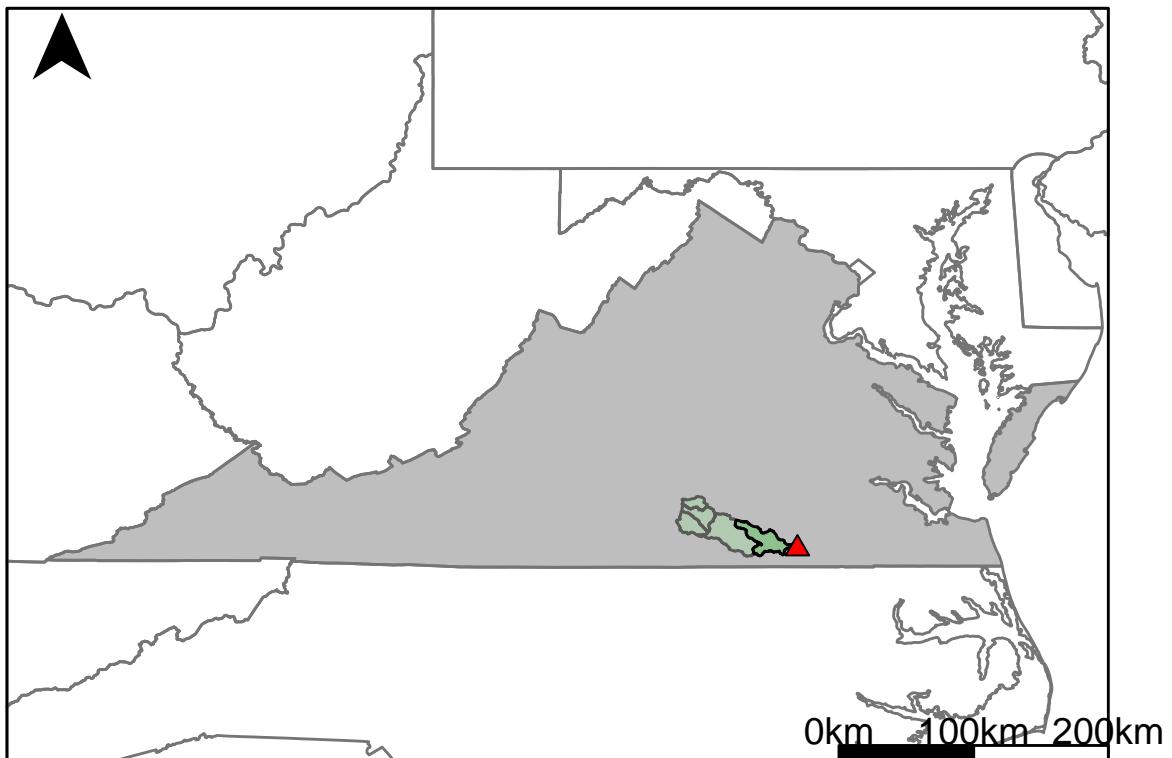


Fig. 9: Residuals Plot



## Appendix E.4: USGS Gage 02052000 vs. MN4\_8260\_8400



This river segment follows part of the flow of the Meherrin River. The gage is located in Emporia City, VA (Lat 36°41'24", Long 77°32'27") approximately 0.3 miles north of Emporia, VA. Drainage area is 744 sq. miles. This gage started taking data in 1951 and is still taking data. The flow in this area is regulated by the Virginia Electric Power Companys dam that is 0.8 miles upstream. The average daily discharge error between the model and gage data for the 20 year timespan was 3.3%, with 45.4% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	61	58.7	3.77
Feb. Low Flow	151	144	4.64
Mar. Low Flow	166	183	-10.2
Apr. Low Flow	298	313	-5.03
May Low Flow	397	535	-34.8
Jun. Low Flow	413	403	2.42
Jul. Low Flow	348	303	12.9
Aug. Low Flow	176	171	2.84
Sep. Low Flow	112	116	-3.57
Oct. Low Flow	60	76.3	-27.2
Nov. Low Flow	52	58.3	-12.1
Dec. Low Flow	58	66.9	-15.3

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	727	703	3.3
Jan. Mean Flow	1010	941	6.83
Feb. Mean Flow	1130	1170	-3.54
Mar. Mean Flow	1430	1470	-2.8
Apr. Mean Flow	1120	1070	4.46
May Mean Flow	701	605	13.7
Jun. Mean Flow	451	396	12.2
Jul. Mean Flow	306	253	17.3
Aug. Mean Flow	364	362	0.55
Sep. Mean Flow	647	667	-3.09
Oct. Mean Flow	299	362	-21.1
Nov. Mean Flow	599	525	12.4
Dec. Mean Flow	702	649	7.55

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	637	386	39.4
Feb. High Flow	1710	1010	40.9
Mar. High Flow	2910	1170	59.8
Apr. High Flow	4550	2640	42
May High Flow	4230	2470	41.6
Jun. High Flow	5020	3570	28.9
Jul. High Flow	4200	3040	27.6
Aug. High Flow	1940	1020	47.4
Sep. High Flow	782	384	50.9
Oct. High Flow	1040	347	66.6
Nov. High Flow	1180	762	35.4
Dec. High Flow	470	383	18.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	3.6	7.36	-104
Med. 1 Day Min	21	39.6	-88.6
Min. 3 Day Min	4.29	7.51	-75.1
Med. 3 Day Min	28.7	42.4	-47.7
Min. 7 Day Min	6.36	8.29	-30.3
Med. 7 Day Min	40.9	48	-17.4
Min. 30 Day Min	13.5	12.7	5.93
Med. 30 Day Min	81	63.8	21.2
Min. 90 Day Min	25	34.3	-37.2
Med. 90 Day Min	162	122	24.7
7Q10	15.1	15.6	-3.31
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	165	703	-326
Mean Baseflow	260	329	-26.5

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	18000	29700	-65
Med. 1 Day Max	8320	7780	6.49
Max. 3 Day Max	16800	18900	-12.5
Med. 3 Day Max	6910	6510	5.79
Max. 7 Day Max	10700	12500	-16.8
Med. 7 Day Max	4080	4560	-11.8
Max. 30 Day Max	4370	4250	2.75
Med. 30 Day Max	1870	1900	-1.6
Max. 90 Day Max	2990	2920	2.34
Med. 90 Day Max	1410	1390	1.42

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	16.5	21.6	-30.9
5% Non-Exceedance	48	44.4	7.5
50% Non-Exceedance	334	347	-3.89
95% Non-Exceedance	2820	2470	12.4
99% Non-Exceedance	6700	5790	13.6
Sept. 10% Non-Exceedance	39.9	40.4	-1.25

**Fig. 1: Hydrograph**

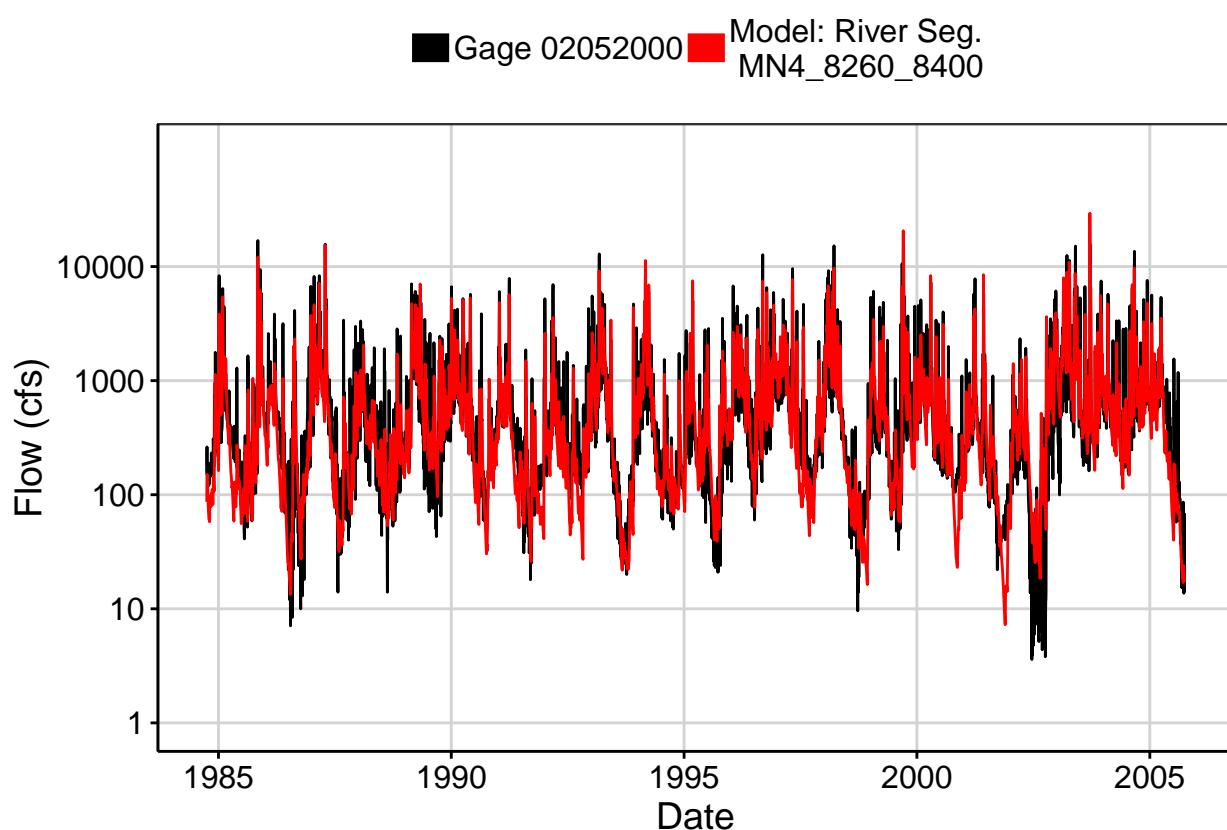


Fig. 2: Zoomed Hydrograph

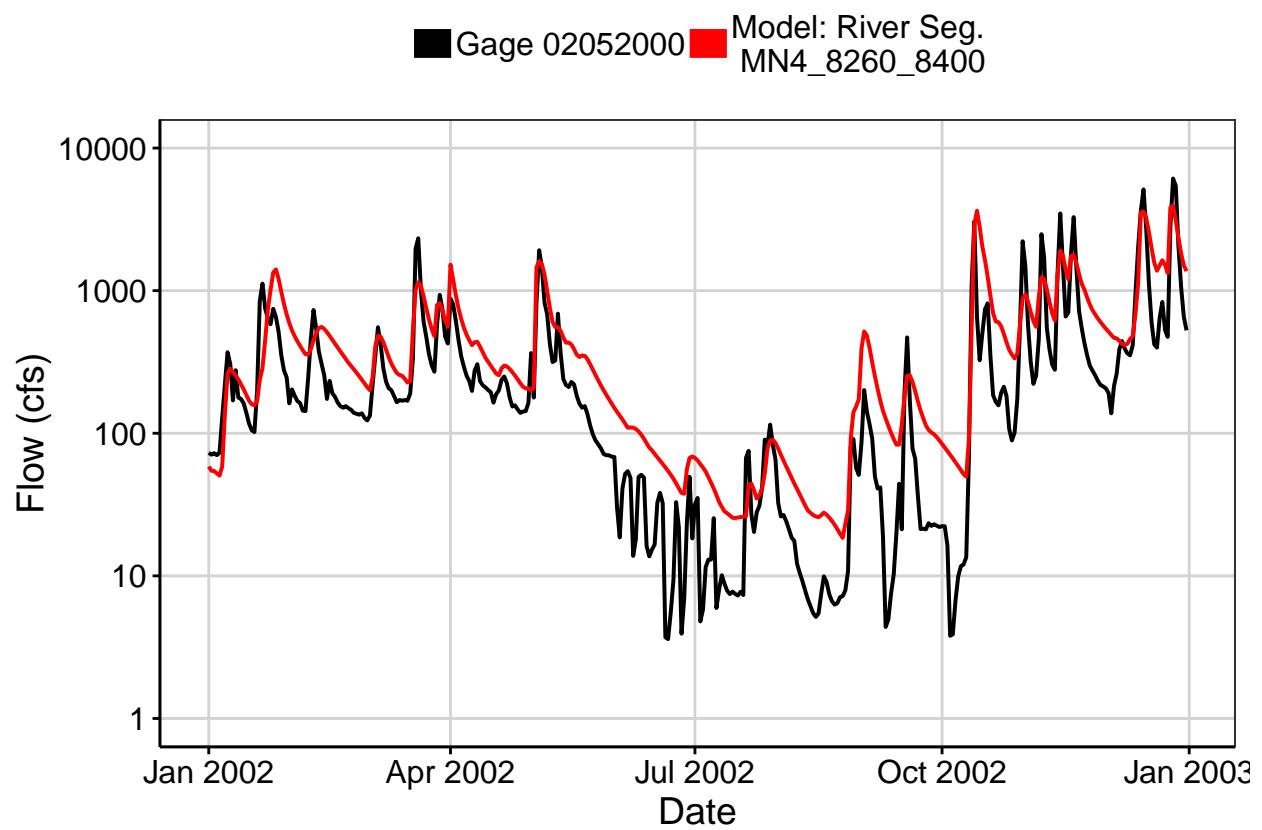


Fig. 3: Flow Exceedance

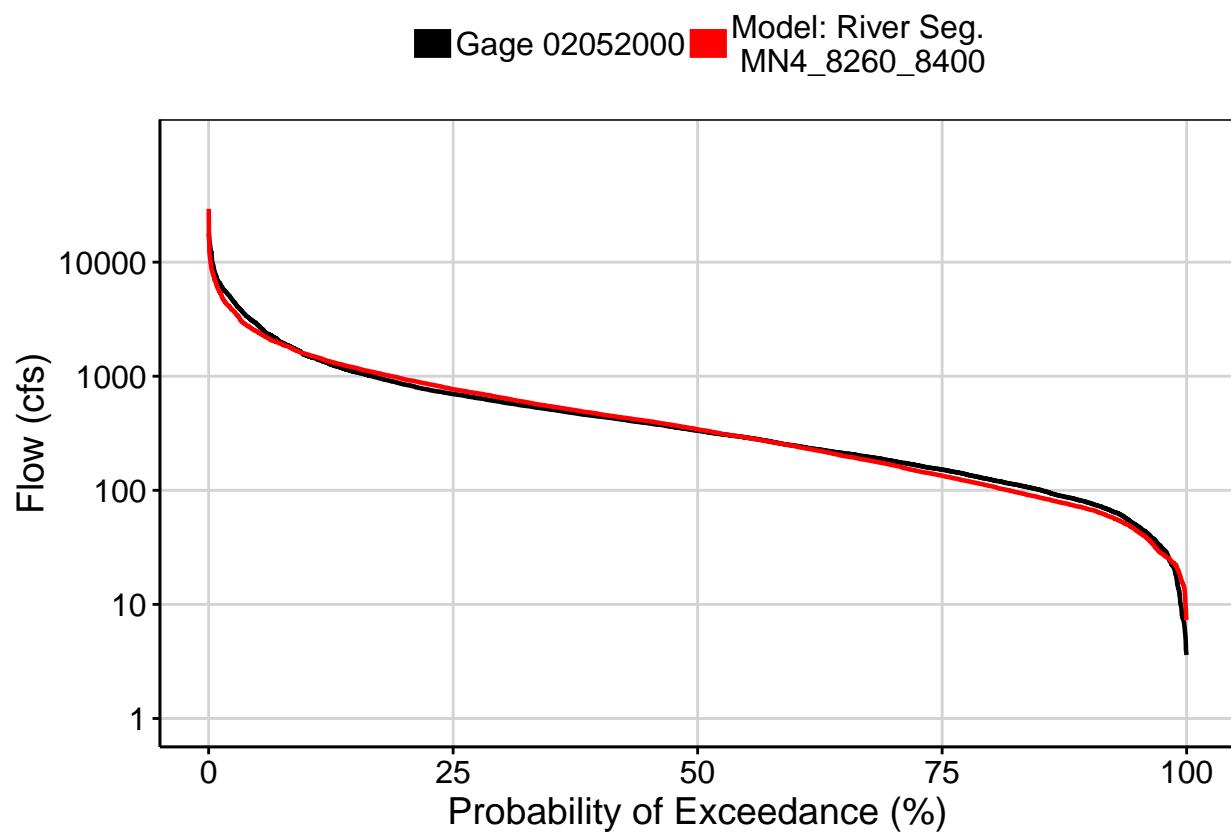


Fig. 4: Baseflow

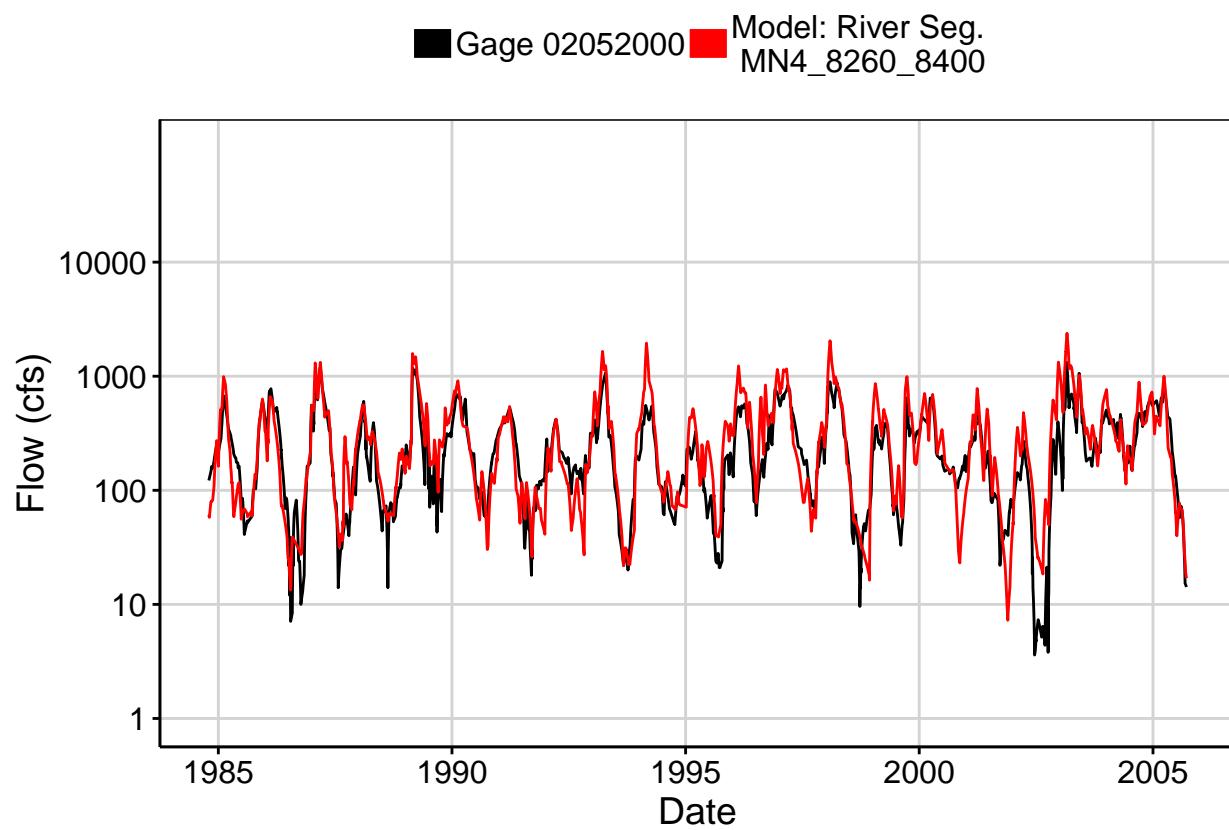


Fig. 5: Combined Baseflow

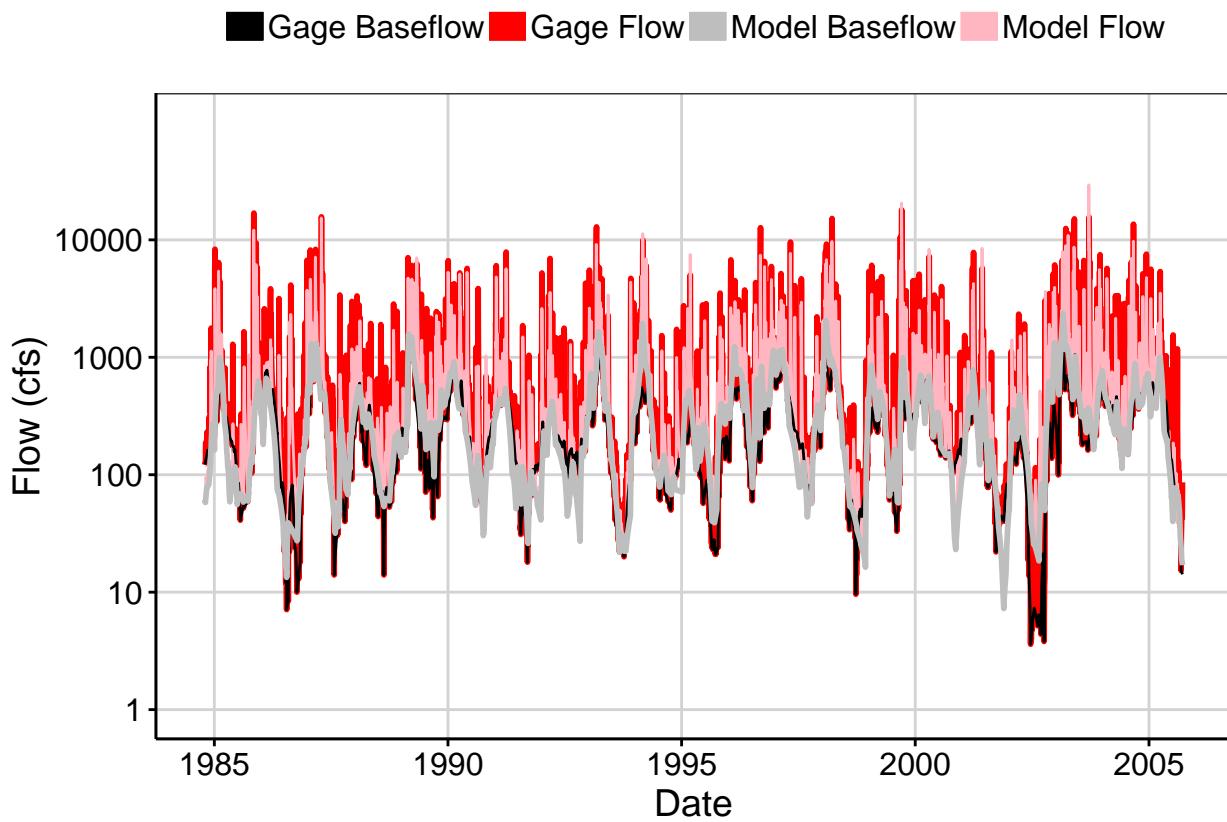


Fig. 6: Largest Error Segment

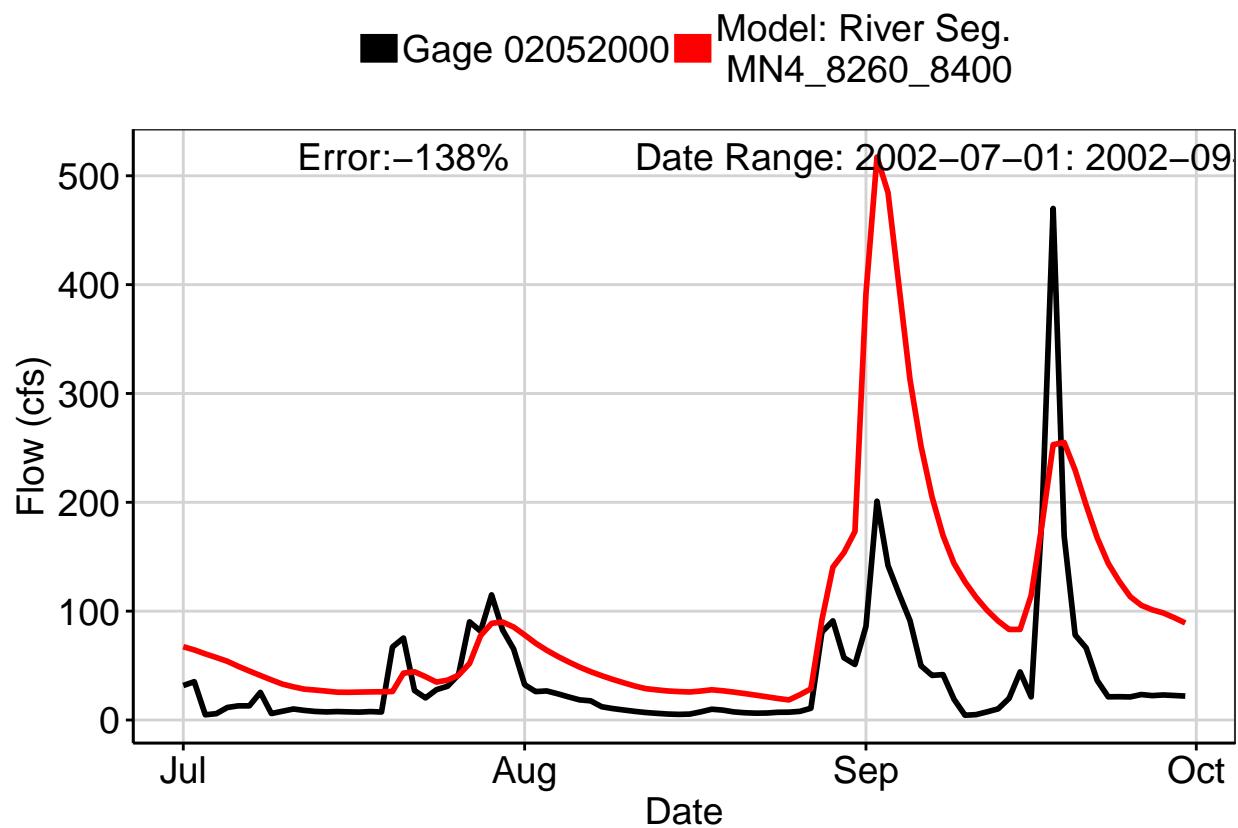


Fig. 7: Second Largest Error Segment

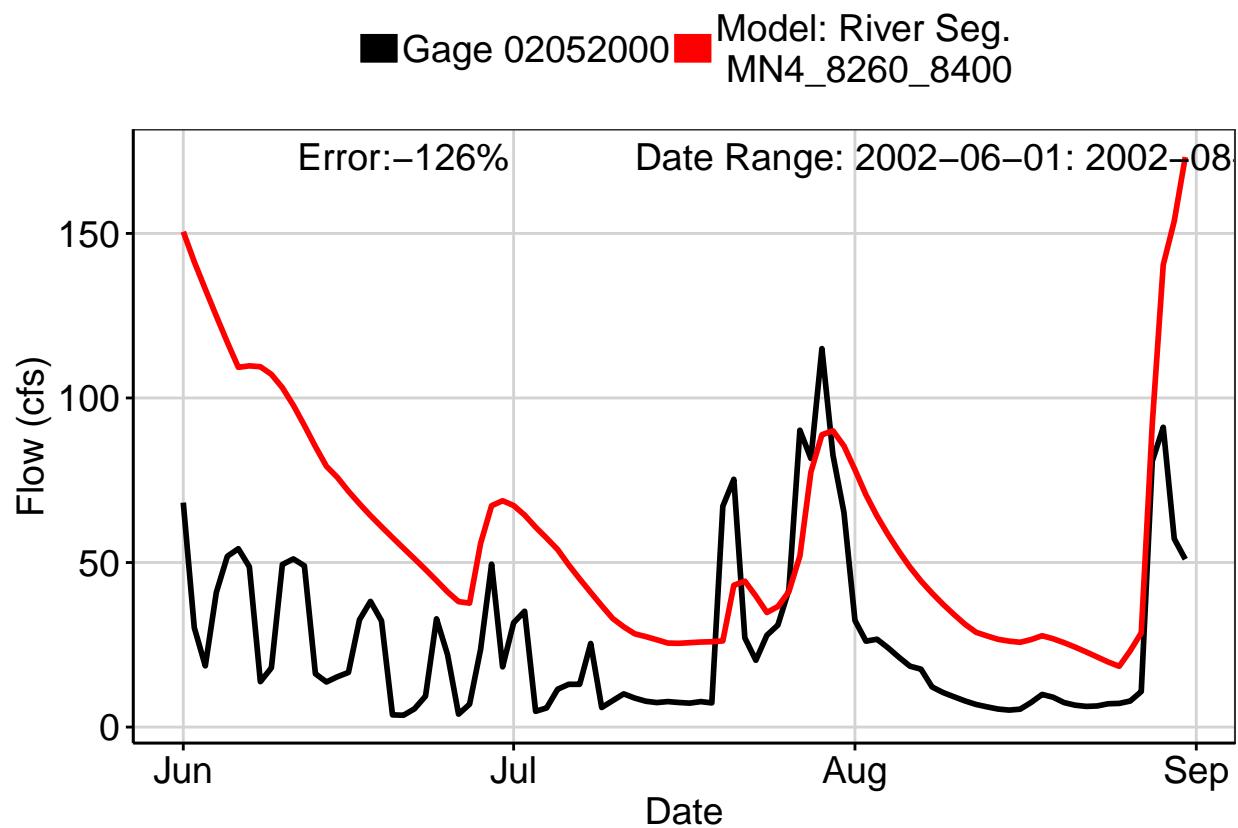


Fig. 8: Third Largest Error Segment

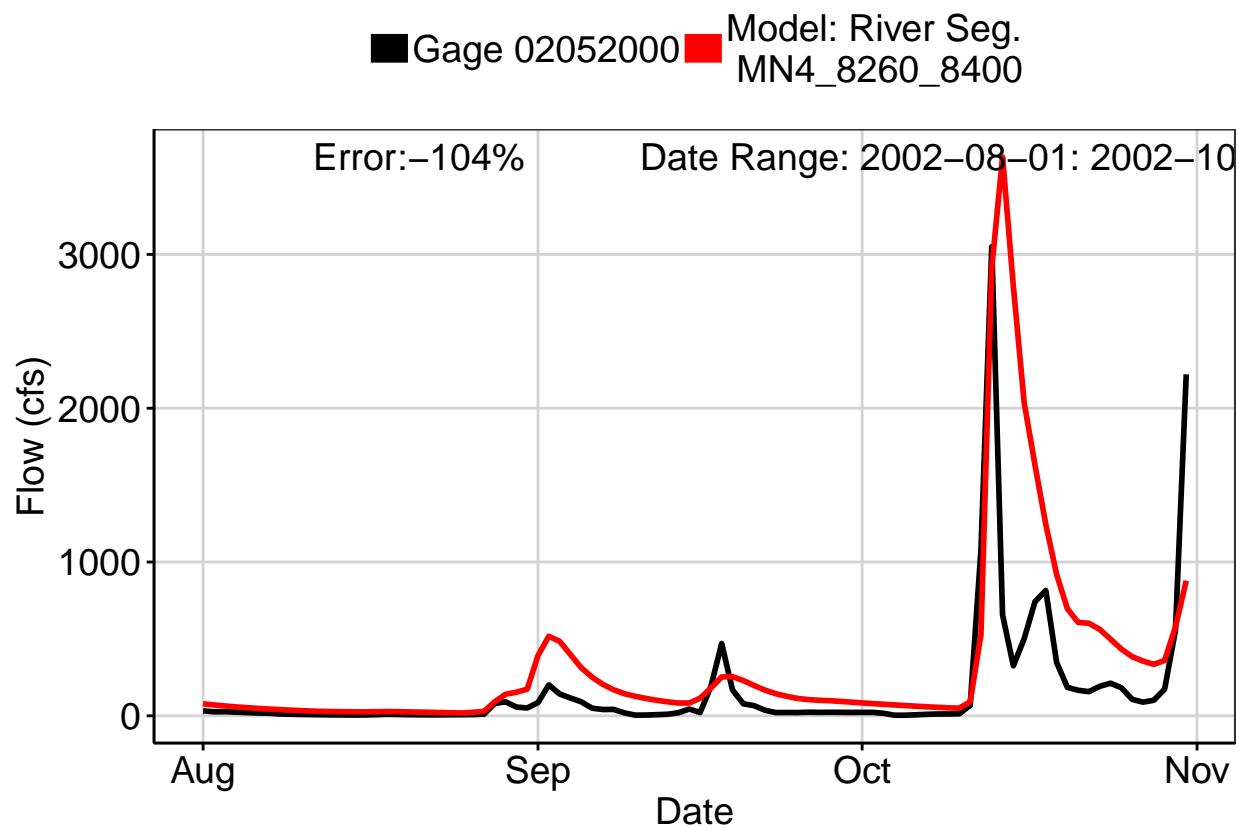
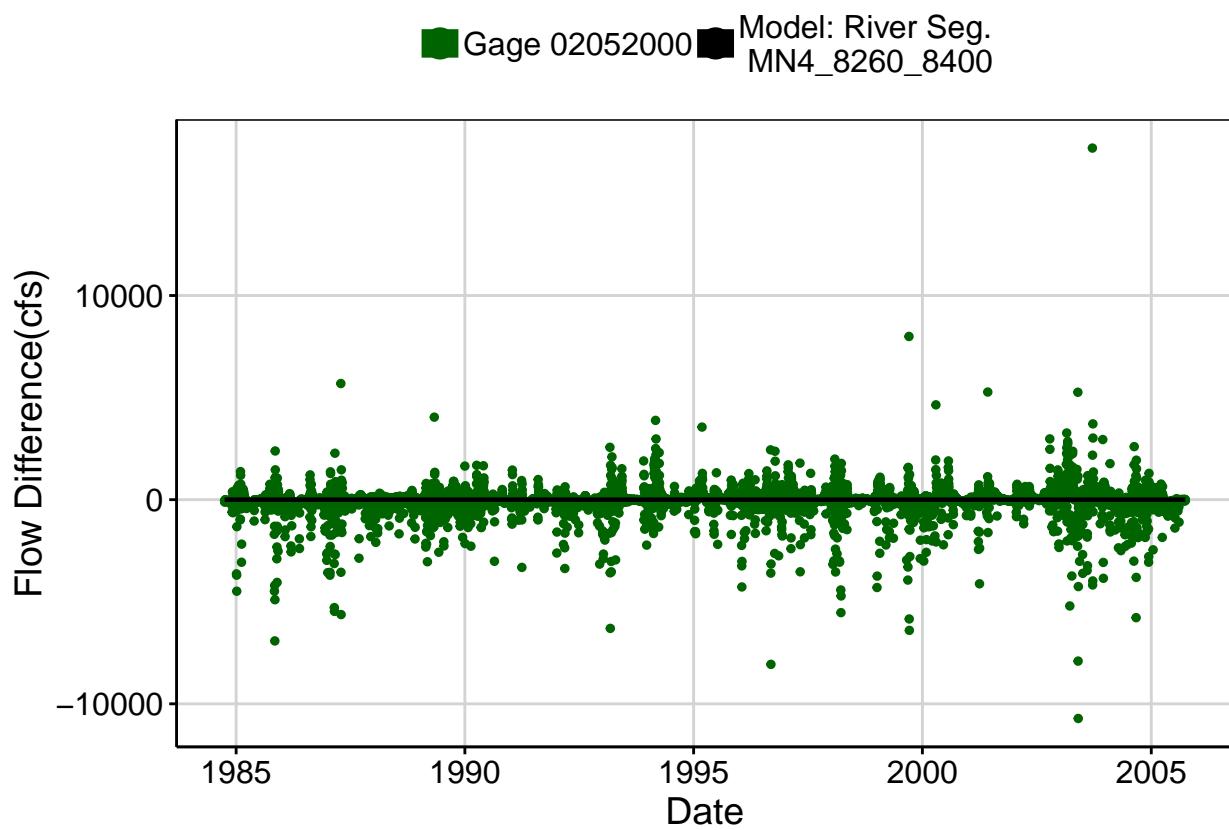
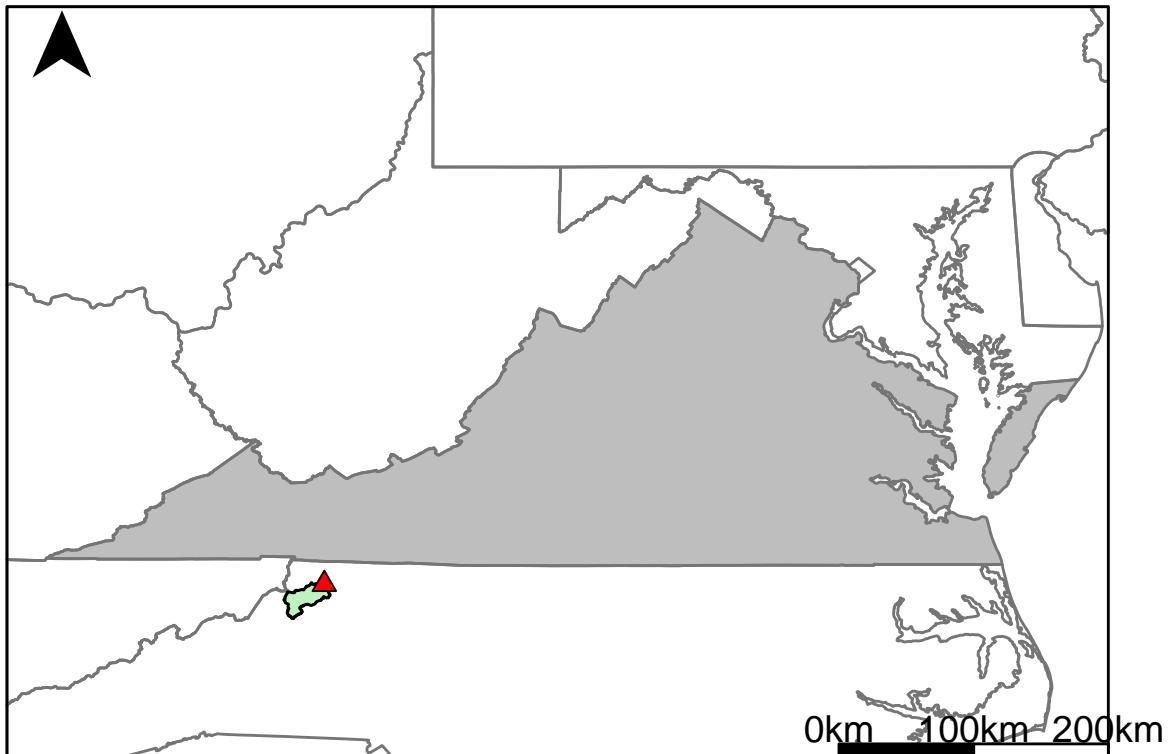


Fig. 9: Residuals Plot



## Appendix F: New River Gages

### Appendix F.1: USGS Gage 03161000 vs. NR3\_9310\_9240



This river segment follows part of the flow of the South Fork of the New River. The gage is located in Ashe County, NC (Lat 36°23'36", Long 81°24'25") approximately 33 miles southwest of Galax, VA. Drainage area is 205 sq. miles. This gage started taking data in 1924 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 2.15%, with 22.5% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	163	136	16.6
Feb. Low Flow	187	151	19.3
Mar. Low Flow	226	216	4.42
Apr. Low Flow	255	212	16.9
May Low Flow	270	285	-5.56
Jun. Low Flow	356	336	5.62
Jul. Low Flow	345	293	15.1
Aug. Low Flow	284	250	12
Sep. Low Flow	271	213	21.4
Oct. Low Flow	204	183	10.3
Nov. Low Flow	173	166	4.05
Dec. Low Flow	157	138	12.1

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	418	409	2.15
Jan. Mean Flow	474	487	-2.74
Feb. Mean Flow	480	552	-15
Mar. Mean Flow	565	617	-9.2
Apr. Mean Flow	547	543	0.73
May Mean Flow	430	415	3.49
Jun. Mean Flow	405	382	5.68
Jul. Mean Flow	338	286	15.4
Aug. Mean Flow	337	301	10.7
Sep. Mean Flow	344	333	3.2
Oct. Mean Flow	313	307	1.92
Nov. Mean Flow	401	359	10.5
Dec. Mean Flow	388	339	12.6

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	477	402	15.7
Feb. High Flow	1010	705	30.2
Mar. High Flow	954	617	35.3
Apr. High Flow	936	1170	-25
May High Flow	995	1080	-8.54
Jun. High Flow	1280	1700	-32.8
Jul. High Flow	1020	1110	-8.82
Aug. High Flow	659	883	-34
Sep. High Flow	645	469	27.3
Oct. High Flow	660	451	31.7
Nov. High Flow	601	400	33.4
Dec. High Flow	556	494	11.2

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	74.7	58.1	22.2
Med. 1 Day Min	142	108	23.9
Min. 3 Day Min	76.5	59.2	22.6
Med. 3 Day Min	144	109	24.3
Min. 7 Day Min	83.3	61.3	26.4
Med. 7 Day Min	154	112	27.3
Min. 30 Day Min	101	71.6	29.1
Med. 30 Day Min	174	143	17.8
Min. 90 Day Min	137	124	9.49
Med. 90 Day Min	233	209	10.3
7Q10	102	81.1	20.5
Year of 90-Day Min. Flow	2002	2001	100
Drought Year Mean	215	409	-90.2
Mean Baseflow	291	263	9.62

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	15400	10800	29.9
Med. 1 Day Max	3330	5040	-51.4
Max. 3 Day Max	7700	7810	-1.43
Med. 3 Day Max	2260	3300	-46
Max. 7 Day Max	4080	4190	-2.7
Med. 7 Day Max	1710	1930	-12.9
Max. 30 Day Max	1560	1750	-12.2
Med. 30 Day Max	890	900	-1.12
Max. 90 Day Max	1000	1310	-31
Med. 90 Day Max	683	677	0.88

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	108	93	13.9
5% Non-Exceedance	138	122	11.6
50% Non-Exceedance	329	290	11.9
95% Non-Exceedance	908	1050	-15.6
99% Non-Exceedance	1860	2340	-25.8
Sept. 10% Non-Exceedance	135	131	2.96

**Fig. 1: Hydrograph**

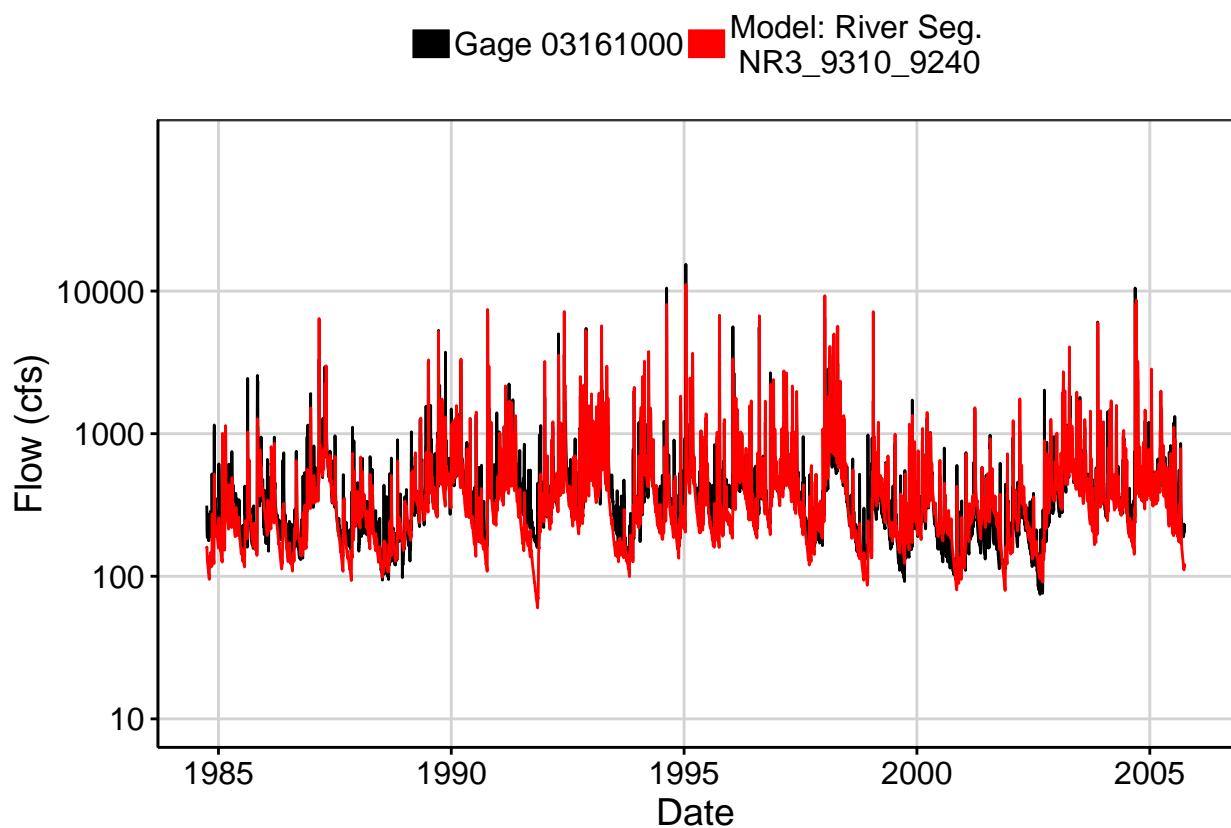


Fig. 2: Zoomed Hydrograph

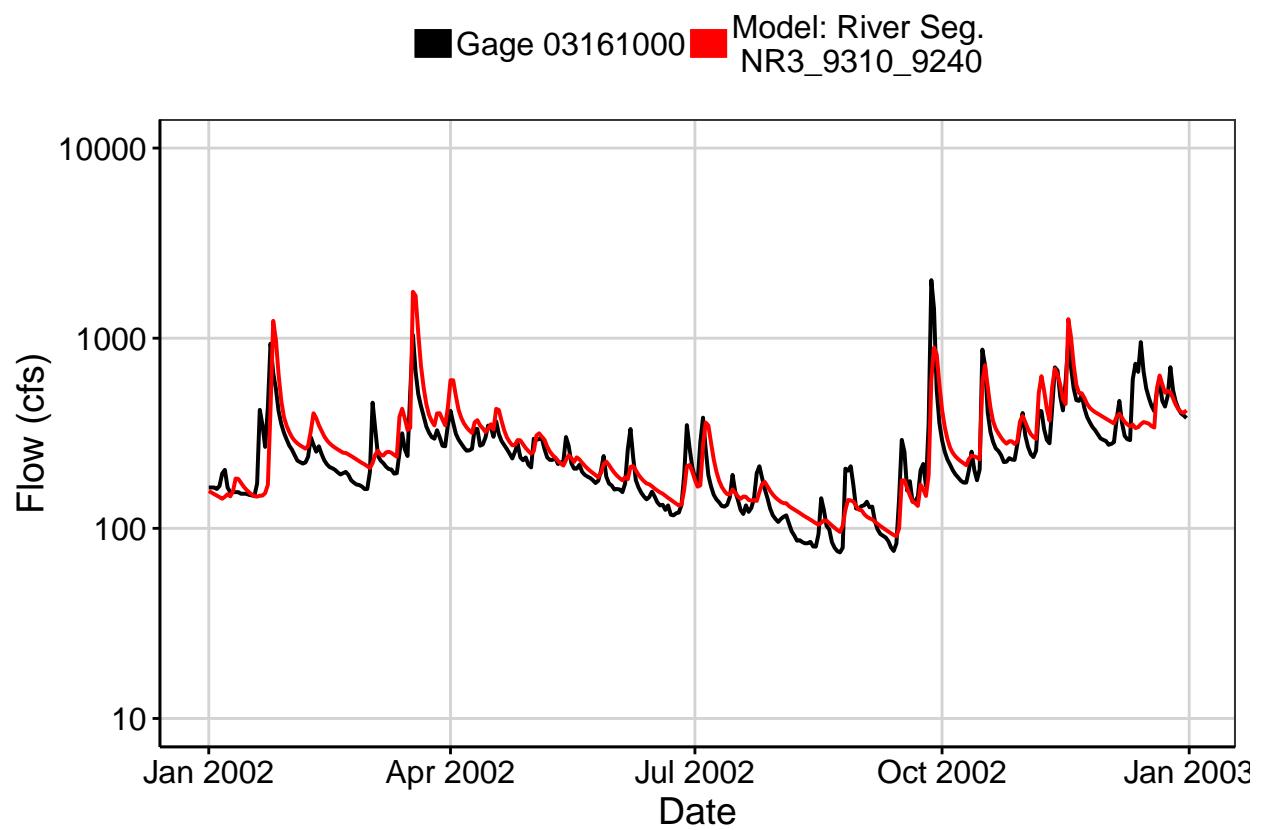


Fig. 3: Flow Exceedance

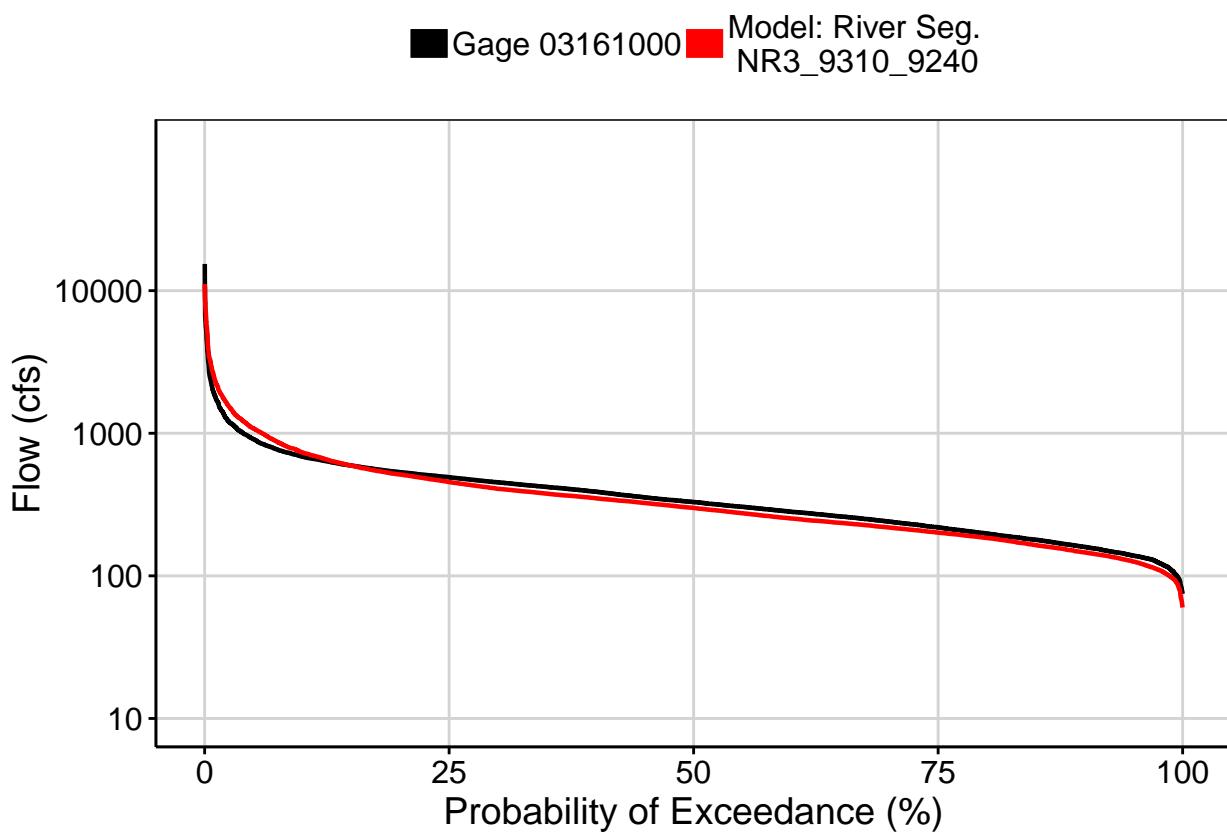
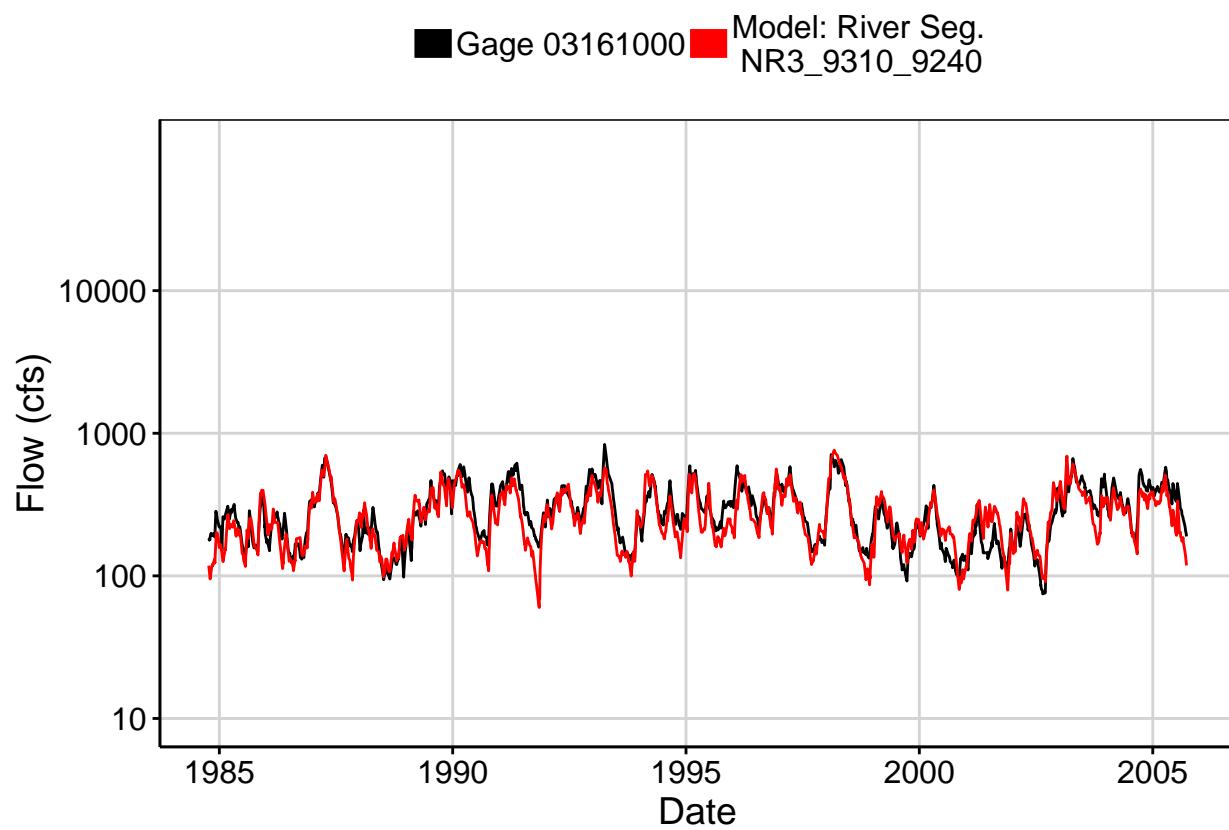


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

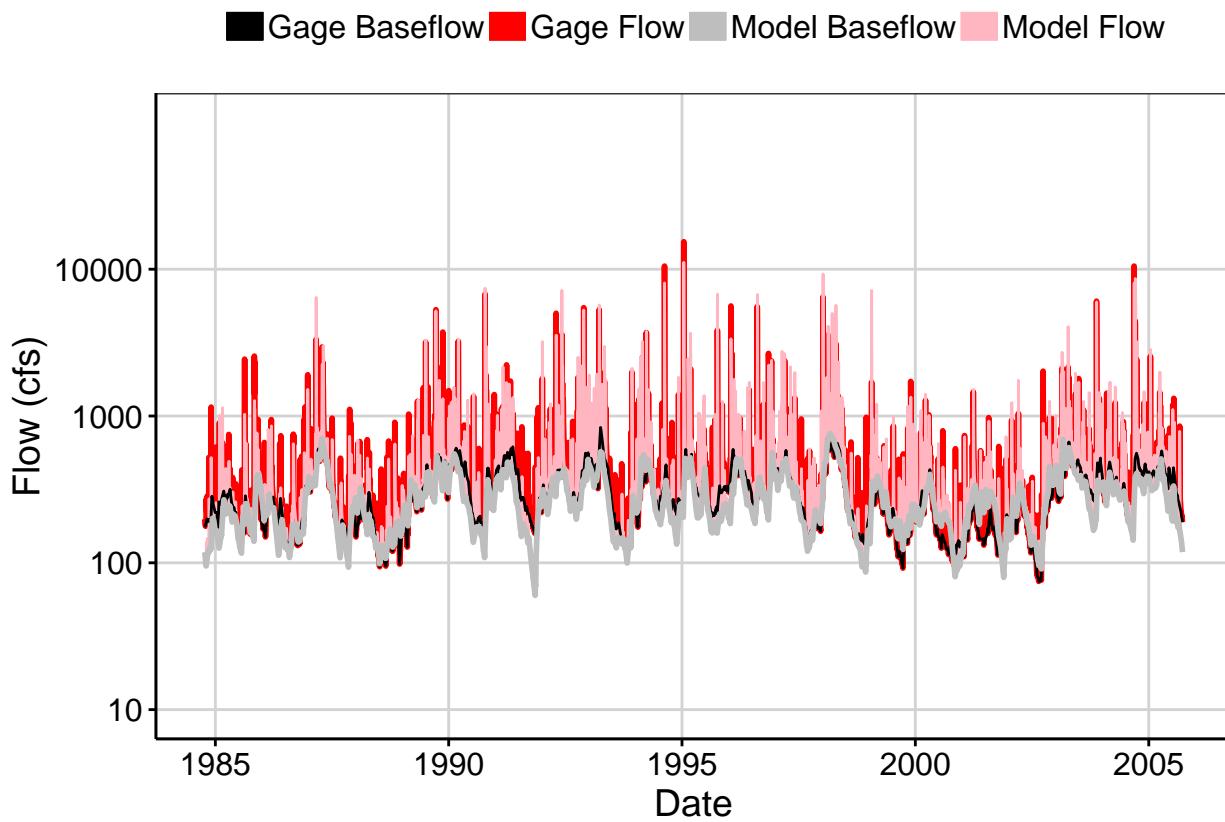


Fig. 6: Largest Error Segment

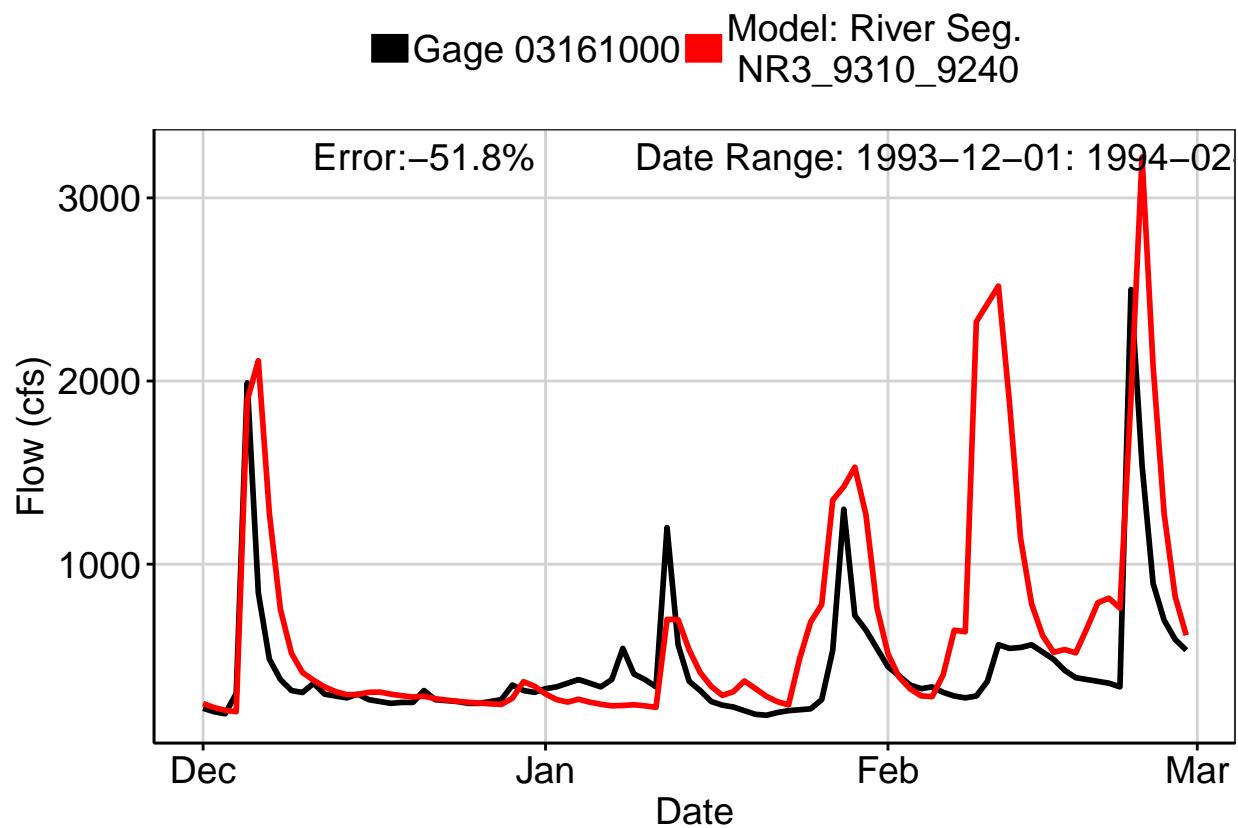


Fig. 7: Second Largest Error Segment

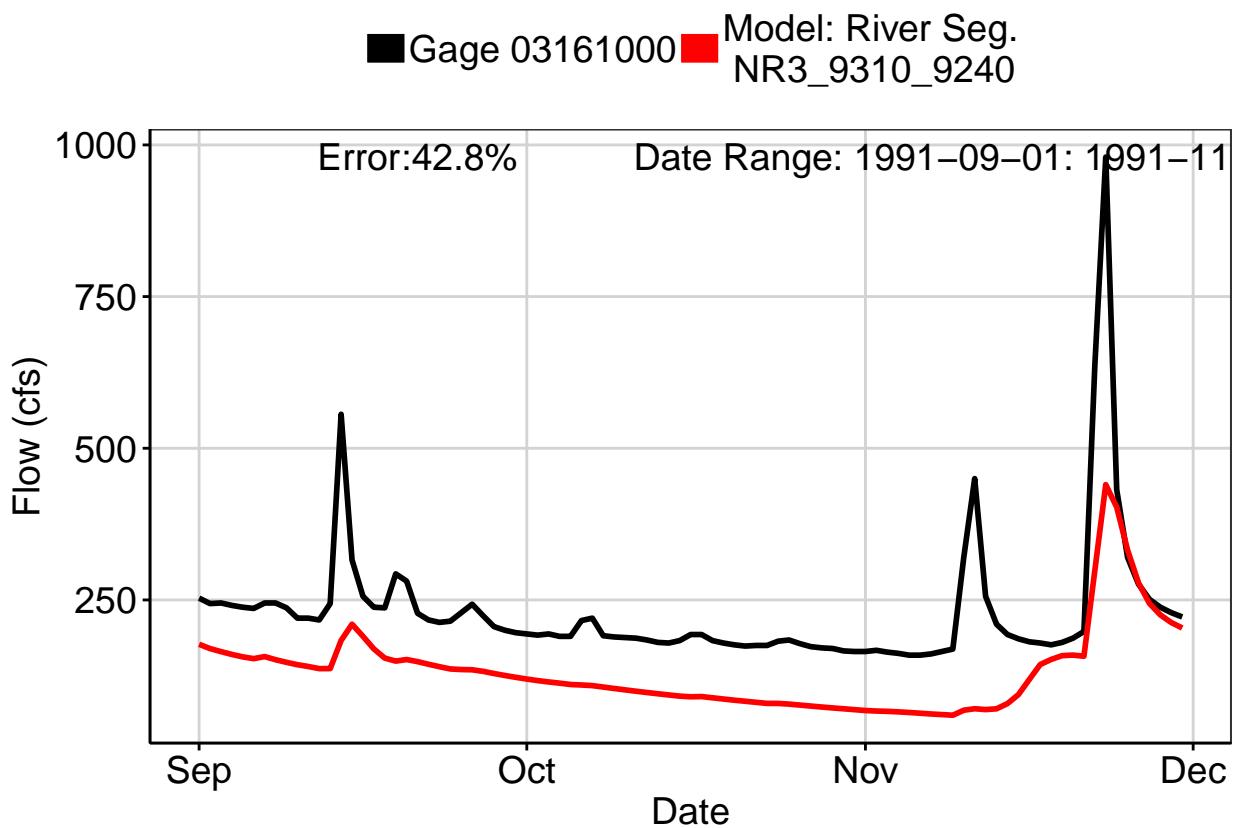


Fig. 8: Third Largest Error Segment

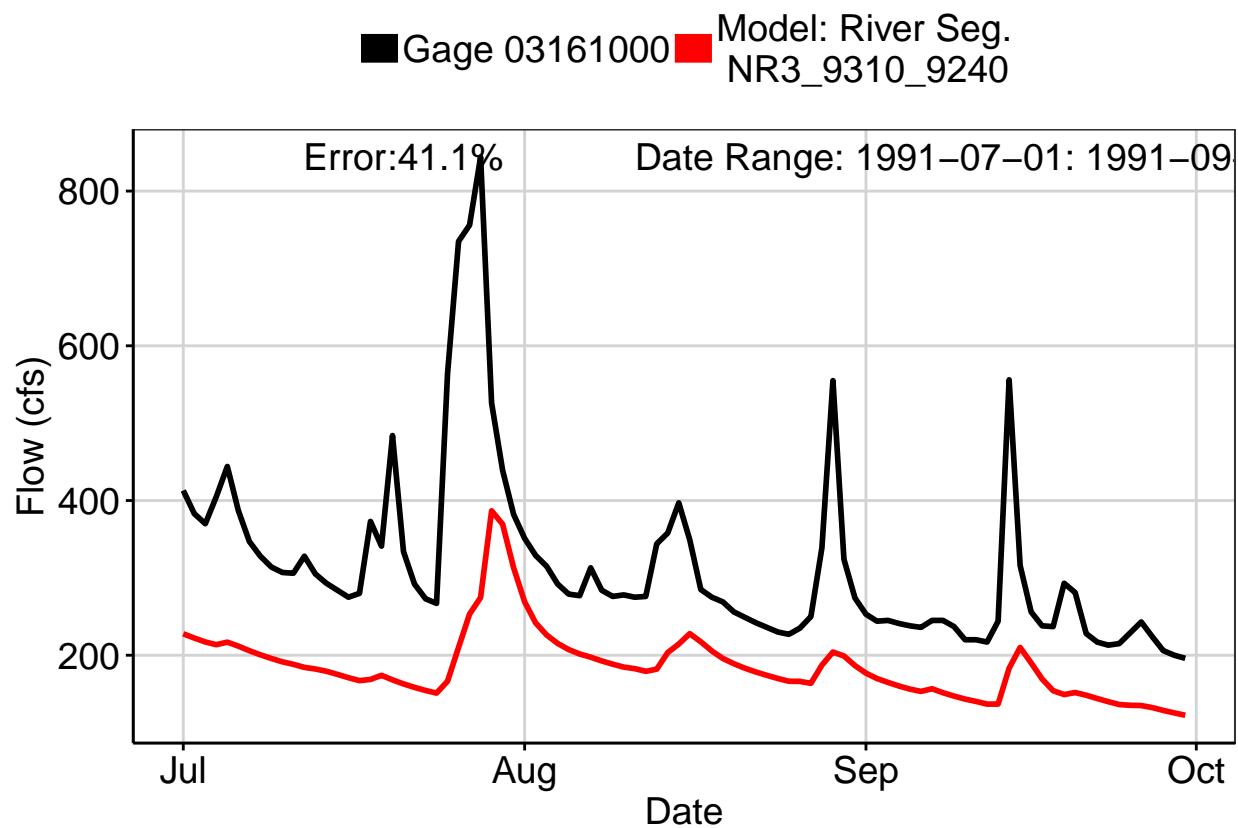
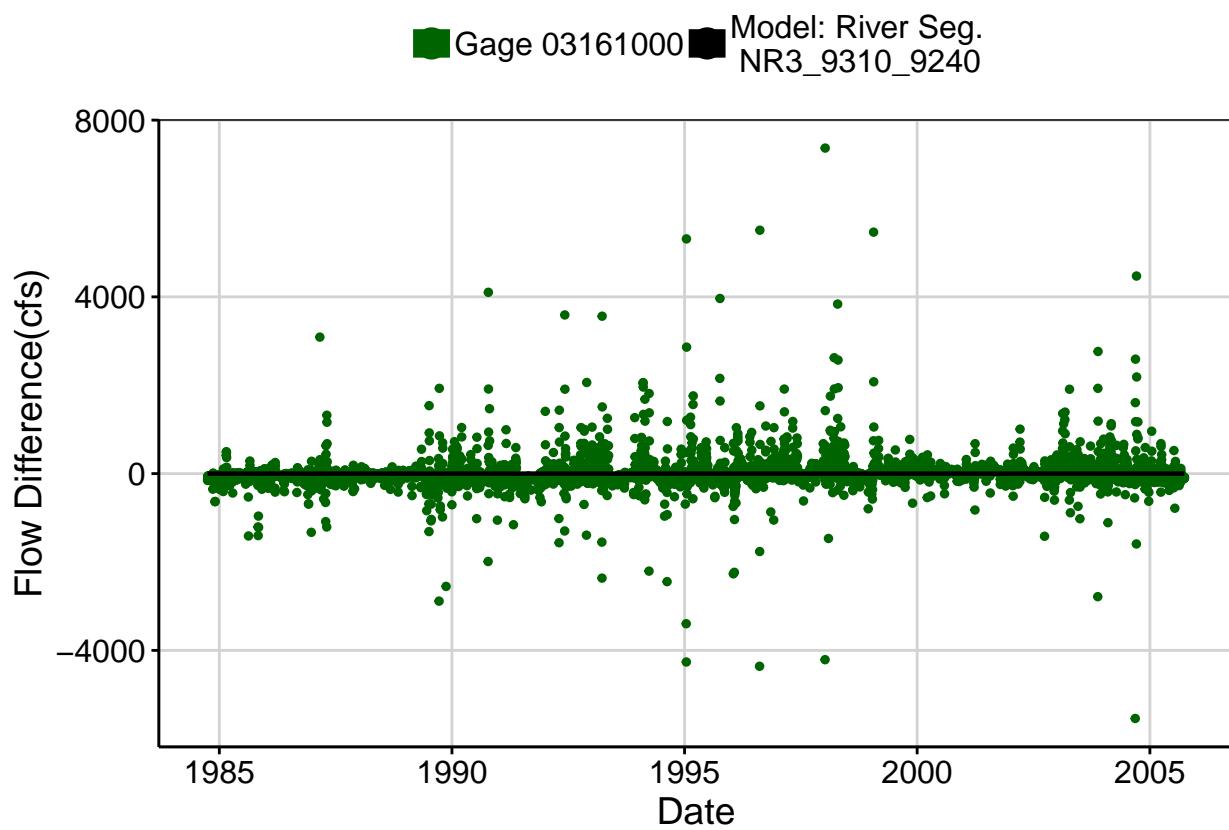
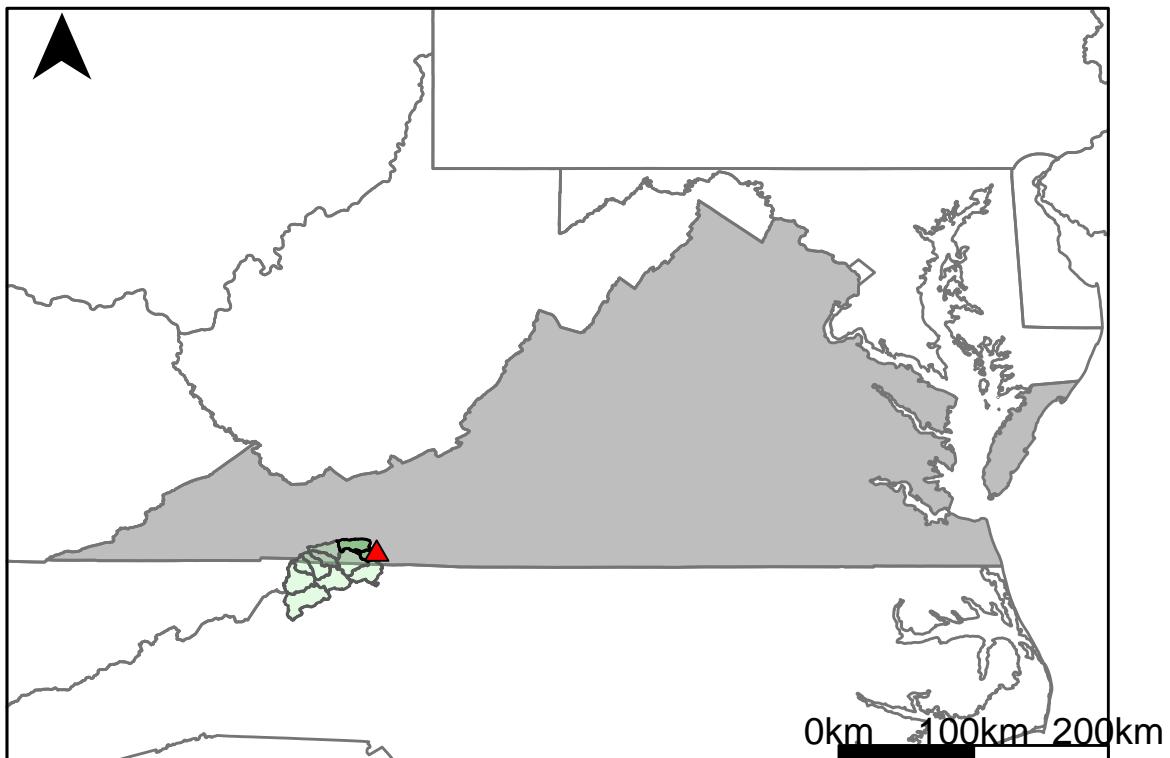


Fig. 9: Residuals Plot



## Appendix F.2: USGS Gage 03164000 vs. NR5\_9050\_8870+NR1\_8960\_8870



This river segment follows part of the flow of the New River. The gage is located in Grayson County, VA (Lat 36°38'50", Long 80°58'45") approximately 3 miles east of Galax, VA. Drainage area is 1141 sq. miles. This gage started taking data in 1929 and is still taking data. There is a privately owned low concrete dam with a small generator for electricity 36.4 miles upstream of the station near the Mouth of Wilson, VA. Almost all of the water flows over the dam because it has very little storage capacity but it can cause problems for extremely low flows. The average daily discharge error between the model and gage data for the 20 year timespan was 5.32%, with 28.7% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	610	510	16.4
Feb. Low Flow	754	611	19
Mar. Low Flow	943	976	-3.5
Apr. Low Flow	781	965	-23.6
May Low Flow	1300	1290	0.77
Jun. Low Flow	1540	1590	-3.25
Jul. Low Flow	1540	1310	14.9
Aug. Low Flow	1400	1070	23.6
Sep. Low Flow	1110	943	15
Oct. Low Flow	857	727	15.2
Nov. Low Flow	685	640	6.57
Dec. Low Flow	587	568	3.24

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	1880	1780	5.32
Jan. Mean Flow	2210	2150	2.71
Feb. Mean Flow	2490	2570	-3.21
Mar. Mean Flow	2810	2940	-4.63
Apr. Mean Flow	2620	2440	6.87
May Mean Flow	2100	1800	14.3
Jun. Mean Flow	1860	1610	13.4
Jul. Mean Flow	1390	1160	16.5
Aug. Mean Flow	1250	1230	1.6
Sep. Mean Flow	1340	1290	3.73
Oct. Mean Flow	1200	1230	-2.5
Nov. Mean Flow	1640	1500	8.54
Dec. Mean Flow	1710	1510	11.7

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	1440	1180	18.1
Feb. High Flow	4140	2450	40.8
Mar. High Flow	3850	2570	33.2
Apr. High Flow	4740	5250	-10.8
May High Flow	6070	4790	21.1
Jun. High Flow	8060	7220	10.4
Jul. High Flow	5500	4840	12
Aug. High Flow	3890	3970	-2.06
Sep. High Flow	2430	2160	11.1
Oct. High Flow	2320	1700	26.7
Nov. High Flow	2200	1300	40.9
Dec. High Flow	1930	1410	26.9

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	283	190	32.9
Med. 1 Day Min	486	417	14.2
Min. 3 Day Min	298	194	34.9
Med. 3 Day Min	505	426	15.6
Min. 7 Day Min	317	201	36.6
Med. 7 Day Min	524	446	14.9
Min. 30 Day Min	398	248	37.7
Med. 30 Day Min	654	569	13
Min. 90 Day Min	524	481	8.21
Med. 90 Day Min	1000	778	22.2
7Q10	362	271	25.1
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	1030	1780	-72.8
Mean Baseflow	1210	1190	1.65

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	57800	44700	22.7
Med. 1 Day Max	18300	17300	5.46
Max. 3 Day Max	31000	30800	0.64
Med. 3 Day Max	11900	14500	-21.8
Max. 7 Day Max	17100	17000	0.58
Med. 7 Day Max	7810	9350	-19.7
Max. 30 Day Max	6560	6460	1.52
Med. 30 Day Max	4050	4250	-4.94
Max. 90 Day Max	4750	5500	-15.8
Med. 90 Day Max	3150	3020	4.13

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	397	336	15.4
5% Non-Exceedance	532	468	12
50% Non-Exceedance	1390	1250	10.1
95% Non-Exceedance	4540	4540	0
99% Non-Exceedance	9300	9980	-7.31
Sept. 10% Non-Exceedance	558	518	7.17

**Fig. 1: Hydrograph**

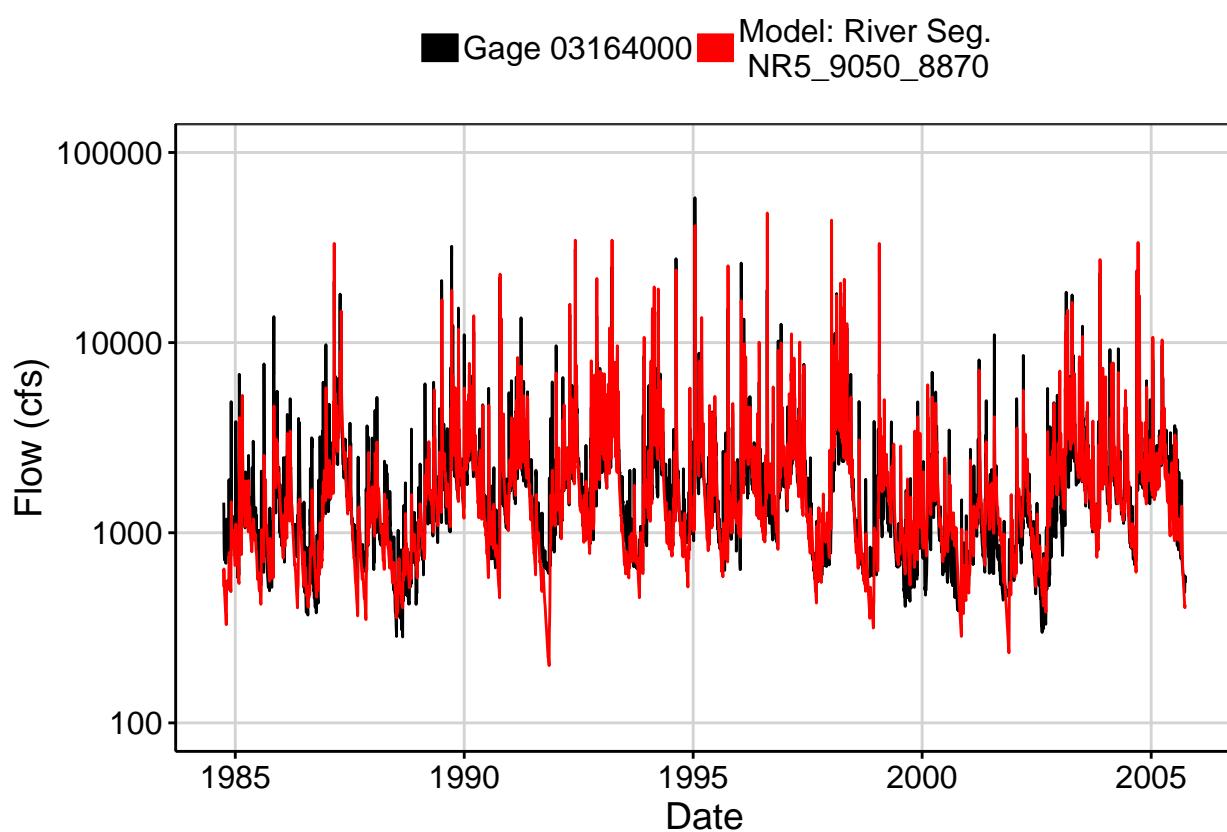


Fig. 2: Zoomed Hydrograph

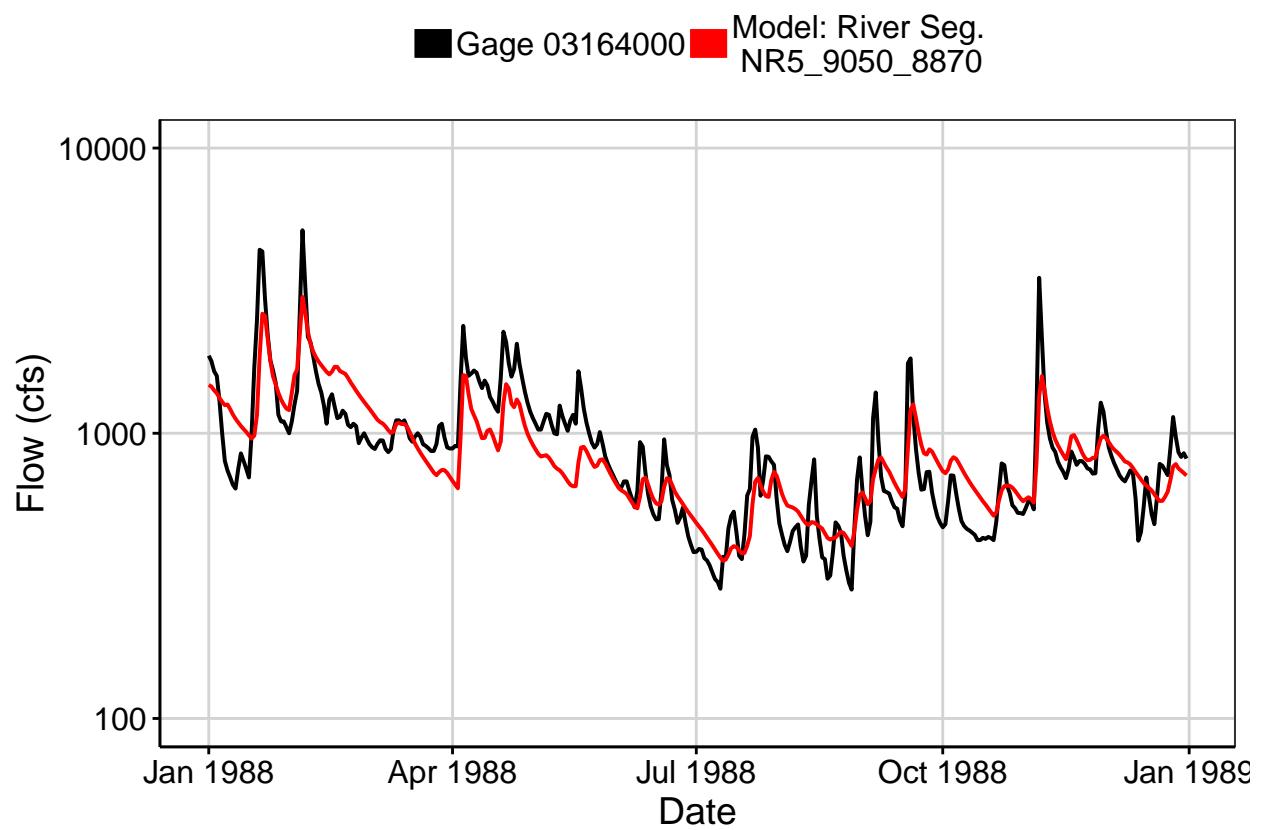


Fig. 3: Flow Exceedance

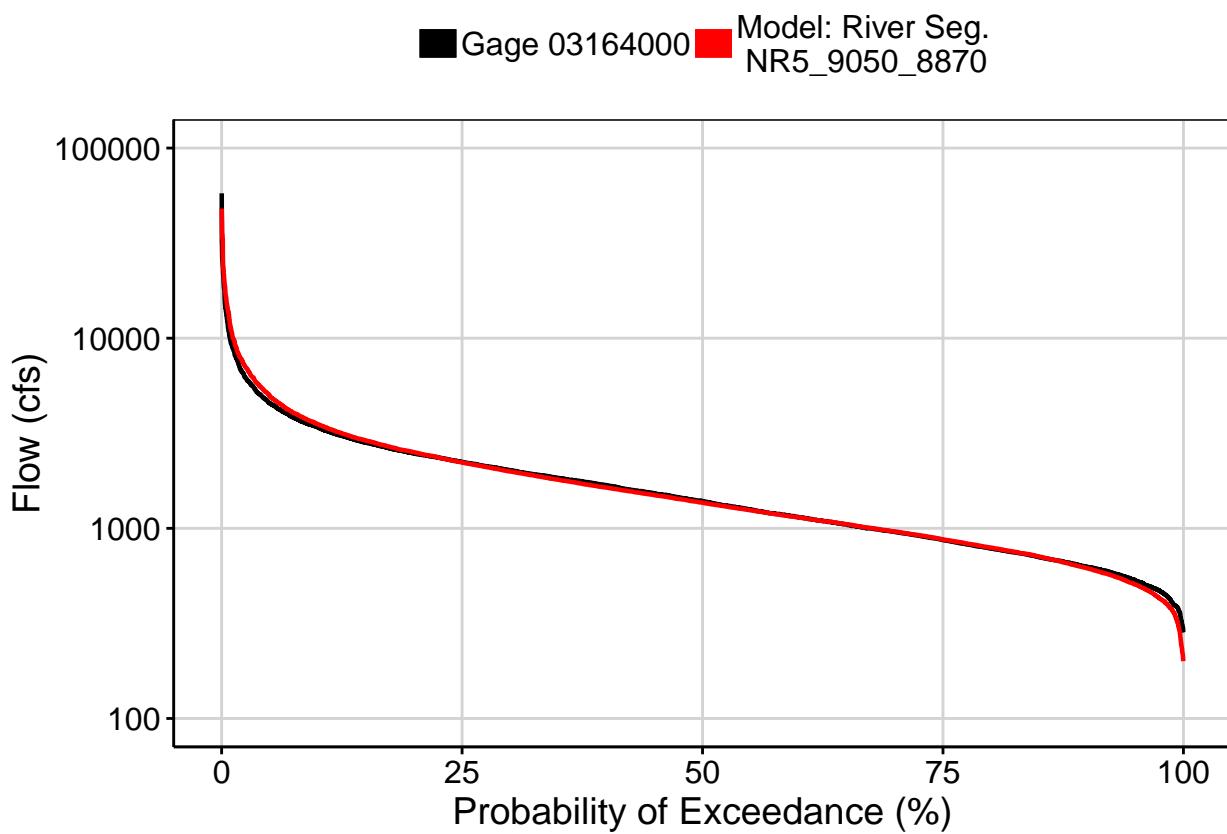


Fig. 4: Baseflow

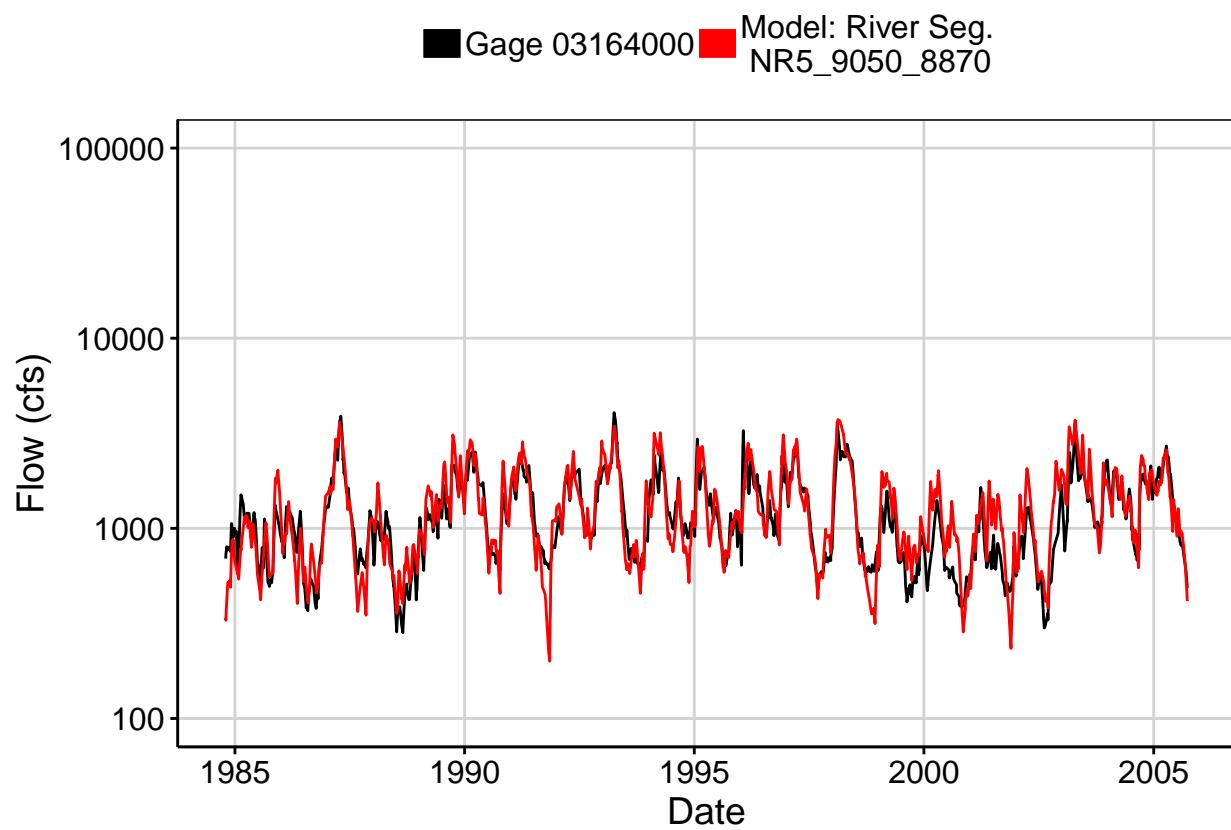


Fig. 5: Combined Baseflow

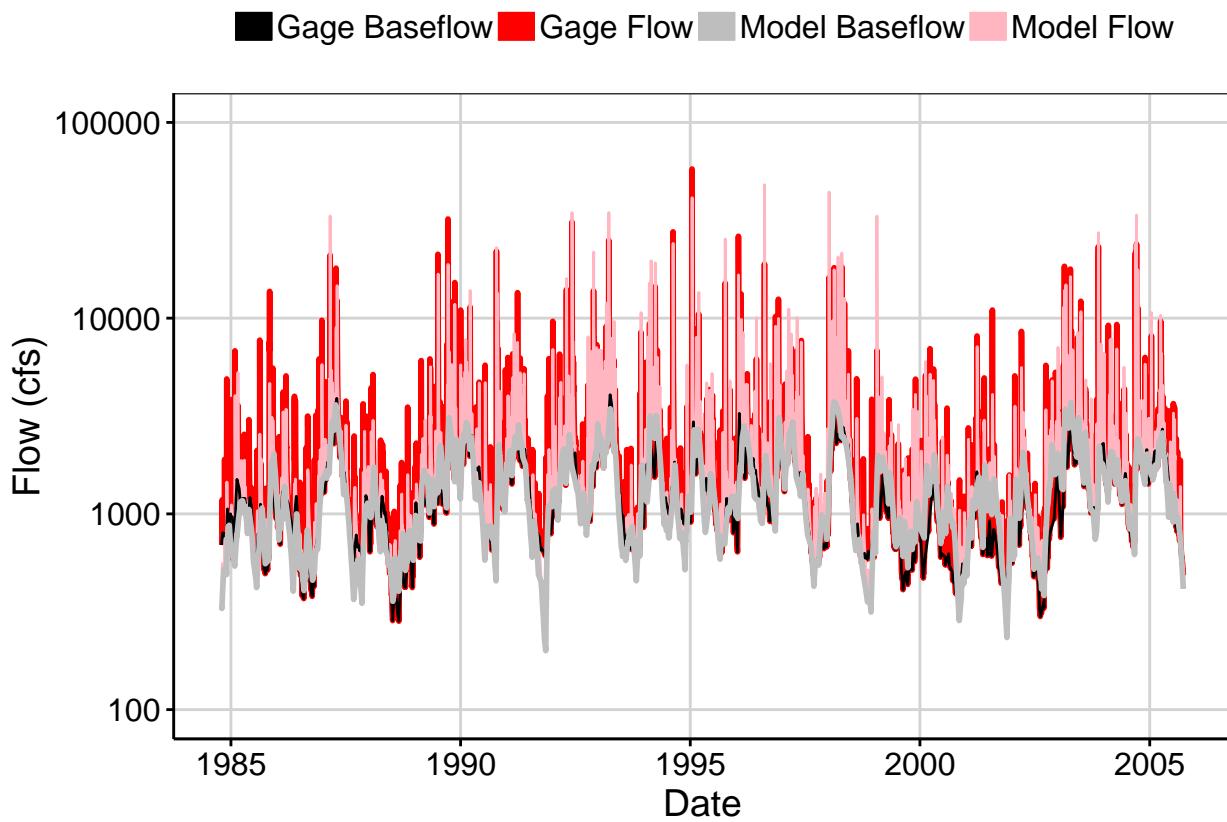


Fig. 6: Largest Error Segment

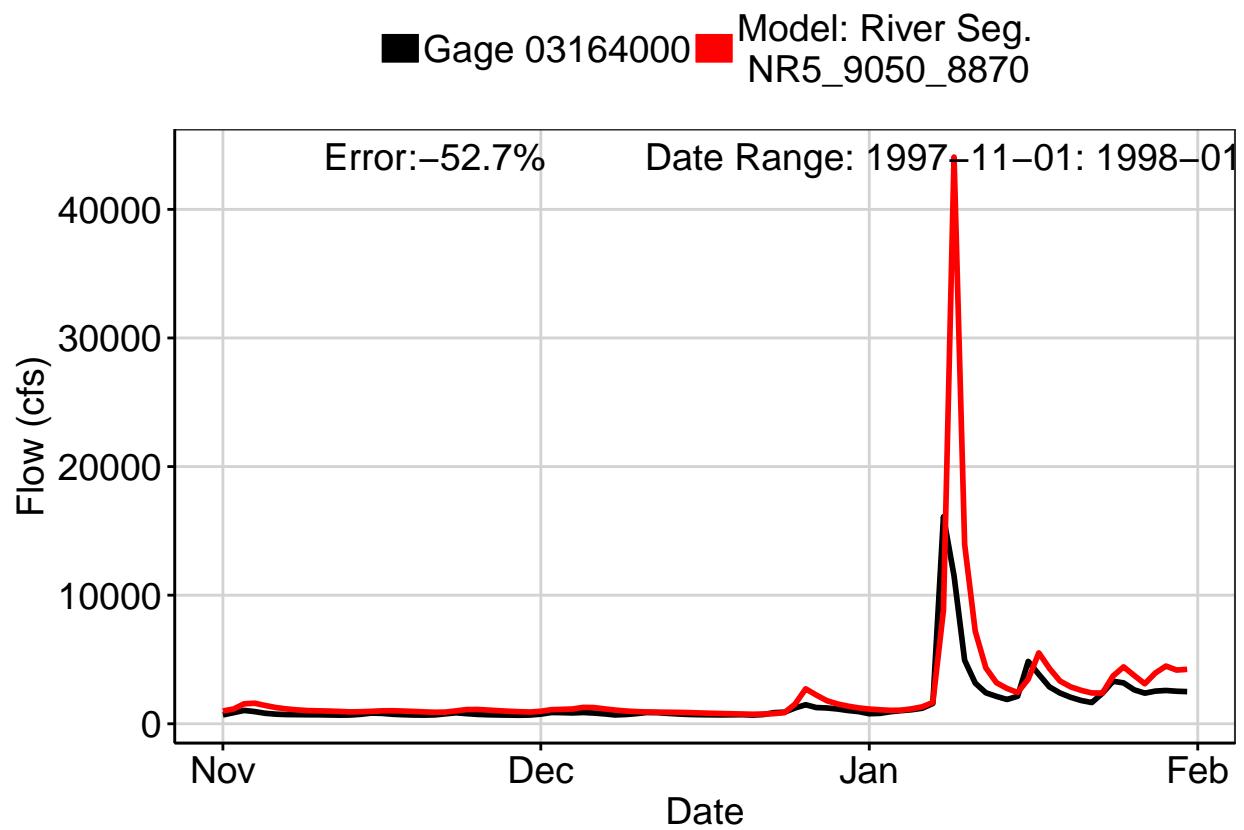


Fig. 7: Second Largest Error Segment

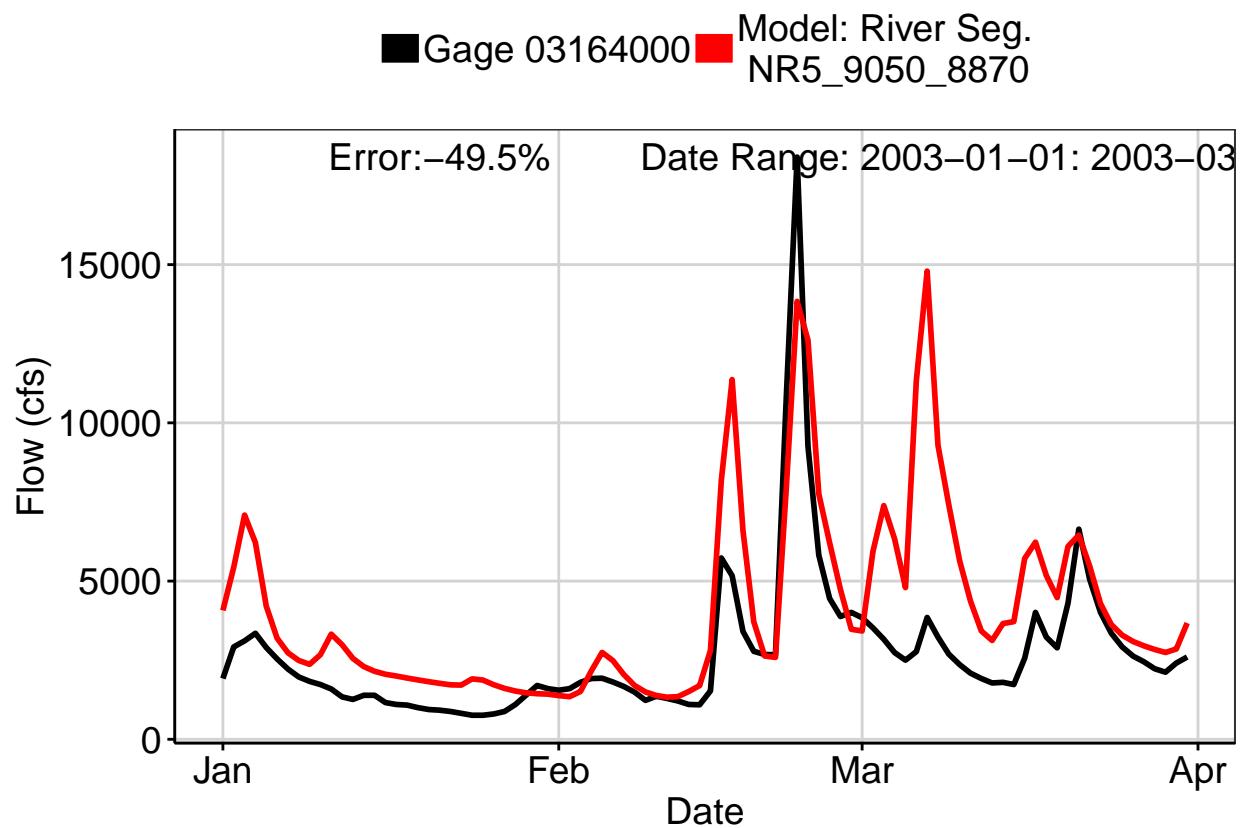


Fig. 8: Third Largest Error Segment

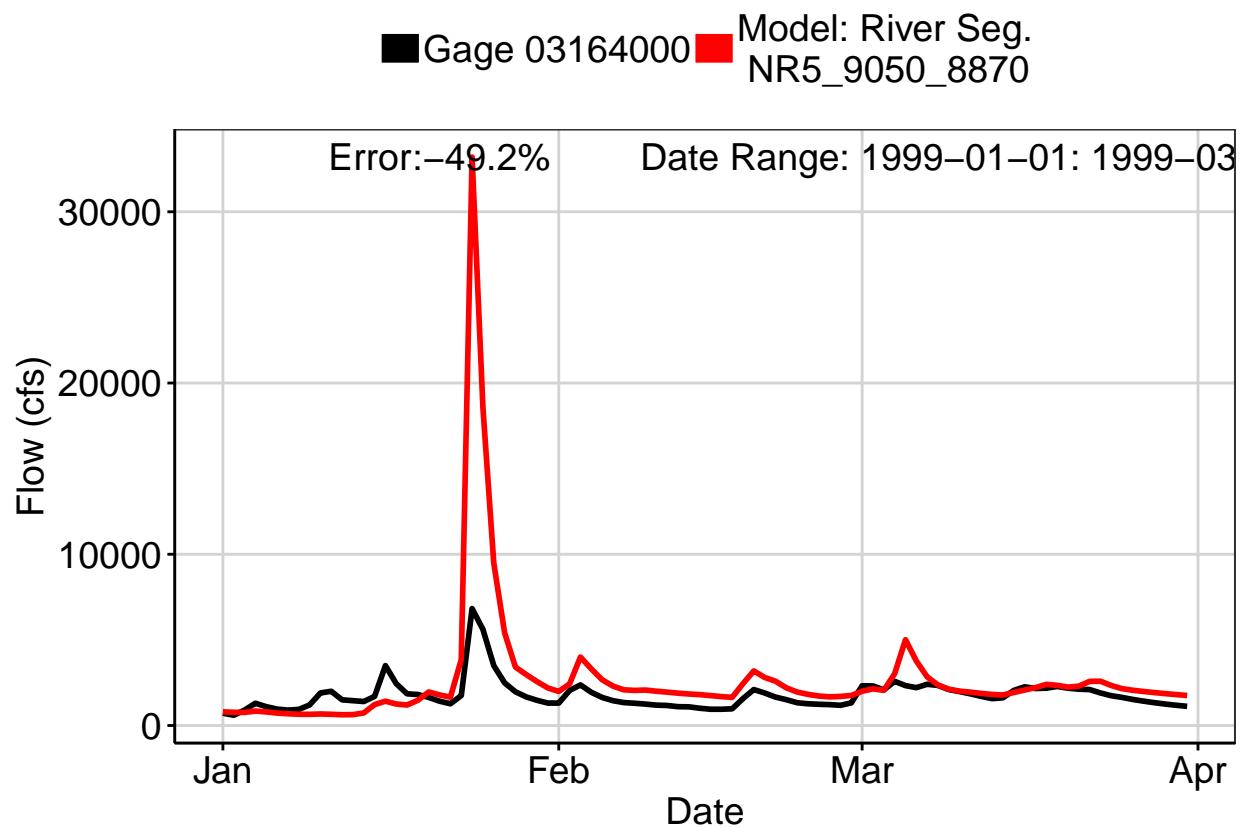
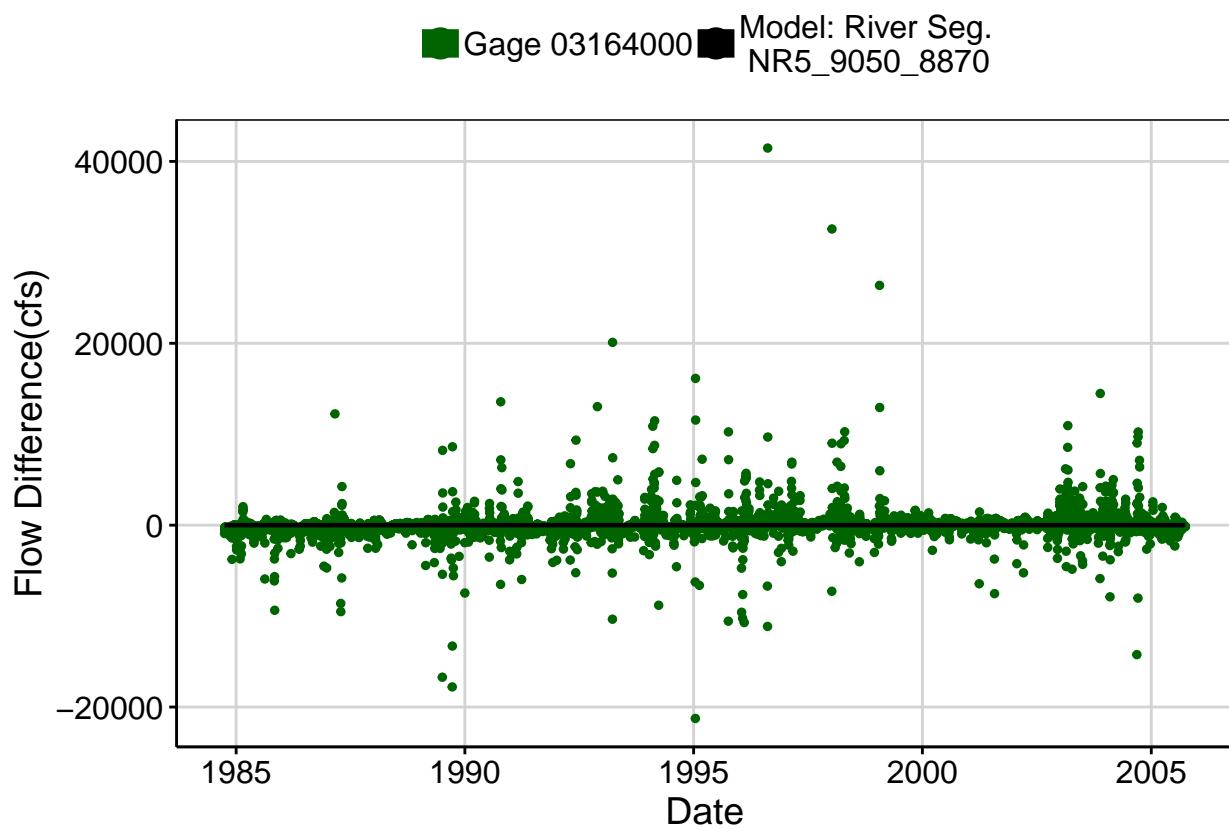
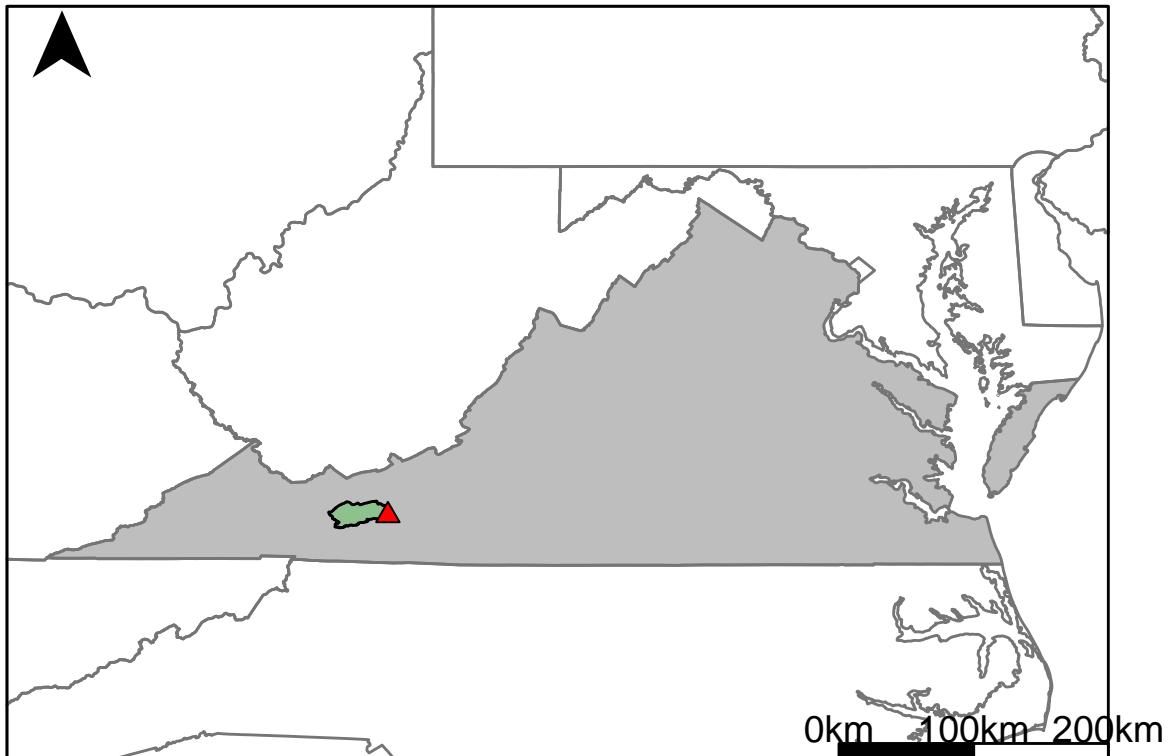


Fig. 9: Residuals Plot



## Appendix F.3: USGS Gage 03167000 vs. NR2\_8600\_8700



This river segment follows part of the flow of the Reed Creek, a tributary of the New River. The gage is located in Wythe County, VA (Lat 36°56'20", Long 80°53'15") approximately 19 miles north of Galax, VA. Drainage area is 258 sq. miles. This gage started taking data in 1908 and is still taking data, but there is a gap from 1916-09-30 to 1991-09-29. For this reason, analysis was carried out from 1991-10-01 to 2005-09-30. There are no known anthropogenic alterations to the area that would affect flow. The average daily discharge error between the model and gage data for the 20 year timespan was 3.68%, with 34% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	72.6	42.7	41.2
Feb. Low Flow	81.5	43	47.2
Mar. Low Flow	89.5	65	27.4
Apr. Low Flow	102	133	-30.4
May Low Flow	190	235	-23.7
Jun. Low Flow	234	270	-15.4
Jul. Low Flow	226	201	11.1
Aug. Low Flow	152	185	-21.7
Sep. Low Flow	128	147	-14.8
Oct. Low Flow	99.8	97.6	2.2
Nov. Low Flow	85.1	64.3	24.4
Dec. Low Flow	76	40	47.4

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	272	262	3.68
Jan. Mean Flow	324	296	8.64
Feb. Mean Flow	463	439	5.18
Mar. Mean Flow	509	483	5.11
Apr. Mean Flow	405	423	-4.44
May Mean Flow	334	319	4.49
Jun. Mean Flow	268	252	5.97
Jul. Mean Flow	192	176	8.33
Aug. Mean Flow	152	140	7.89
Sep. Mean Flow	124	150	-21
Oct. Mean Flow	104	134	-28.8
Nov. Mean Flow	171	150	12.3
Dec. Mean Flow	236	193	18.2

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	134	109	18.7
Feb. High Flow	235	145	38.3
Mar. High Flow	730	301	58.8
Apr. High Flow	1140	962	15.6
May High Flow	1600	801	49.9
Jun. High Flow	1560	1010	35.3
Jul. High Flow	980	910	7.14
Aug. High Flow	795	616	22.5
Sep. High Flow	469	429	8.53
Oct. High Flow	222	228	-2.7
Nov. High Flow	160	166	-3.75
Dec. High Flow	166	136	18.1

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	40.8	15.1	63
Med. 1 Day Min	68	30.2	55.6
Min. 3 Day Min	44.1	15.3	65.3
Med. 3 Day Min	69	31	55.1
Min. 7 Day Min	46.8	16	65.8
Med. 7 Day Min	69.4	32.5	53.2
Min. 30 Day Min	56.9	18.6	67.3
Med. 30 Day Min	76.2	42.6	44.1
Min. 90 Day Min	66.5	28.5	57.1
Med. 90 Day Min	100	73	27
7Q10	51.6	18.5	64.1
Year of 90-Day Min. Flow	1999	1999	0
Drought Year Mean	143	262	-83.2
Mean Baseflow	160	171	-6.88

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	7620	8310	-9.06
Med. 1 Day Max	2850	3550	-24.6
Max. 3 Day Max	3880	4690	-20.9
Med. 3 Day Max	2130	2240	-5.16
Max. 7 Day Max	2190	2670	-21.9
Med. 7 Day Max	1420	1340	5.63
Max. 30 Day Max	1120	1420	-26.8
Med. 30 Day Max	706	623	11.8
Max. 90 Day Max	767	940	-22.6
Med. 90 Day Max	513	494	3.7

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	54	21.5	60.2
5% Non-Exceedance	66.9	31.1	53.5
50% Non-Exceedance	165	161	2.42
95% Non-Exceedance	797	724	9.16
99% Non-Exceedance	1680	1840	-9.52
Sept. 10% Non-Exceedance	36.6	35	4.37

**Fig. 1: Hydrograph**

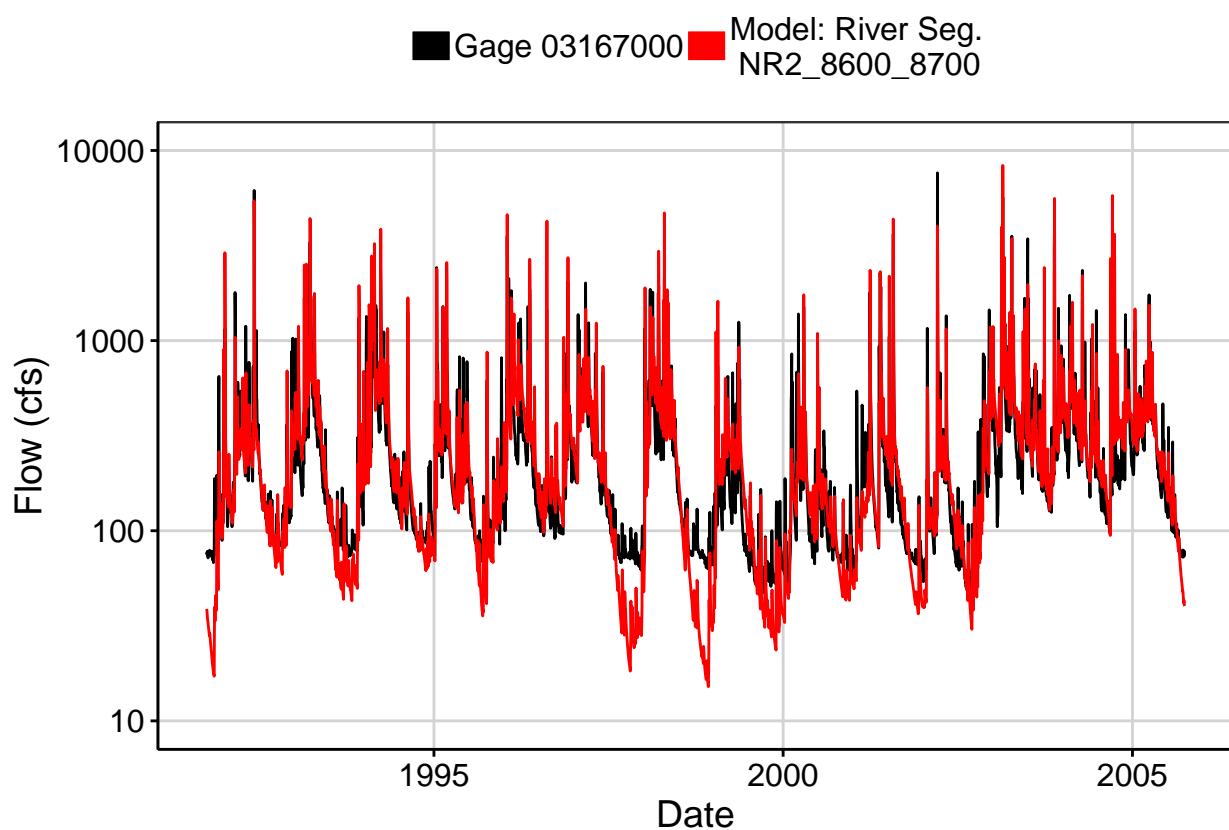


Fig. 2: Zoomed Hydrograph

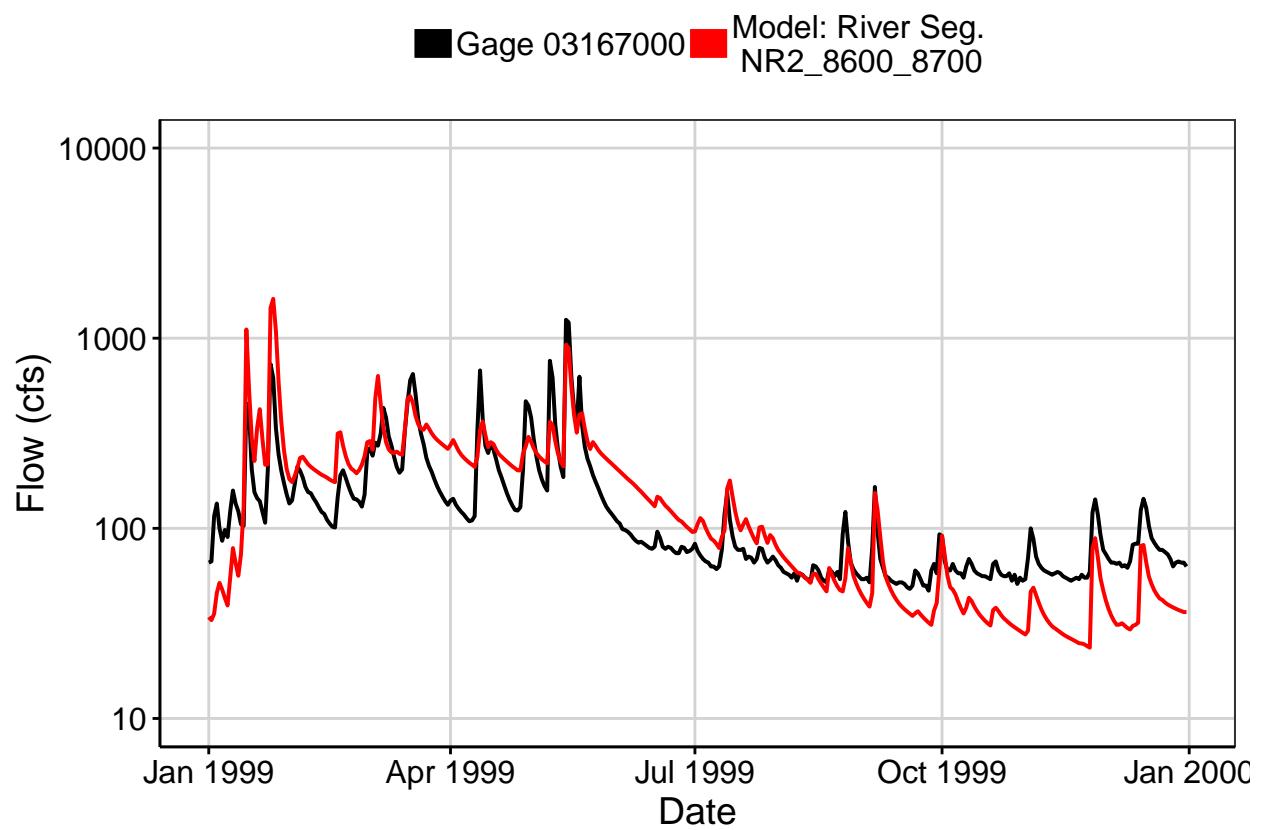


Fig. 3: Flow Exceedance

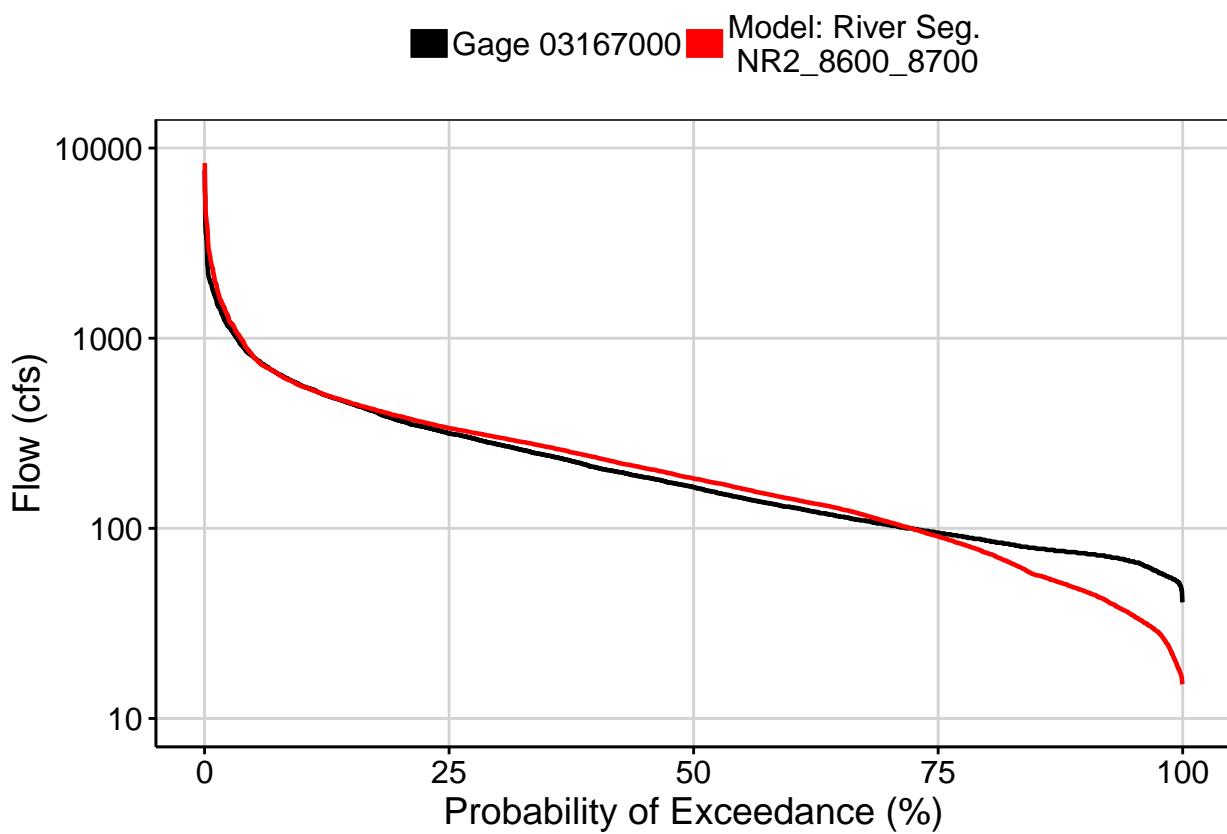


Fig. 4: Baseflow

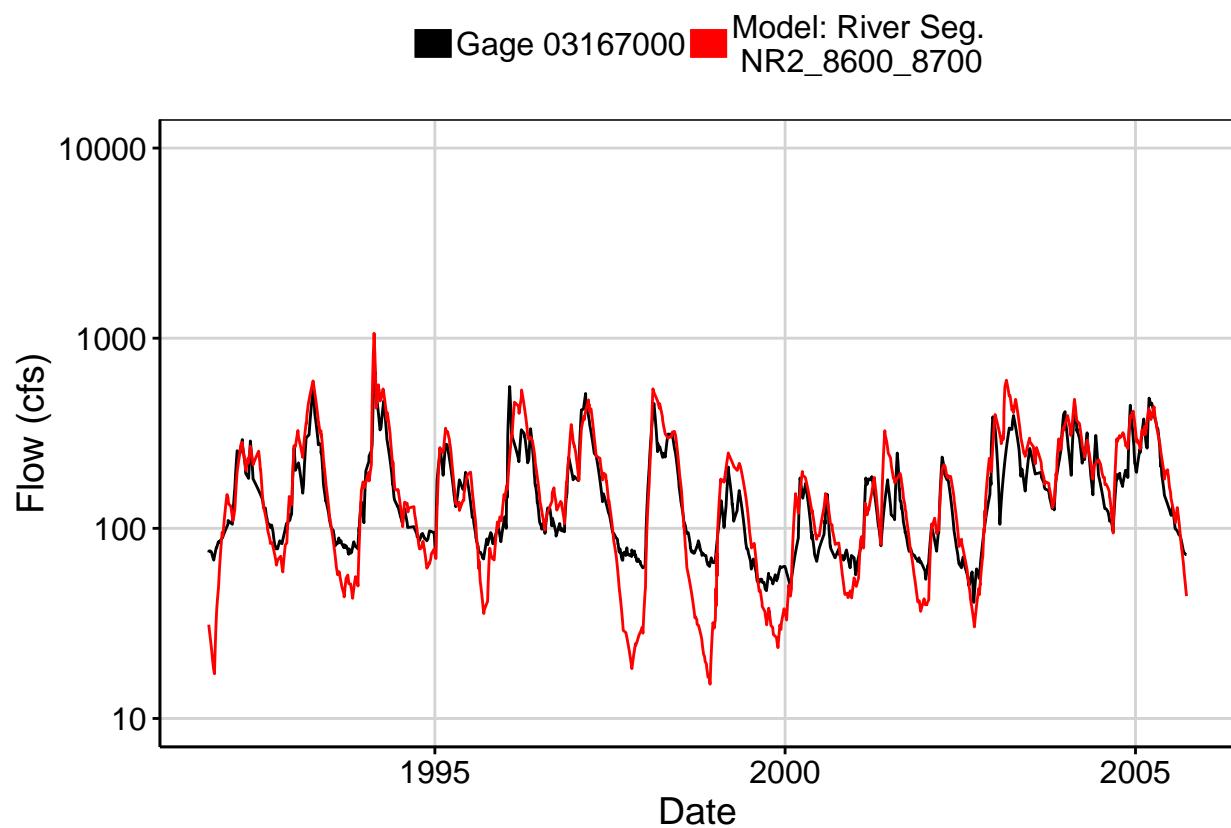


Fig. 5: Combined Baseflow

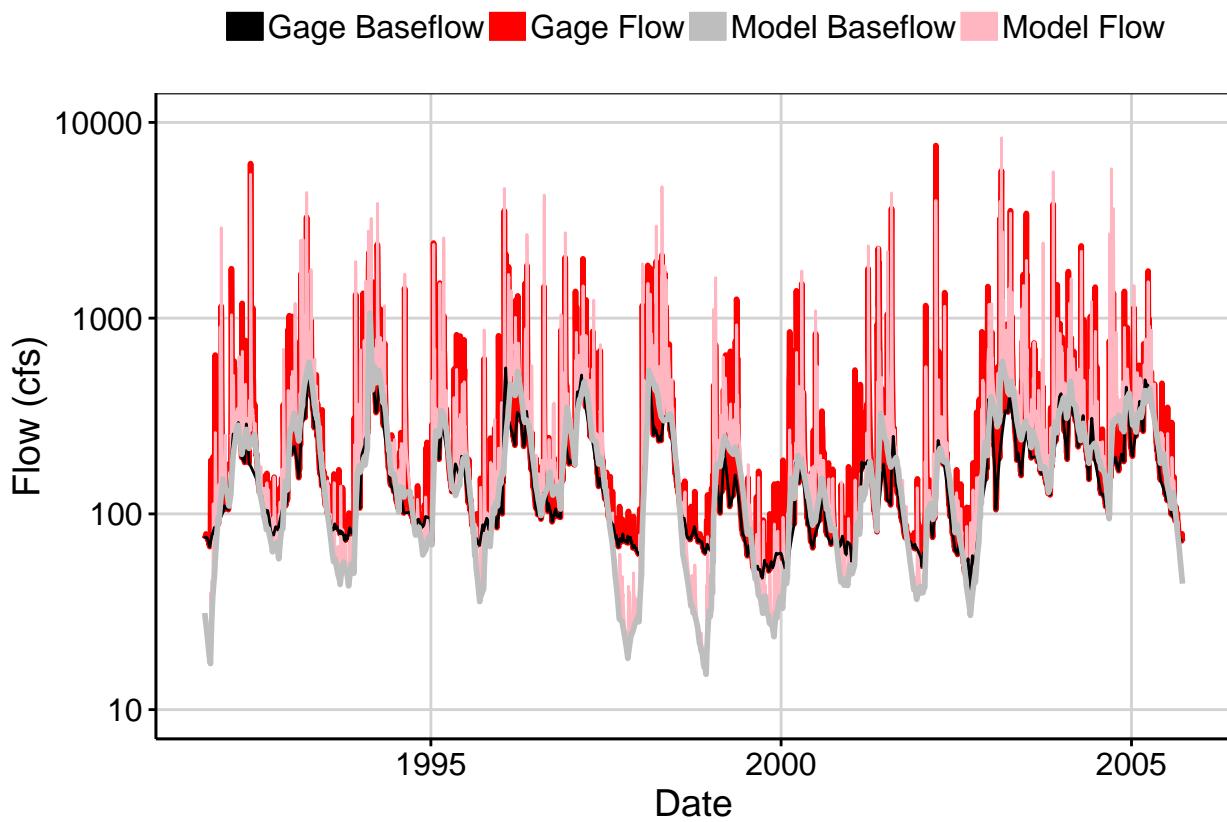


Fig. 6: Largest Error Segment

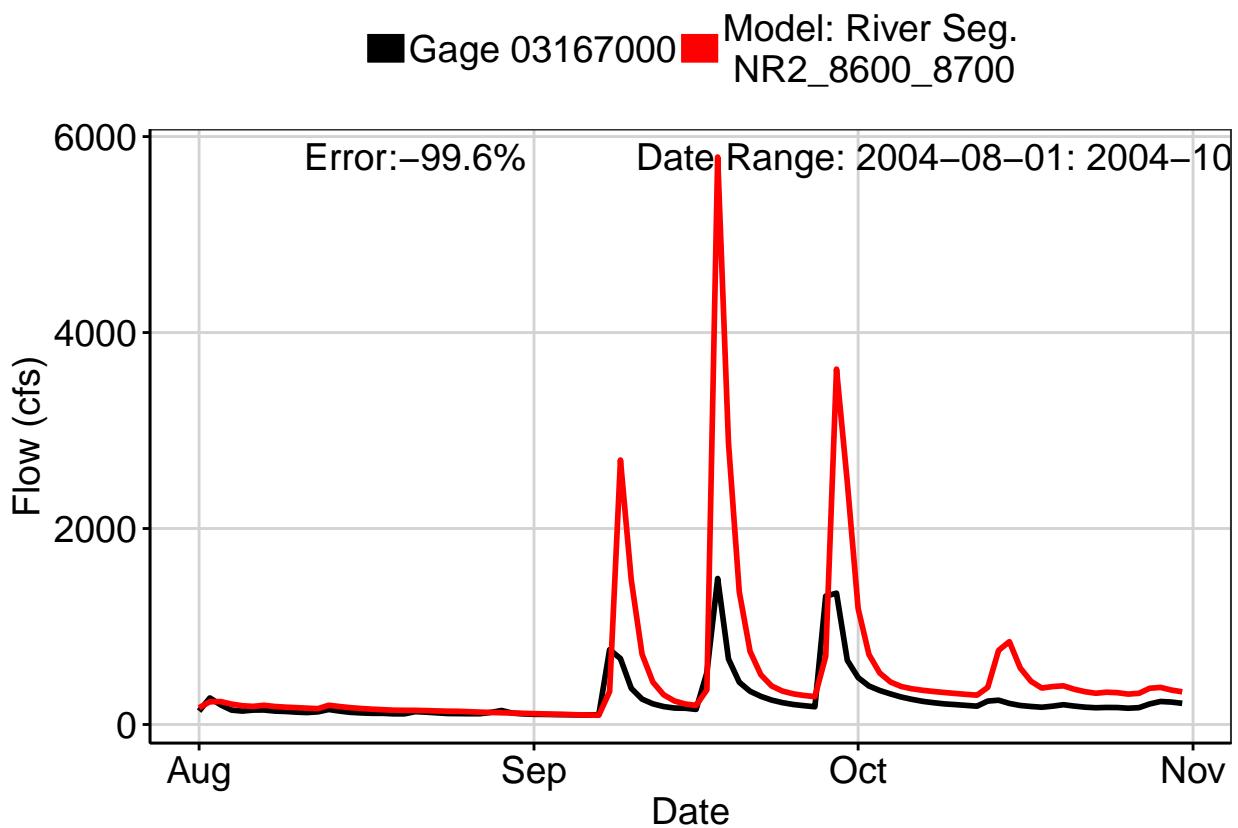


Fig. 7: Second Largest Error Segment

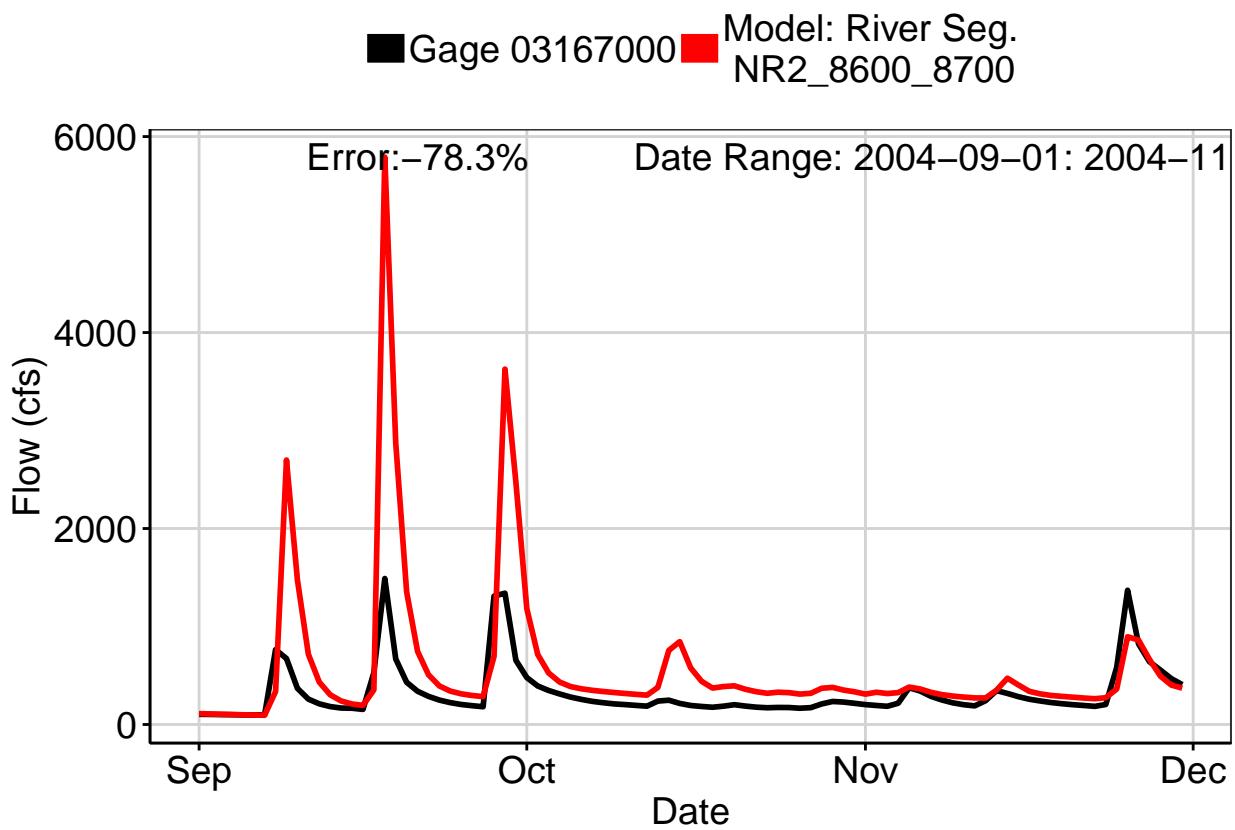


Fig. 8: Third Largest Error Segment

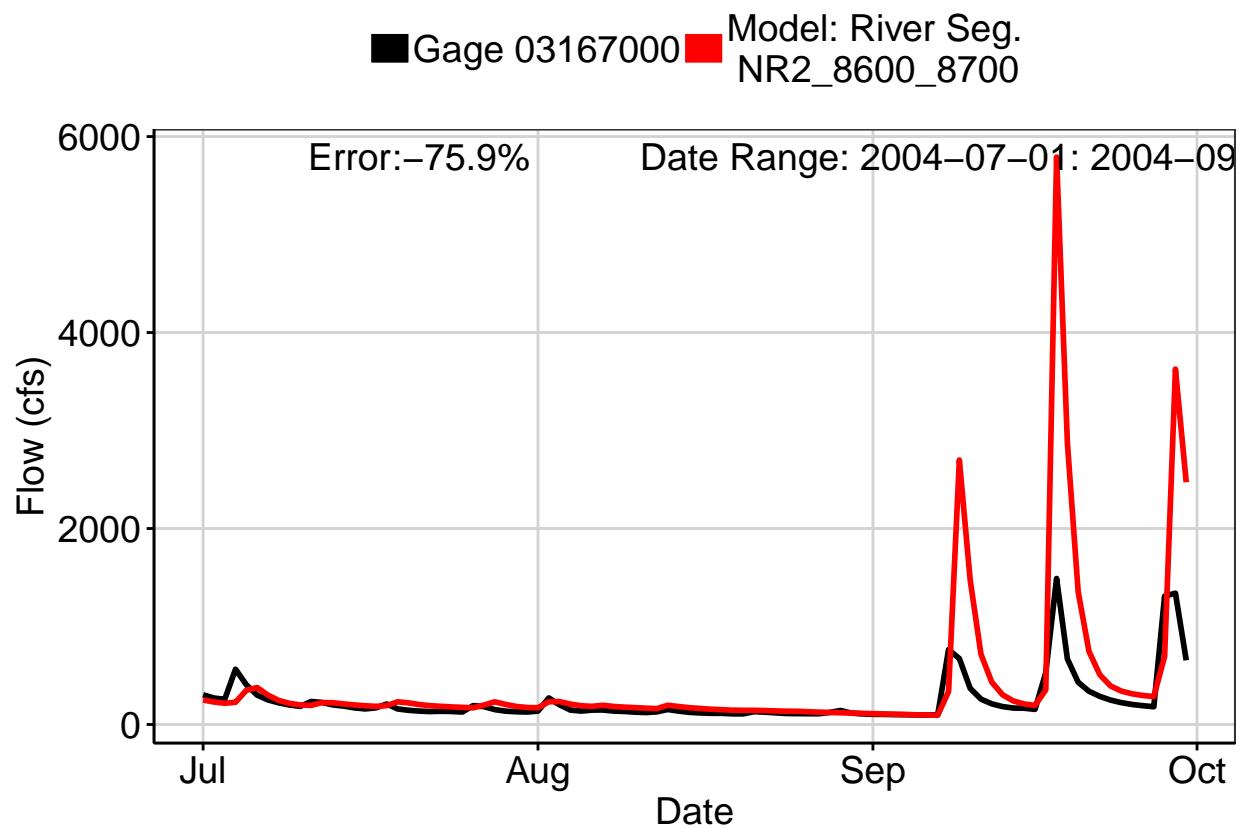
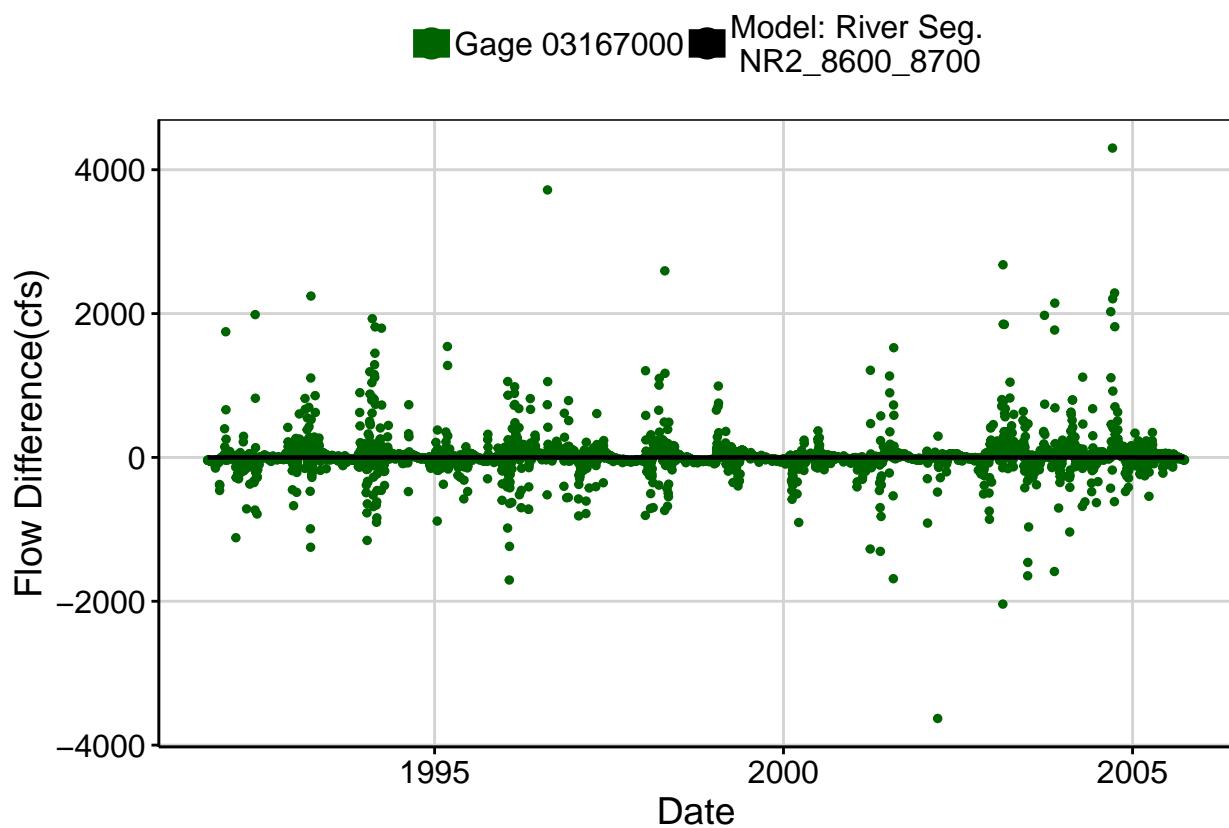
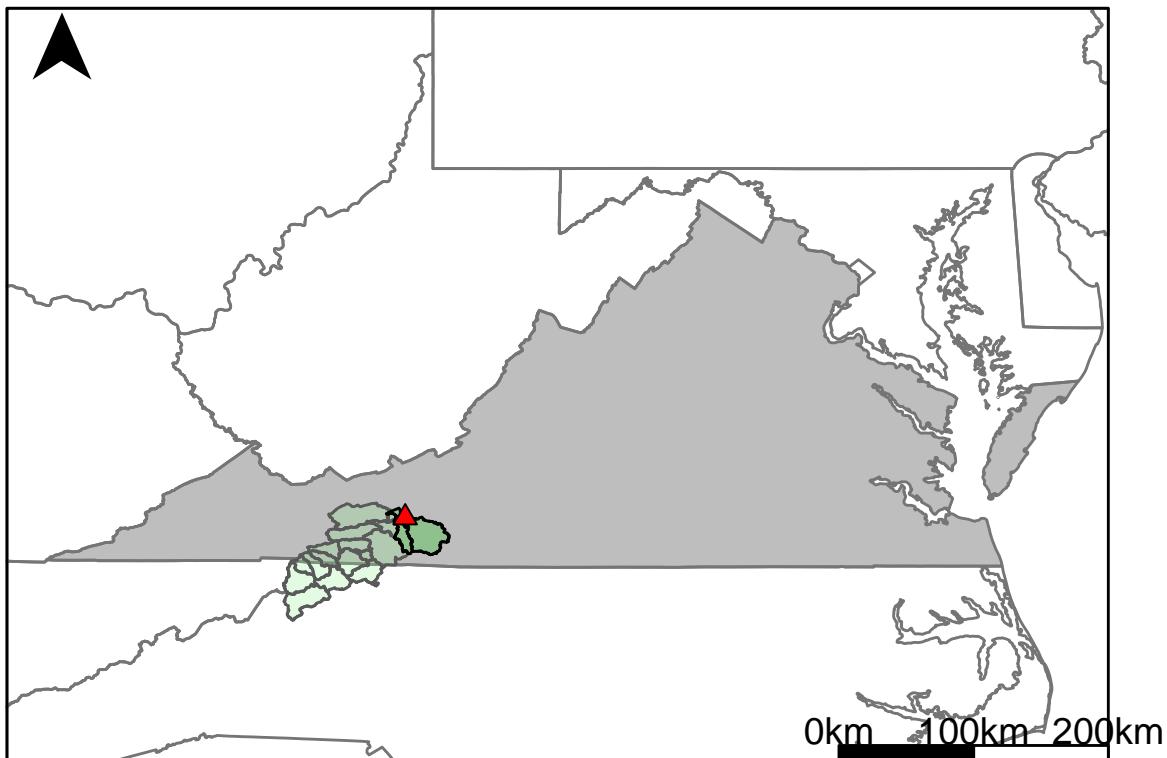


Fig. 9: Residuals Plot



## Appendix F.4: USGS Gage 03168000 vs. NR6\_8640\_8500+NR3\_8740\_8500+NR3\_8690\_8500



This river segment follows part of the flow of the New River. The gage is located in Pulaski County, VA (Lat 36°56'15", Long 80°44'45") approximately 21 miles north of Galax, VA. Drainage area is 2212 sq. miles. This gage started taking data in 1929 and is still taking data. Flow in this area is regulated by the American Electric Power Company's power plants at Buck and Byllesby approximately 25 miles upstream. This station is also 21 miles upstream of Claytor Dam, which is also owned and operated by the American Electric Power Company. The average daily discharge error between the model and gage data for the 20 year timespan was 11.5%, with 27.1% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	900	674	25.1
Feb. Low Flow	1040	843	18.9
Mar. Low Flow	1450	1480	-2.07
Apr. Low Flow	1200	1450	-20.8
May Low Flow	2220	2200	0.9
Jun. Low Flow	2590	2630	-1.54
Jul. Low Flow	2520	2070	17.9
Aug. Low Flow	2180	1750	19.7
Sep. Low Flow	1730	1510	12.7
Oct. Low Flow	1360	1050	22.8
Nov. Low Flow	1110	913	17.7
Dec. Low Flow	879	858	2.39

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	3140	2780	11.5
Jan. Mean Flow	3690	3310	10.3
Feb. Mean Flow	4270	4140	3.04
Mar. Mean Flow	4870	4690	3.7
Apr. Mean Flow	4470	3950	11.6
May Mean Flow	3580	2900	19
Jun. Mean Flow	2980	2530	15.1
Jul. Mean Flow	2230	1800	19.3
Aug. Mean Flow	2050	1830	10.7
Sep. Mean Flow	2180	1930	11.5
Oct. Mean Flow	1990	1810	9.05
Nov. Mean Flow	2680	2190	18.3
Dec. Mean Flow	2790	2330	16.5

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	2860	1520	46.9
Feb. High Flow	5960	3690	38.1
Mar. High Flow	5300	3430	35.3
Apr. High Flow	8300	8300	0
May High Flow	8630	6600	23.5
Jun. High Flow	12700	10700	15.7
Jul. High Flow	9720	8120	16.5
Aug. High Flow	7250	6820	5.93
Sep. High Flow	4550	3140	31
Oct. High Flow	3320	2710	18.4
Nov. High Flow	3200	1910	40.3
Dec. High Flow	3350	2050	38.8

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	446	252	43.5
Med. 1 Day Min	823	636	22.7
Min. 3 Day Min	457	256	44
Med. 3 Day Min	874	643	26.4
Min. 7 Day Min	501	262	47.7
Med. 7 Day Min	914	672	26.5
Min. 30 Day Min	653	335	48.7
Med. 30 Day Min	1060	774	27
Min. 90 Day Min	825	692	16.1
Med. 90 Day Min	1540	1080	29.9
7Q10	641	373	41.8
Year of 90-Day Min. Flow	2002	1988	100
Drought Year Mean	1500	2780	-85.3
Mean Baseflow	1960	1880	4.08

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	84700	58000	31.5
Med. 1 Day Max	30200	29900	0.99
Max. 3 Day Max	49600	36700	26
Med. 3 Day Max	20300	23100	-13.8
Max. 7 Day Max	26400	21700	17.8
Med. 7 Day Max	13400	14000	-4.48
Max. 30 Day Max	12000	10800	10
Med. 30 Day Max	6930	6890	0.58
Max. 90 Day Max	8580	8240	3.96
Med. 90 Day Max	5600	4770	14.8

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	683	470	31.2
5% Non-Exceedance	887	668	24.7
50% Non-Exceedance	2240	1930	13.8
95% Non-Exceedance	7770	7160	7.85
99% Non-Exceedance	16800	15800	5.95
Sept. 10% Non-Exceedance	818	720	12

**Fig. 1: Hydrograph**

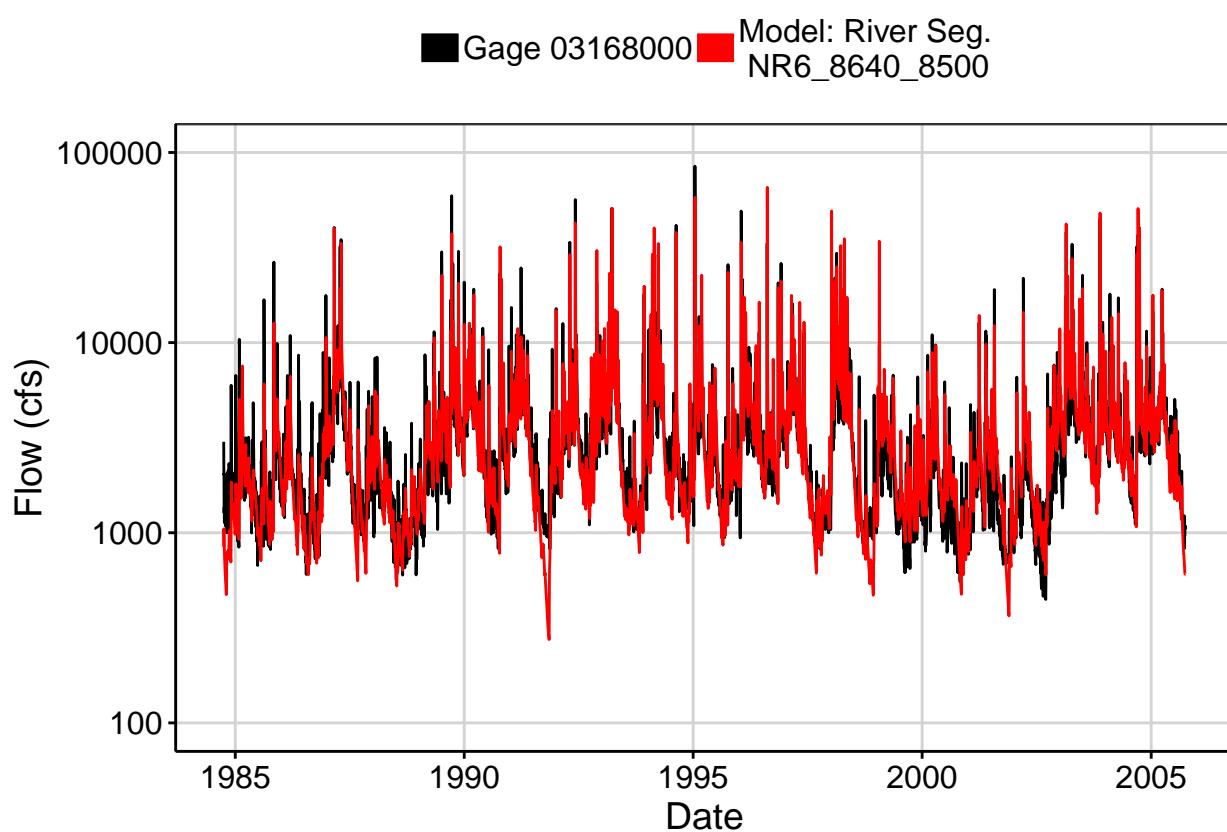


Fig. 2: Zoomed Hydrograph

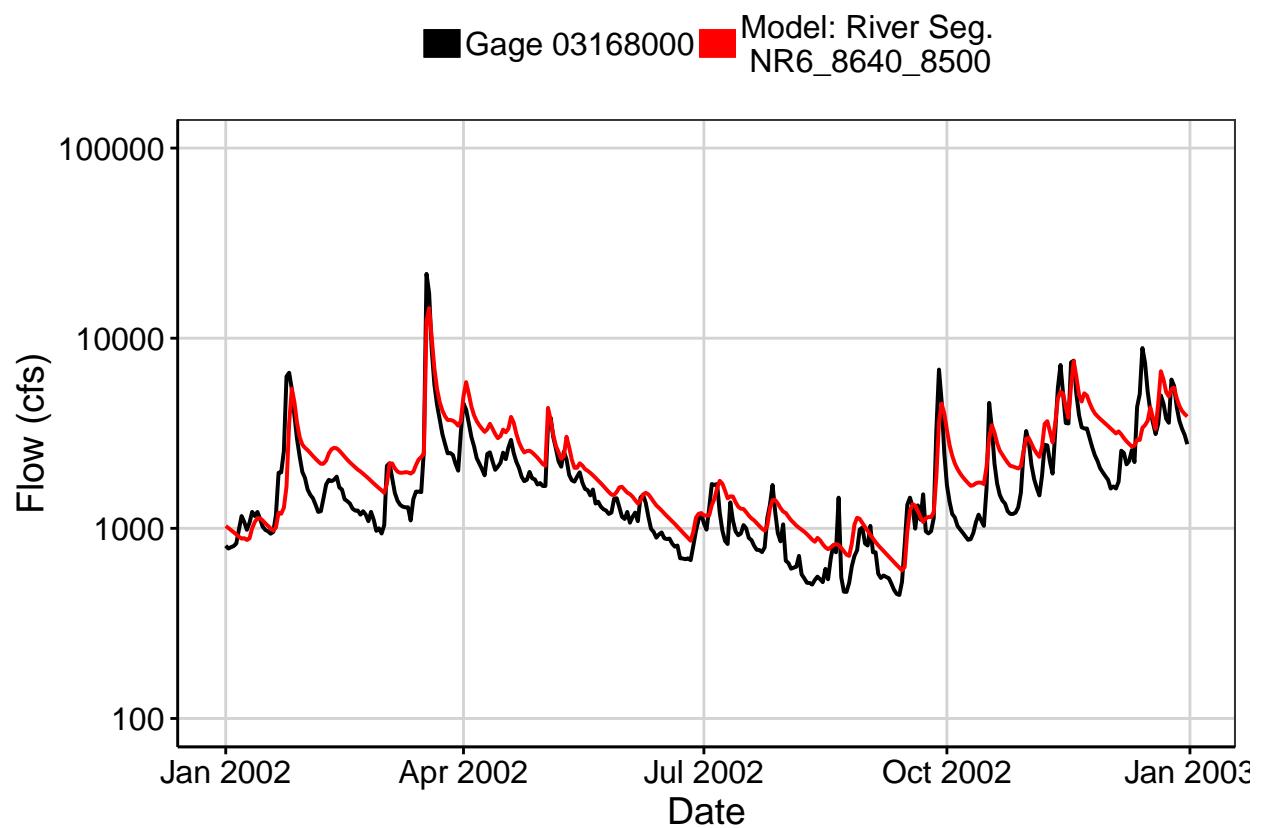


Fig. 3: Flow Exceedance

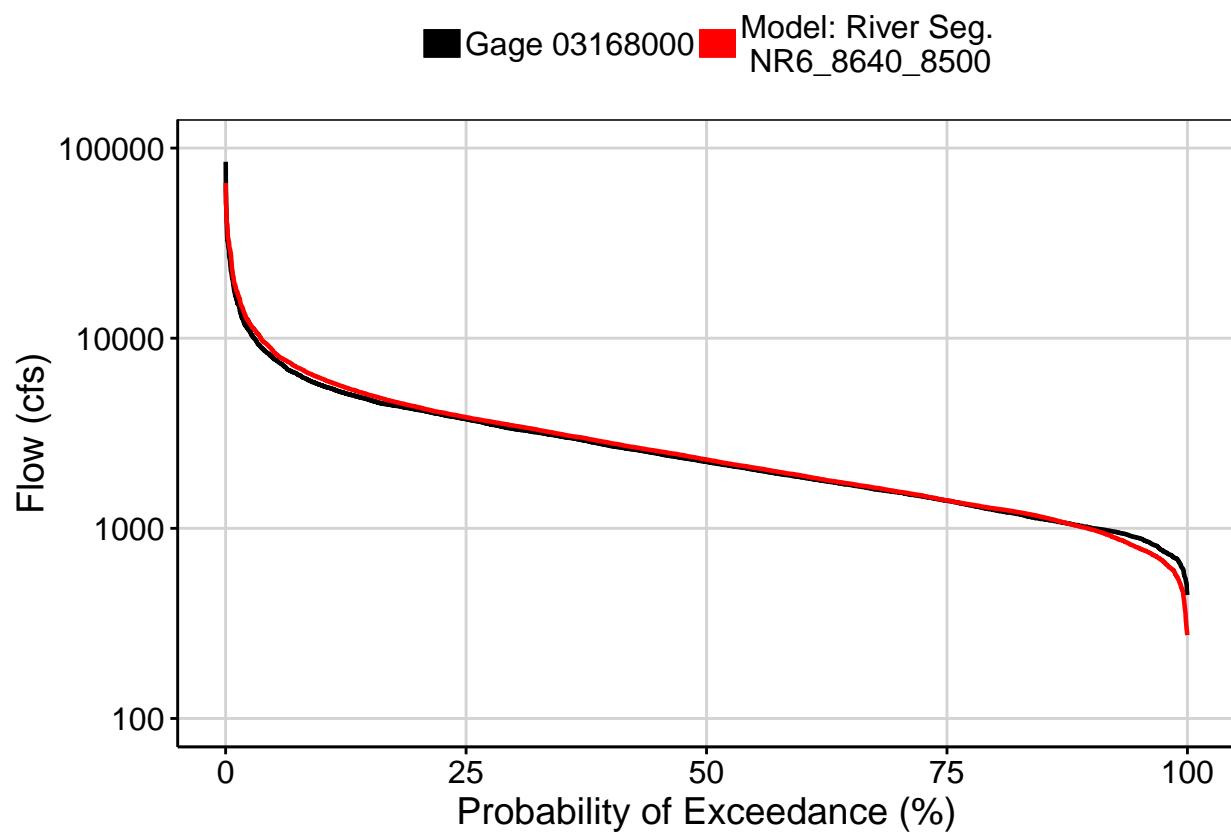


Fig. 4: Baseflow

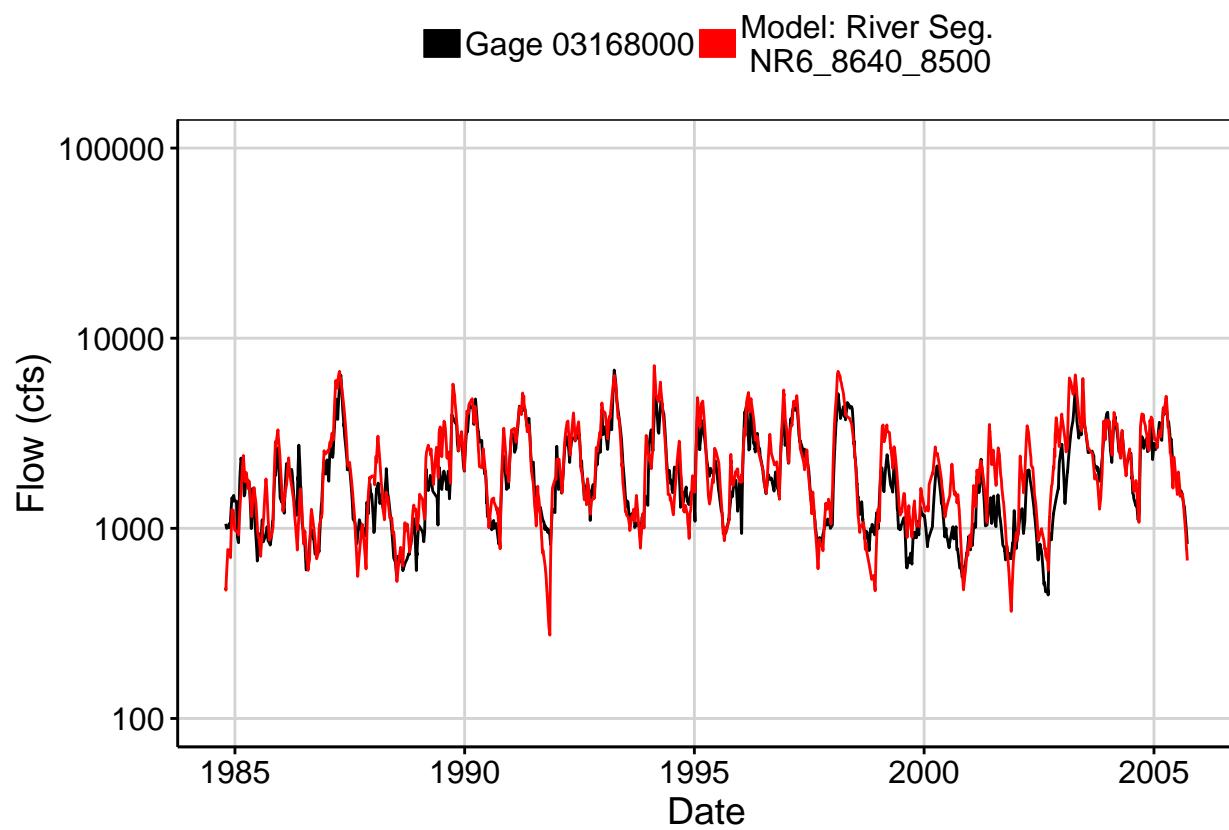


Fig. 5: Combined Baseflow

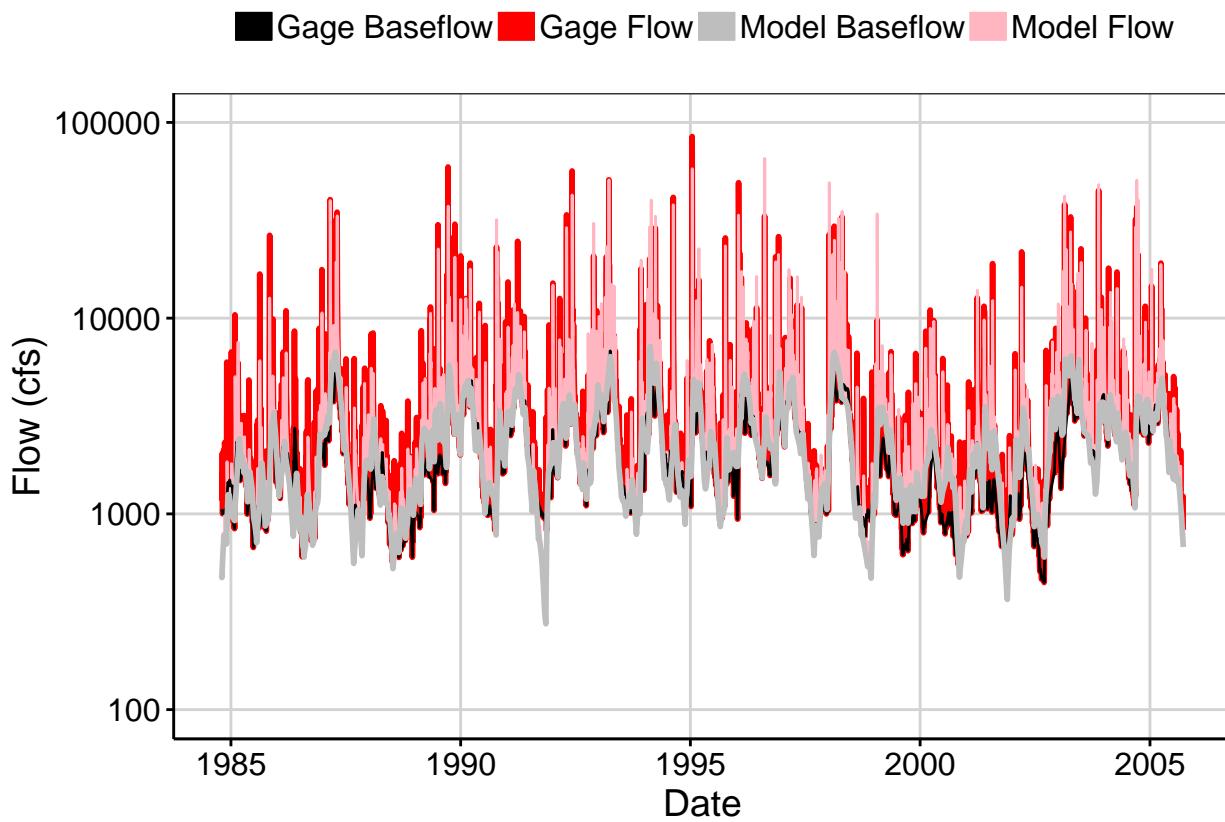


Fig. 6: Largest Error Segment

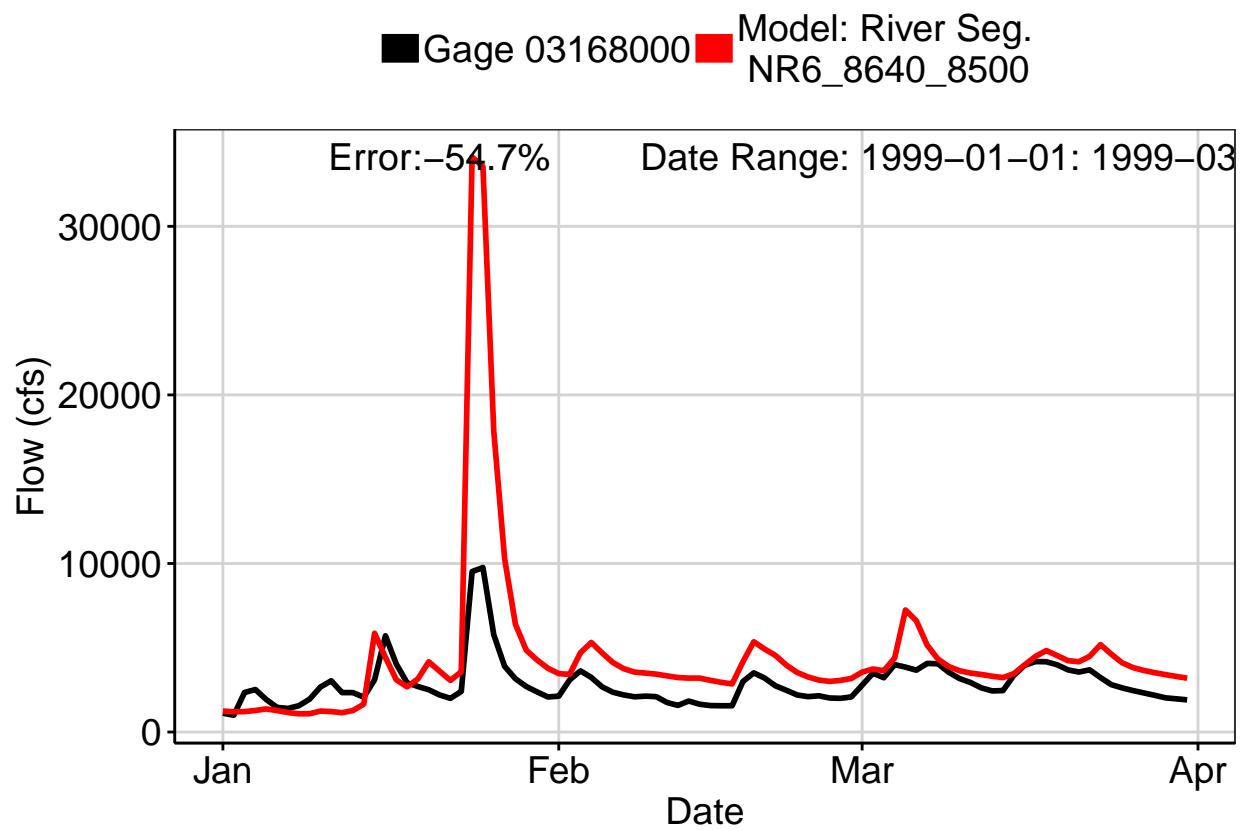


Fig. 7: Second Largest Error Segment

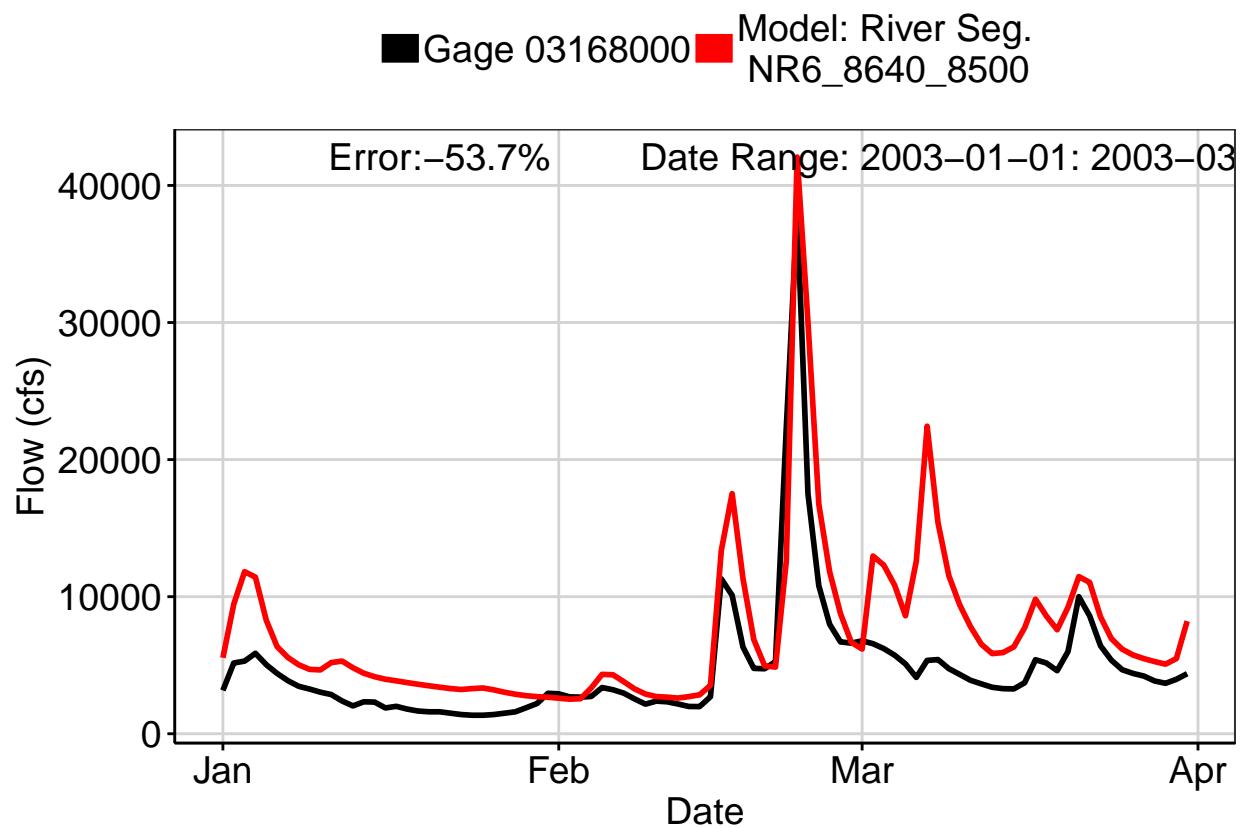


Fig. 8: Third Largest Error Segment

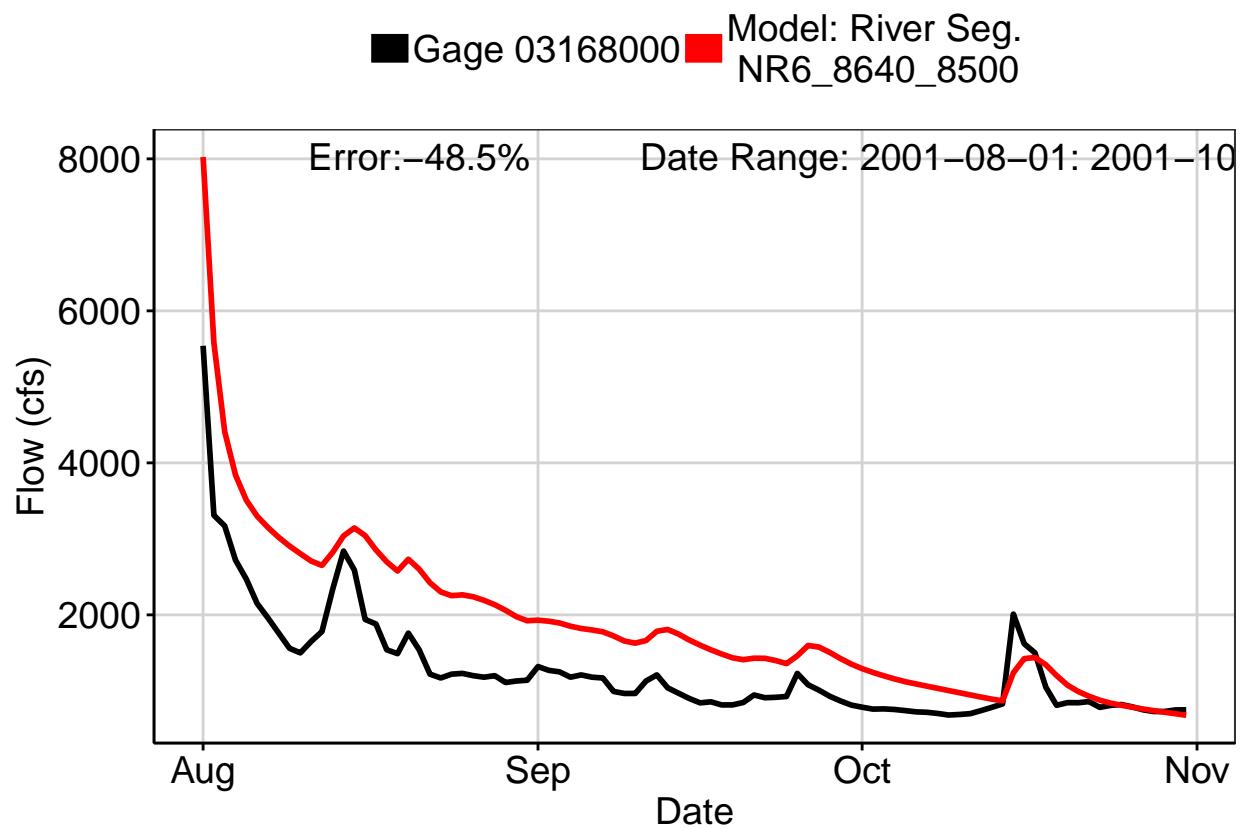
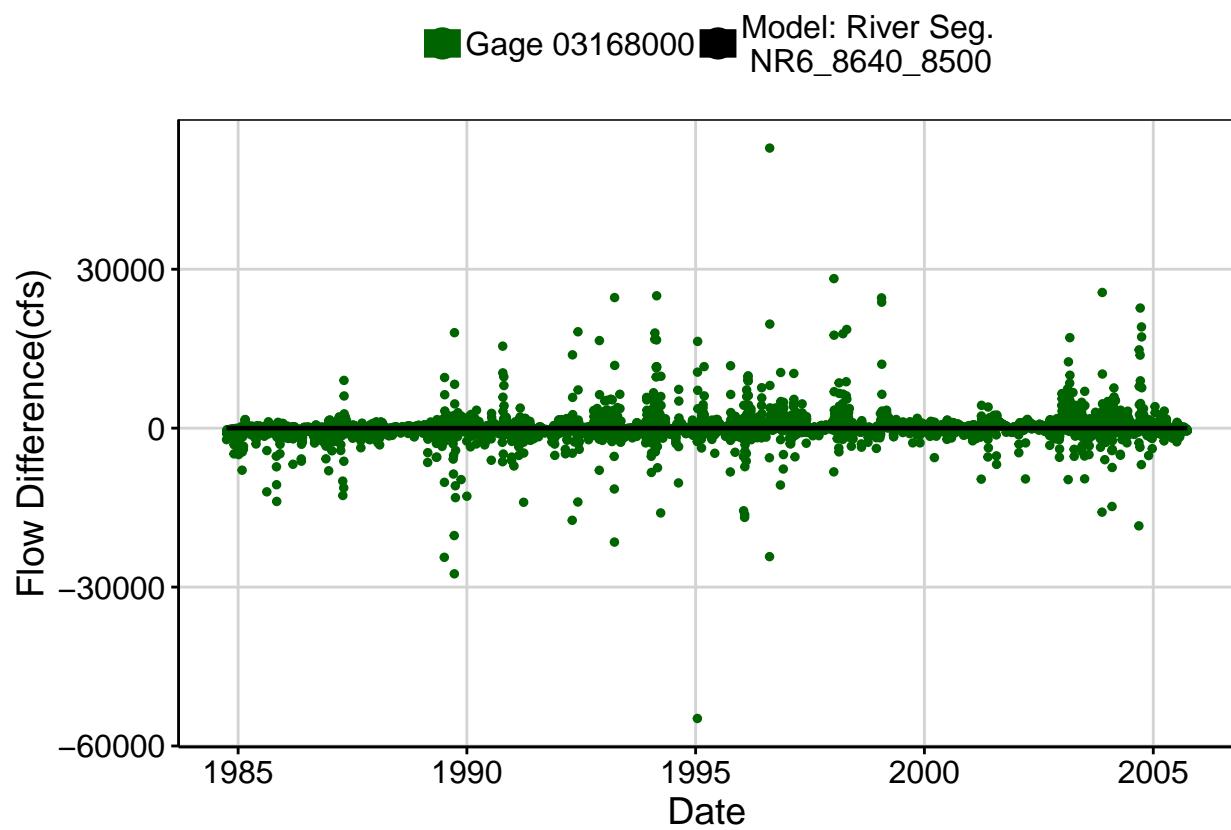
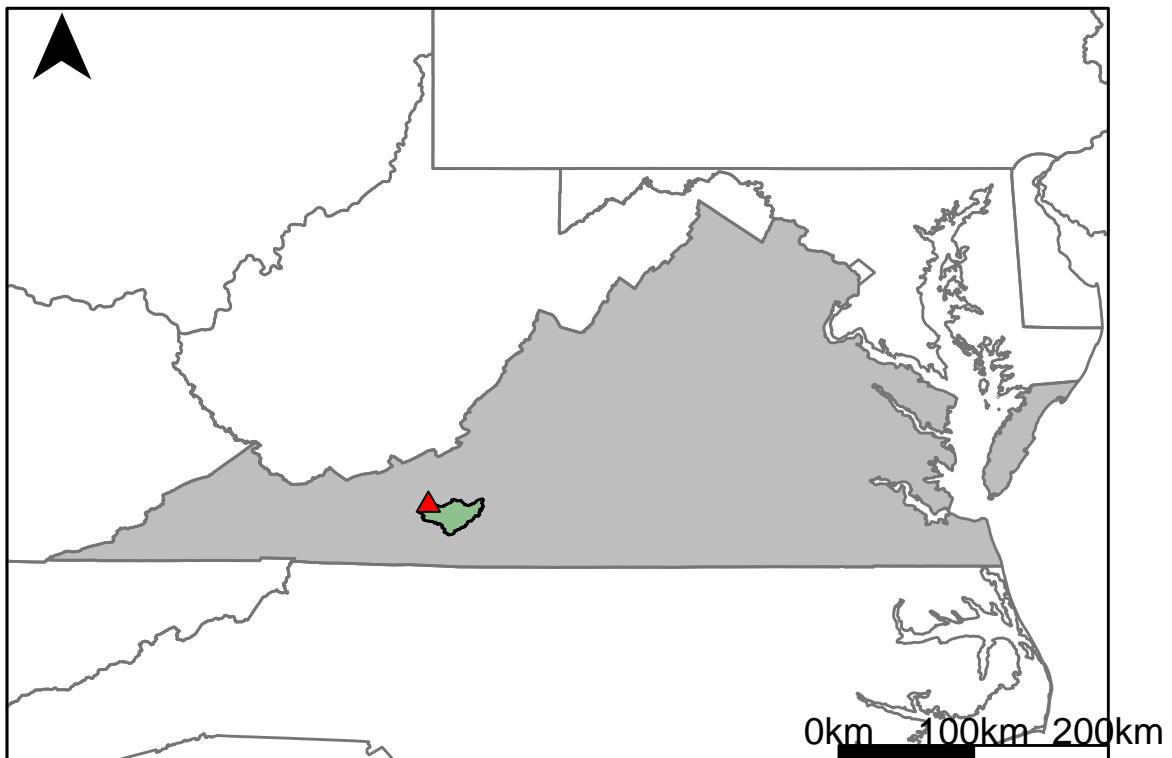


Fig. 9: Residuals Plot



## Appendix F.5: USGS Gage 03170000 vs. NR3\_8420\_8430



This river segment follows part of the flow of the Little River, a tributary of the New River. The gage is located in Pulaski County, VA (Lat 37°02'15", Long 80°33'25") approximately 6 miles south of Radford, VA. Drainage area is 309 sq. miles. This gage started taking data in 1928 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was -2.8%, with 39.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	133	80.2	39.7
Feb. Low Flow	150	114	24
Mar. Low Flow	178	189	-6.18
Apr. Low Flow	130	197	-51.5
May Low Flow	200	325	-62.5
Jun. Low Flow	276	355	-28.6
Jul. Low Flow	301	240	20.3
Aug. Low Flow	279	205	26.5
Sep. Low Flow	218	169	22.5
Oct. Low Flow	169	123	27.2
Nov. Low Flow	142	109	23.2
Dec. Low Flow	122	93.2	23.6

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	357	367	-2.8
Jan. Mean Flow	398	447	-12.3
Feb. Mean Flow	471	575	-22.1
Mar. Mean Flow	532	650	-22.2
Apr. Mean Flow	500	560	-12
May Mean Flow	399	378	5.26
Jun. Mean Flow	358	343	4.19
Jul. Mean Flow	257	216	16
Aug. Mean Flow	232	199	14.2
Sep. Mean Flow	280	250	10.7
Oct. Mean Flow	233	213	8.58
Nov. Mean Flow	318	286	10.1
Dec. Mean Flow	318	310	2.52

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	394	200	49.2
Feb. High Flow	763	480	37.1
Mar. High Flow	695	468	32.7
Apr. High Flow	925	964	-4.22
May High Flow	1000	915	8.5
Jun. High Flow	1560	1580	-1.28
Jul. High Flow	895	1060	-18.4
Aug. High Flow	865	718	17
Sep. High Flow	594	442	25.6
Oct. High Flow	471	347	26.3
Nov. High Flow	399	222	44.4
Dec. High Flow	446	243	45.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	31	11	64.5
Med. 1 Day Min	95	51.7	45.6
Min. 3 Day Min	31.3	11.2	64.2
Med. 3 Day Min	98.5	53.2	46
Min. 7 Day Min	32	11.8	63.1
Med. 7 Day Min	105	57.6	45.1
Min. 30 Day Min	52.9	18.2	65.6
Med. 30 Day Min	133	78.5	41
Min. 90 Day Min	75.4	47.5	37
Med. 90 Day Min	189	126	33.3
7Q10	59.2	26.3	55.6
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	148	367	-148
Mean Baseflow	235	240	-2.13

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	9330	9680	-3.75
Med. 1 Day Max	3760	4150	-10.4
Max. 3 Day Max	4810	5630	-17
Med. 3 Day Max	2340	2830	-20.9
Max. 7 Day Max	2790	3560	-27.6
Med. 7 Day Max	1500	1780	-18.7
Max. 30 Day Max	1480	1920	-29.7
Med. 30 Day Max	785	937	-19.4
Max. 90 Day Max	1030	1340	-30.1
Med. 90 Day Max	587	644	-9.71

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	73	34	53.4
5% Non-Exceedance	104	63.9	38.6
50% Non-Exceedance	261	240	8.05
95% Non-Exceedance	804	994	-23.6
99% Non-Exceedance	1860	2210	-18.8
Sept. 10% Non-Exceedance	58.8	59.4	-1.02

**Fig. 1: Hydrograph**

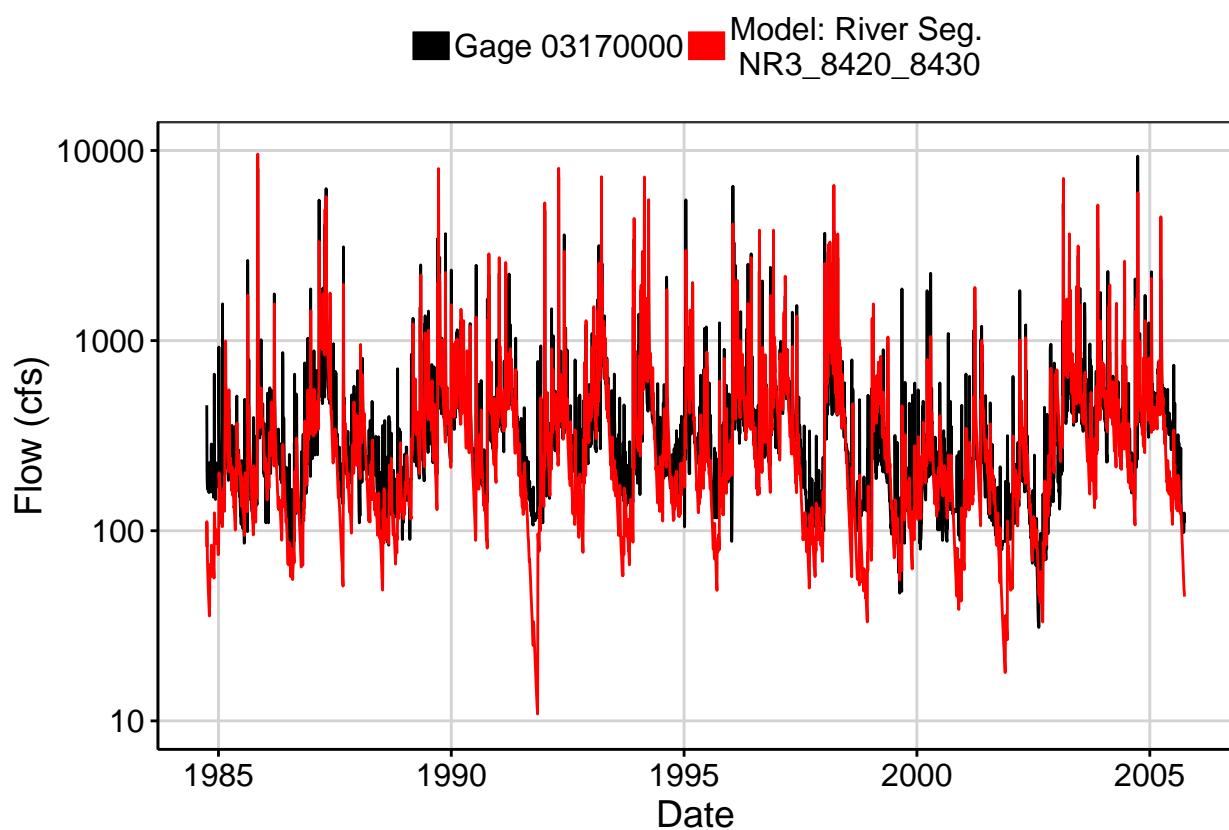


Fig. 2: Zoomed Hydrograph

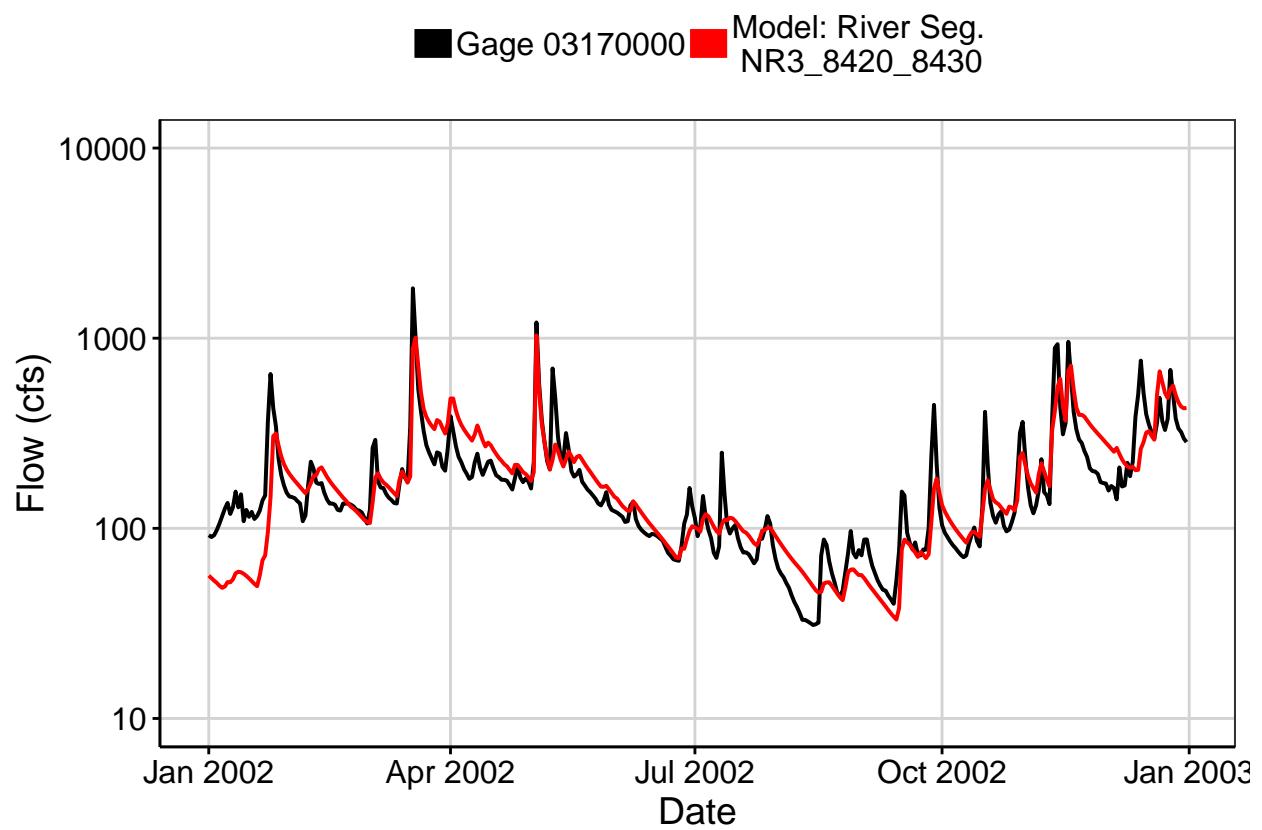


Fig. 3: Flow Exceedance

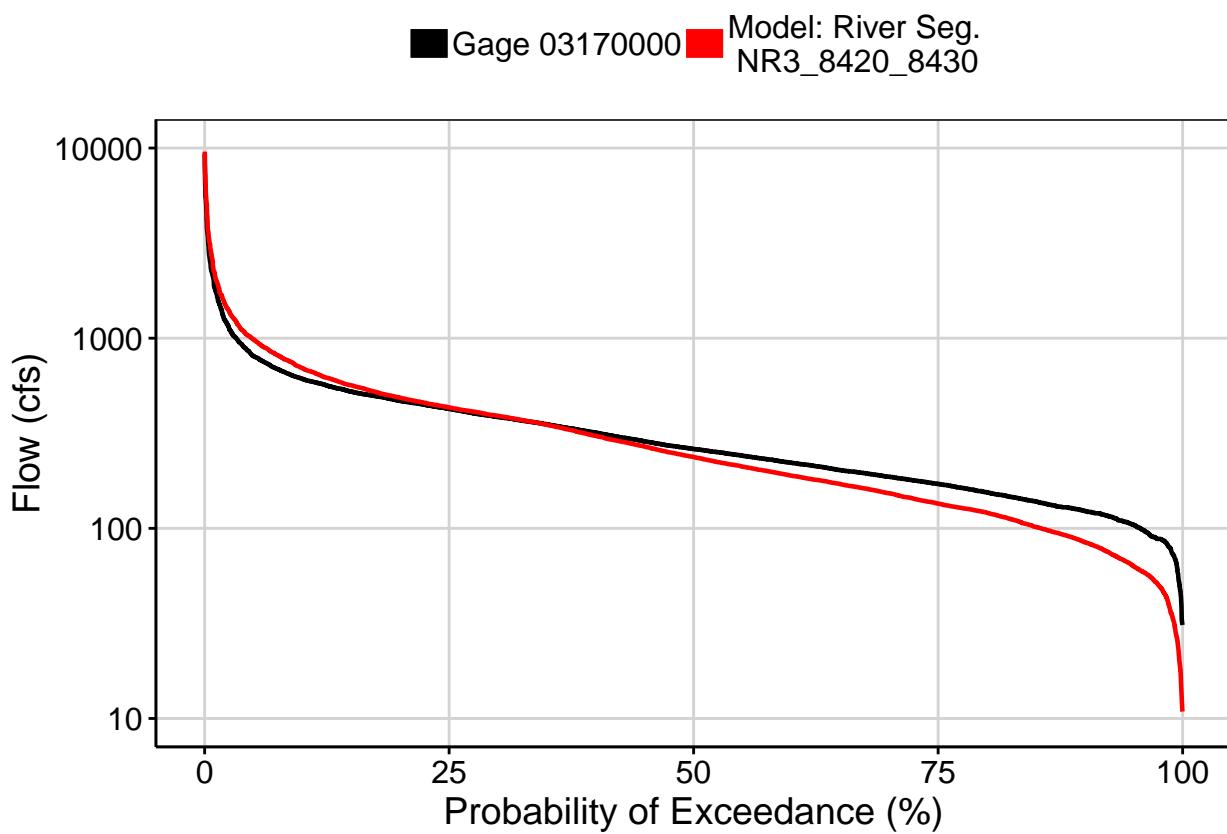


Fig. 4: Baseflow

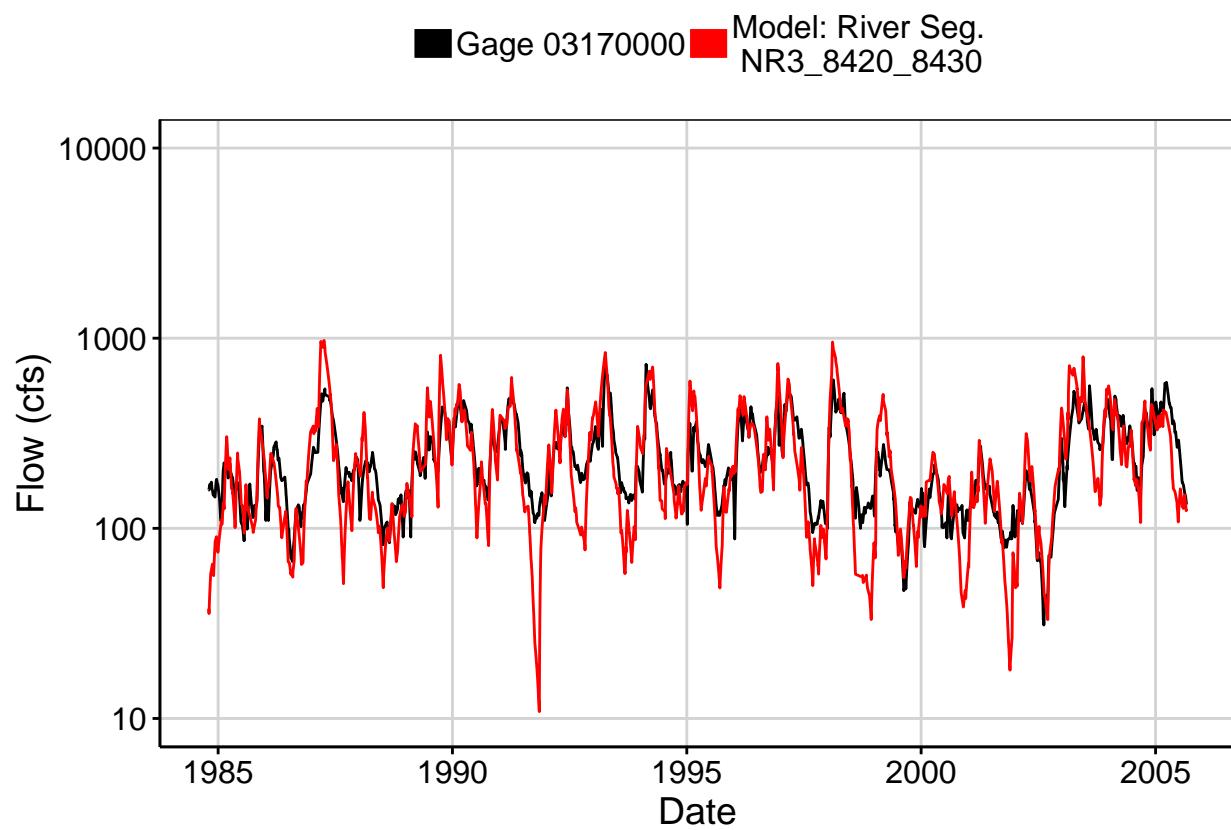


Fig. 5: Combined Baseflow

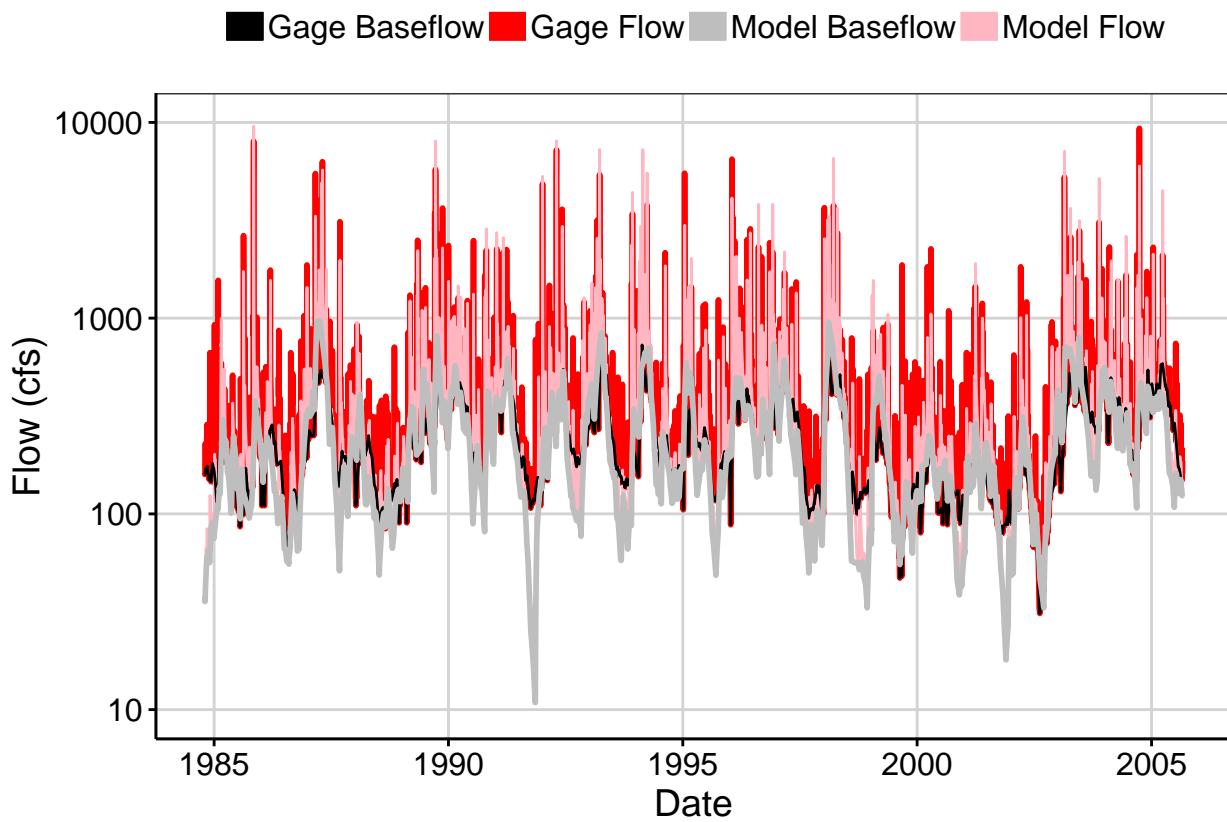


Fig. 6: Largest Error Segment

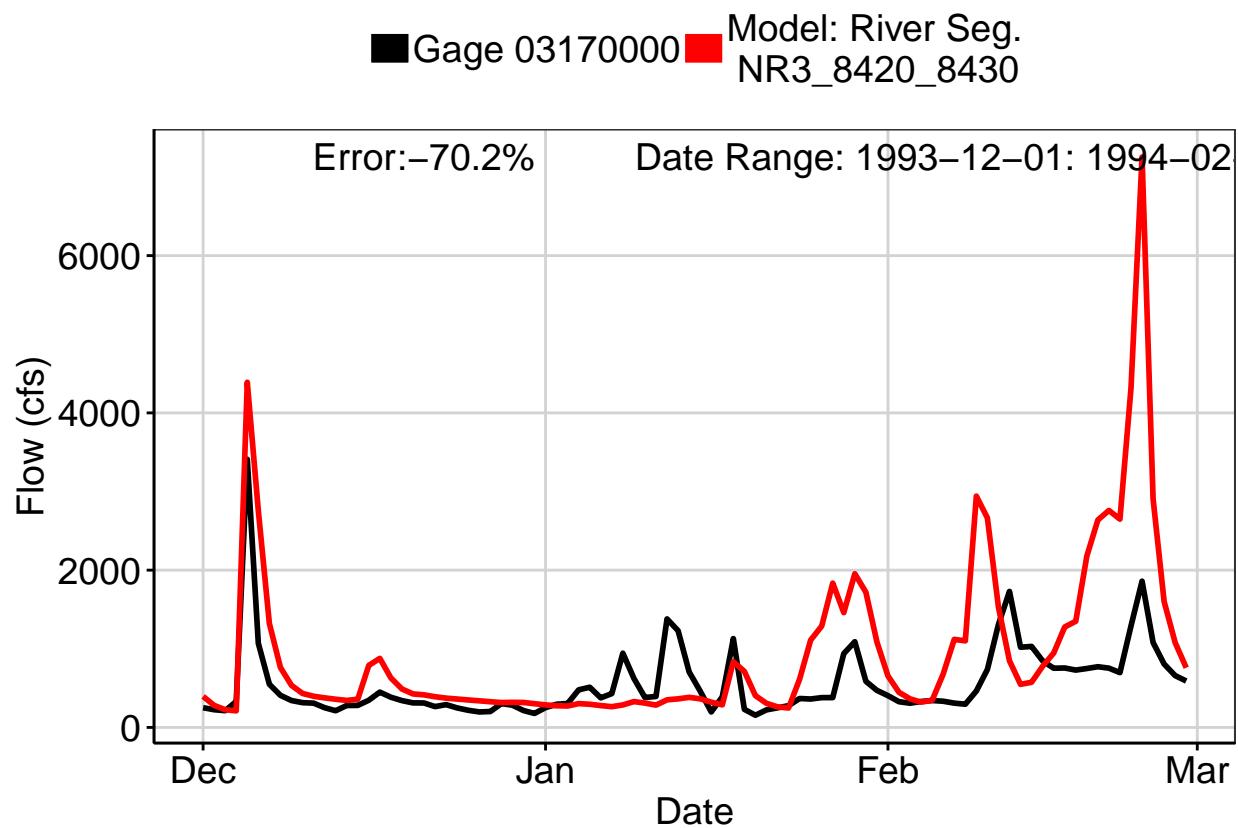


Fig. 7: Second Largest Error Segment

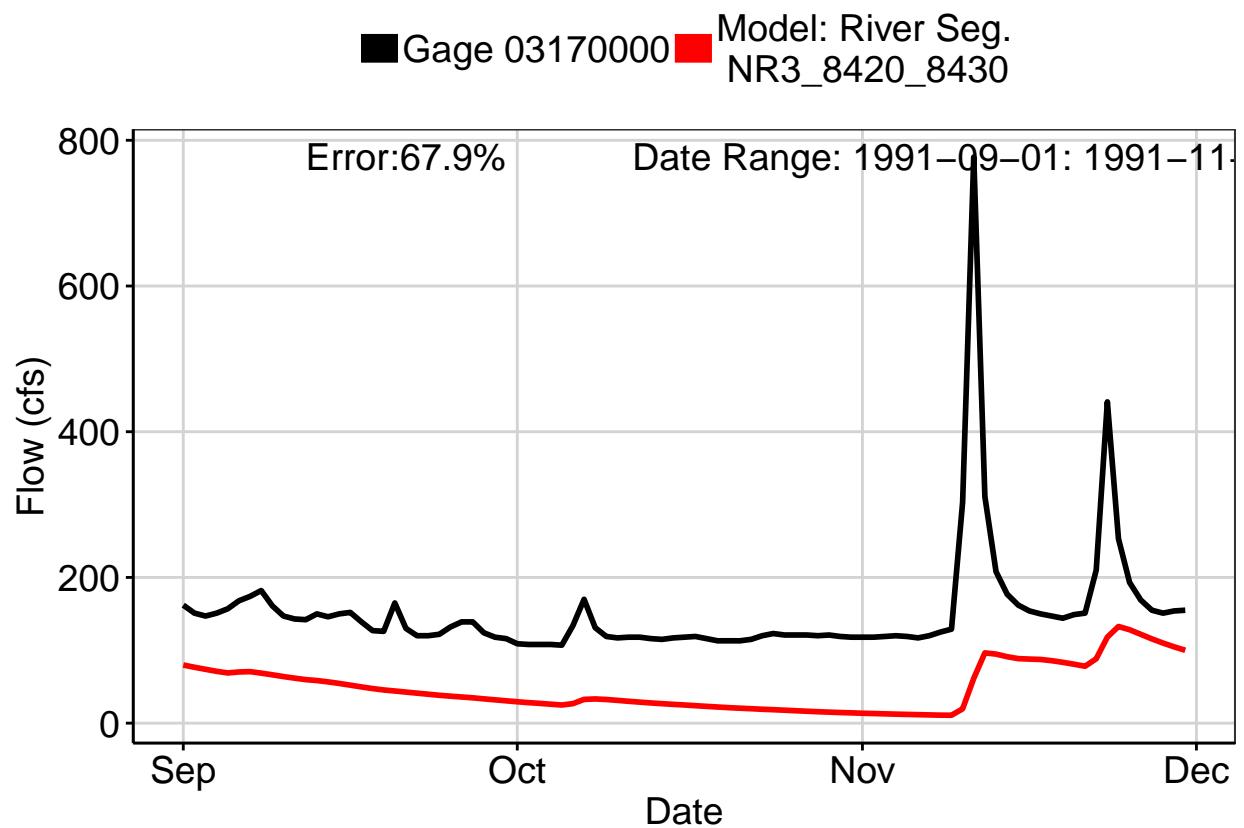


Fig. 8: Third Largest Error Segment

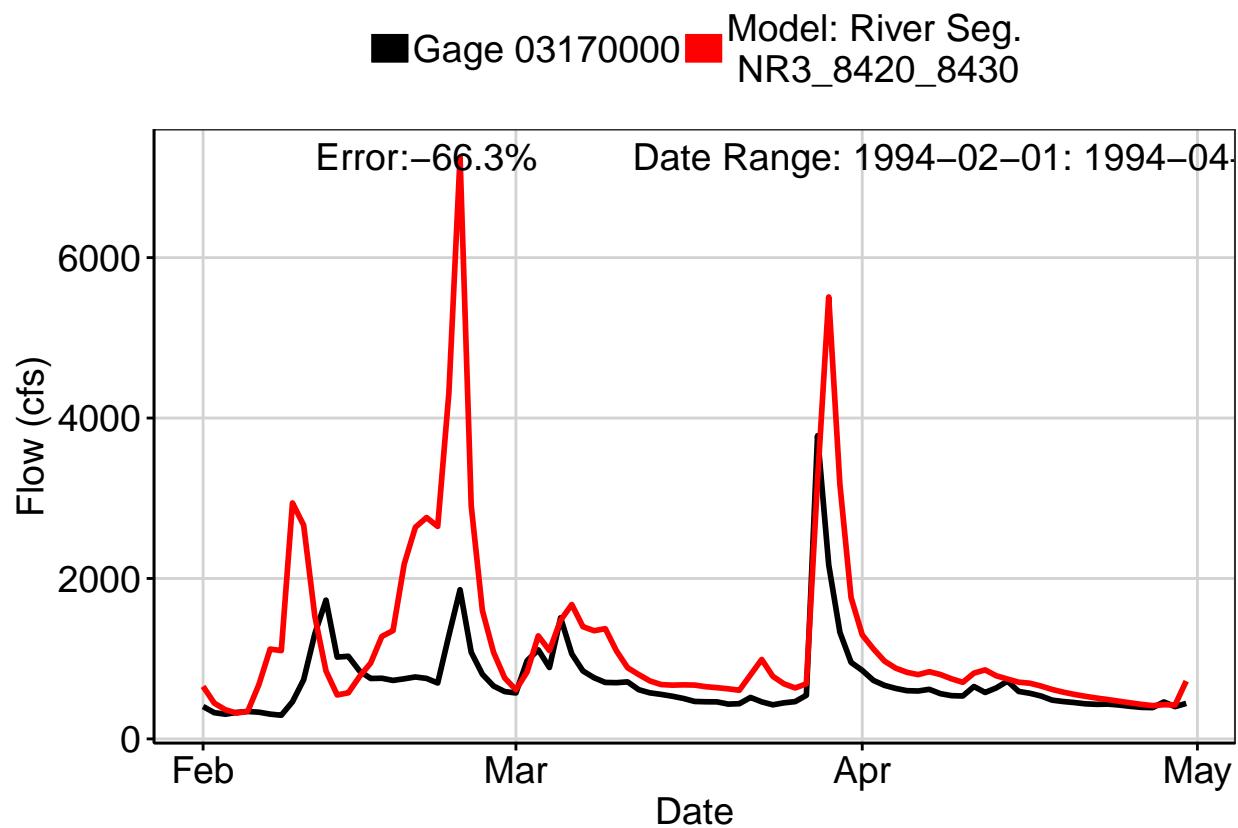
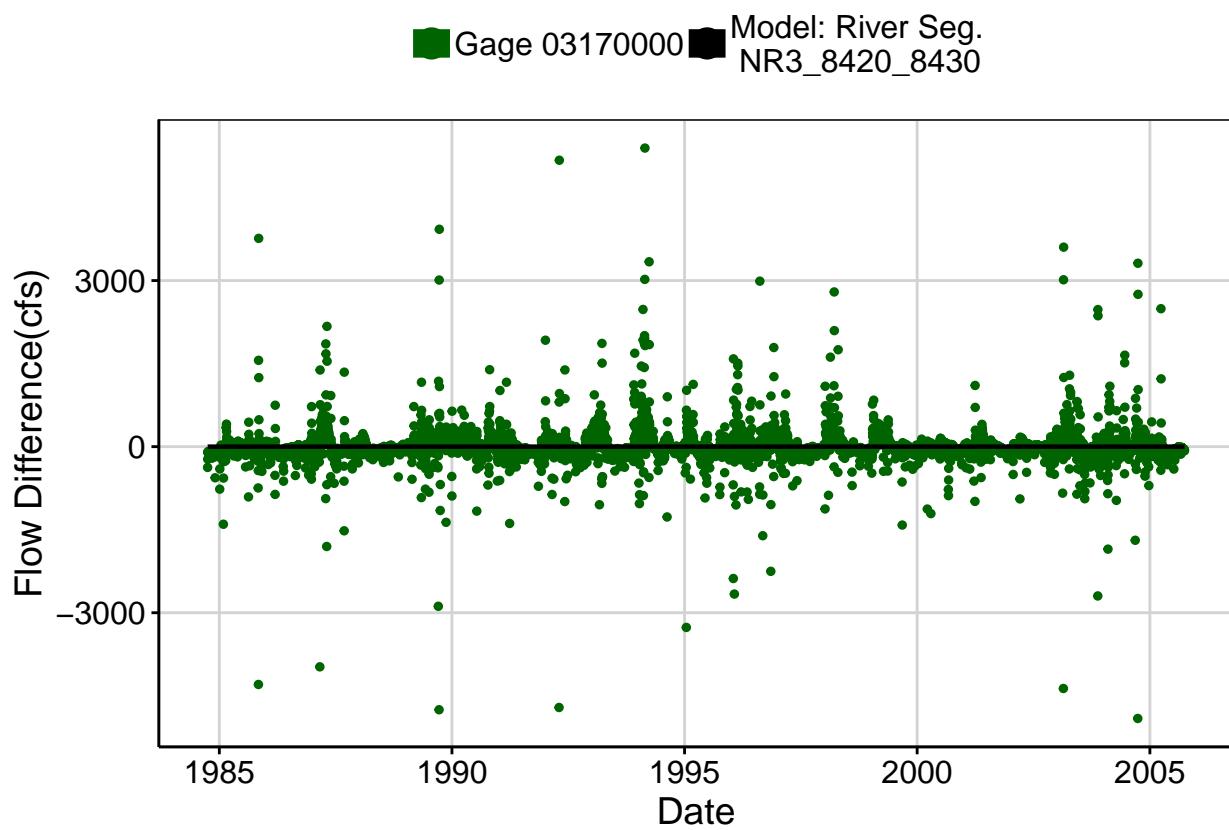
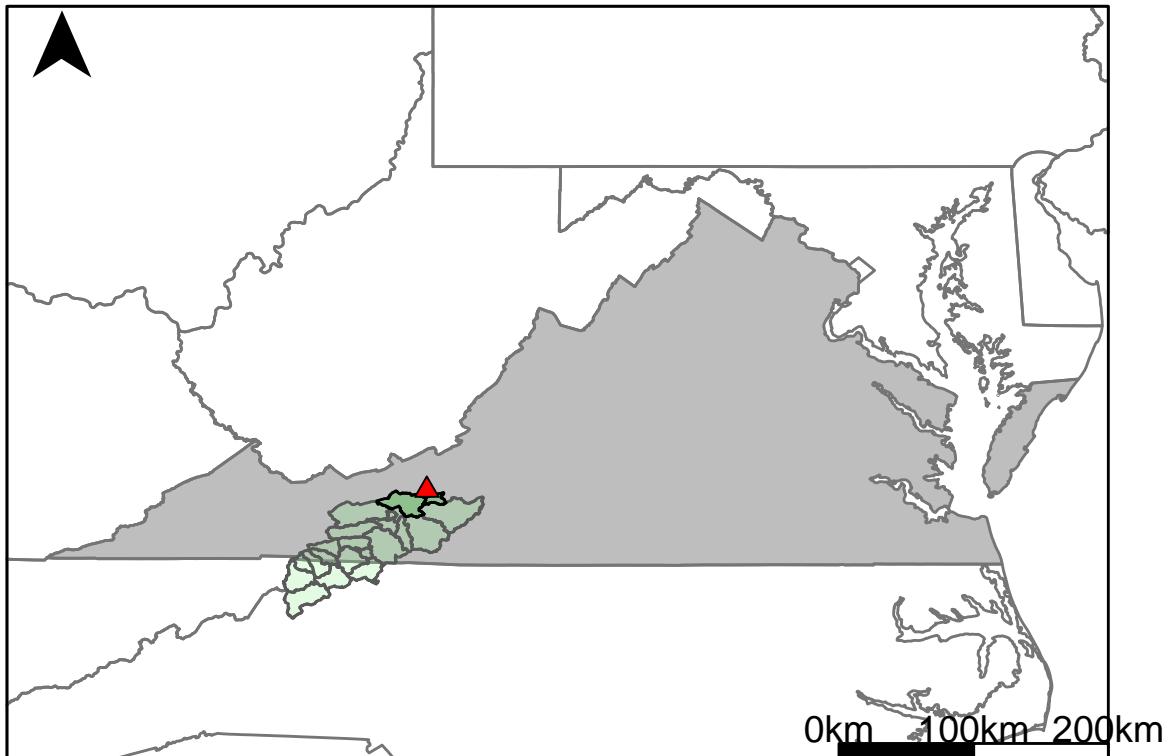


Fig. 9: Residuals Plot



## Appendix F.6: USGS Gage 03171000 vs. NR6\_8500\_7820+NR3\_8430\_7820



This river segment follows part of the flow of the New River. The gage is located in Pulaski County, VA (Lat 3708'30", Long 8034'10") approximately 1 mile northeast of Radford, VA. Drainage area is 2767 sq. miles. This gage started taking data in 1907 and is still taking data. There are two dams and two power plants located in this area; the Claytor Dam, the Radford Dam, the American Electric Power Plant and the Little River Power Plant. Claytor Dam and the American Electric Power Company are located 5.5 miles upstream and regulate a majority of the normal flow that passes this gage. Radford Dam and the power plant at Little River are half a mile below Claytor Dam, which causes fluctuations during low flow periods. The Buck and Byllesby powerplants are also in this area but are before Claytor Dam so their effect on this gage should be minimal to none at all. The average daily discharge error between the model and gage data for the 20 year timespan was 8.36%, with 37.5% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	1060	1110	-4.72
Feb. Low Flow	1060	1200	-13.2
Mar. Low Flow	1050	2210	-110
Apr. Low Flow	1080	2190	-103
May Low Flow	1160	3130	-170
Jun. Low Flow	1400	3580	-156
Jul. Low Flow	1360	1320	2.94
Aug. Low Flow	1720	1000	41.9
Sep. Low Flow	1750	1850	-5.71
Oct. Low Flow	1390	3510	-153
Nov. Low Flow	1120	2190	-95.5
Dec. Low Flow	1090	1440	-32.1

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	3830	3510	8.36
Jan. Mean Flow	4440	3930	11.5
Feb. Mean Flow	5210	4490	13.8
Mar. Mean Flow	5790	5060	12.6
Apr. Mean Flow	5290	3960	25.1
May Mean Flow	4300	2800	34.9
Jun. Mean Flow	3790	3510	7.39
Jul. Mean Flow	2840	4040	-42.3
Aug. Mean Flow	2580	3370	-30.6
Sep. Mean Flow	2690	2570	4.46
Oct. Mean Flow	2490	2710	-8.84
Nov. Mean Flow	3310	2710	18.1
Dec. Mean Flow	3320	3030	8.73

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	4130	2000	51.6
Feb. High Flow	7360	2370	67.8
Mar. High Flow	7420	3250	56.2
Apr. High Flow	8750	6490	25.8
May High Flow	10700	4920	54
Jun. High Flow	12300	6330	48.5
Jul. High Flow	12200	3890	68.1
Aug. High Flow	9120	3670	59.8
Sep. High Flow	6410	4160	35.1
Oct. High Flow	4870	4680	3.9
Nov. High Flow	4800	4070	15.2
Dec. High Flow	4630	2260	51.2

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	754	1000	-32.6
Med. 1 Day Min	917	1000	-9.05
Min. 3 Day Min	787	1000	-27.1
Med. 3 Day Min	964	1000	-3.73
Min. 7 Day Min	793	1000	-26.1
Med. 7 Day Min	1070	1000	6.54
Min. 30 Day Min	810	1000	-23.5
Med. 30 Day Min	1340	1030	23.1
Min. 90 Day Min	990	1000	-1.01
Med. 90 Day Min	2000	1810	9.5
7Q10	860	1010	-17.4
Year of 90-Day Min. Flow	2002	2001	100
Drought Year Mean	1710	3510	-105
Mean Baseflow	1840	2960	-60.9

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	74000	15700	78.8
Med. 1 Day Max	35800	12400	65.4
Max. 3 Day Max	49300	15600	68.4
Med. 3 Day Max	22000	12100	45
Max. 7 Day Max	27800	15000	46
Med. 7 Day Max	15000	10900	27.3
Max. 30 Day Max	14500	11500	20.7
Med. 30 Day Max	8110	8100	0.12
Max. 90 Day Max	10500	8940	14.9
Med. 90 Day Max	6760	5950	12

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	858	1000	-16.6
5% Non-Exceedance	989	1000	-1.11
50% Non-Exceedance	2820	2880	-2.13
95% Non-Exceedance	9930	8560	13.8
99% Non-Exceedance	17800	12500	29.8
Sept. 10% Non-Exceedance	1220	1110	9.02

**Fig. 1: Hydrograph**

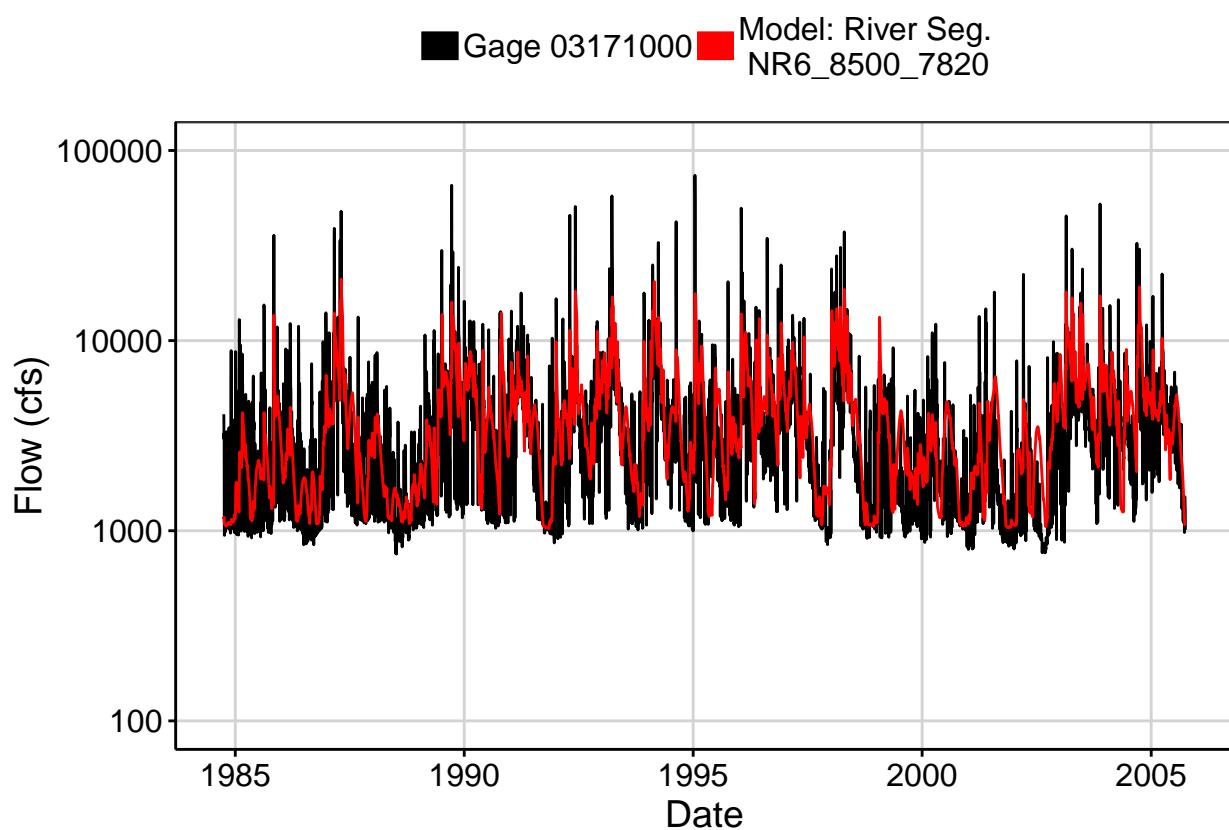


Fig. 2: Zoomed Hydrograph

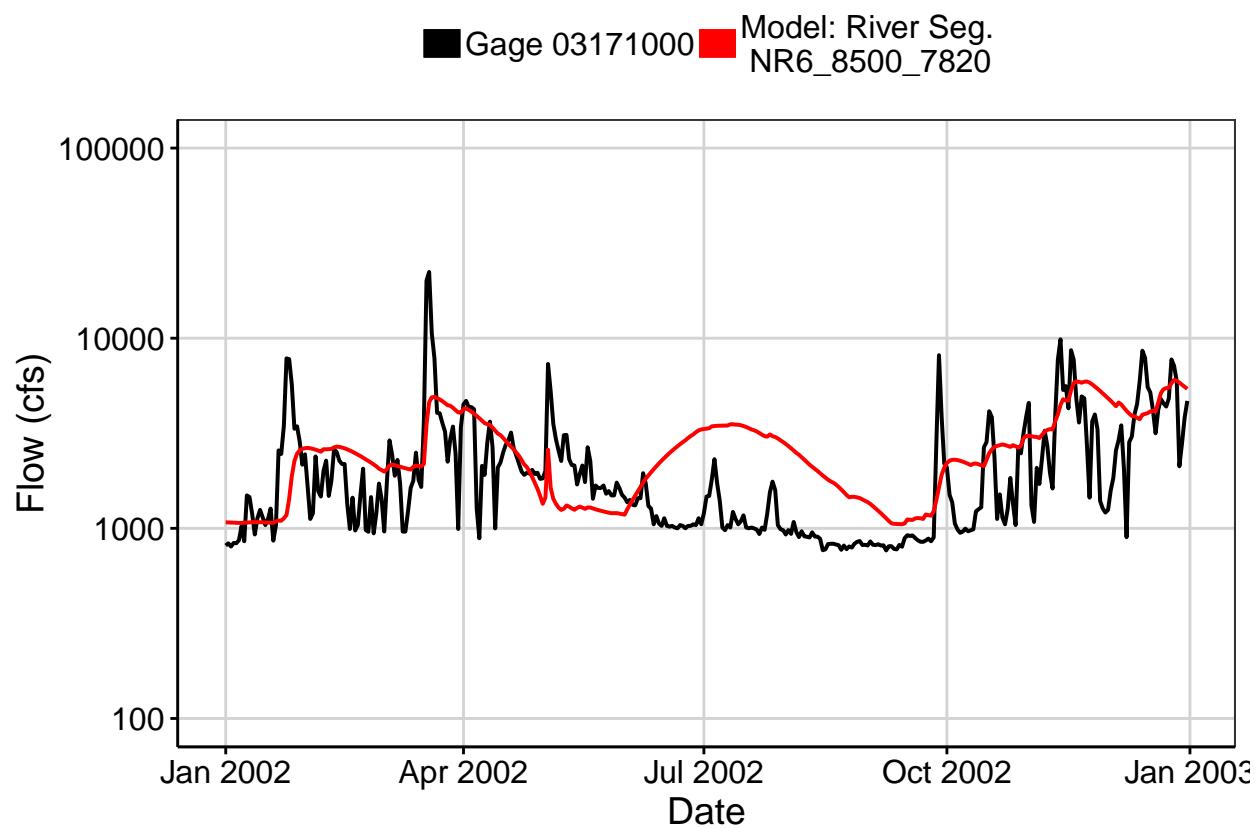


Fig. 3: Flow Exceedance

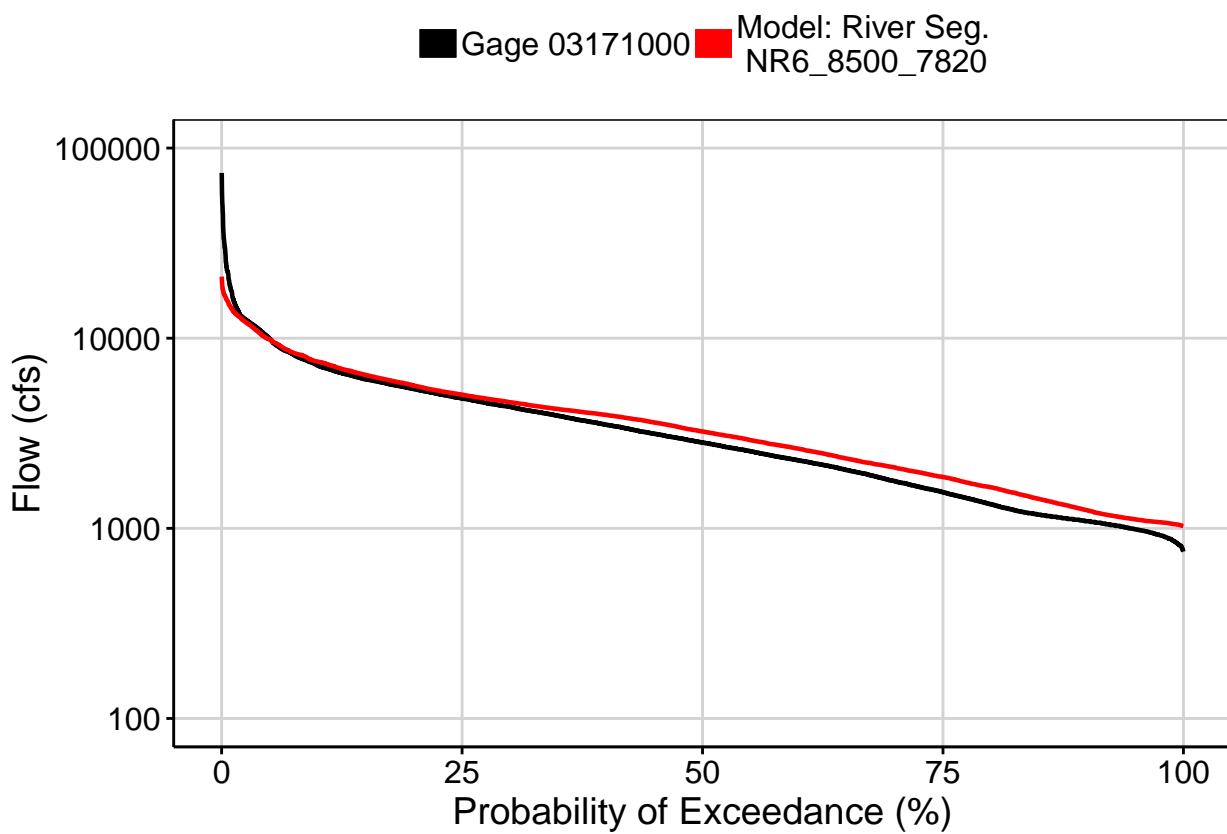


Fig. 4: Baseflow

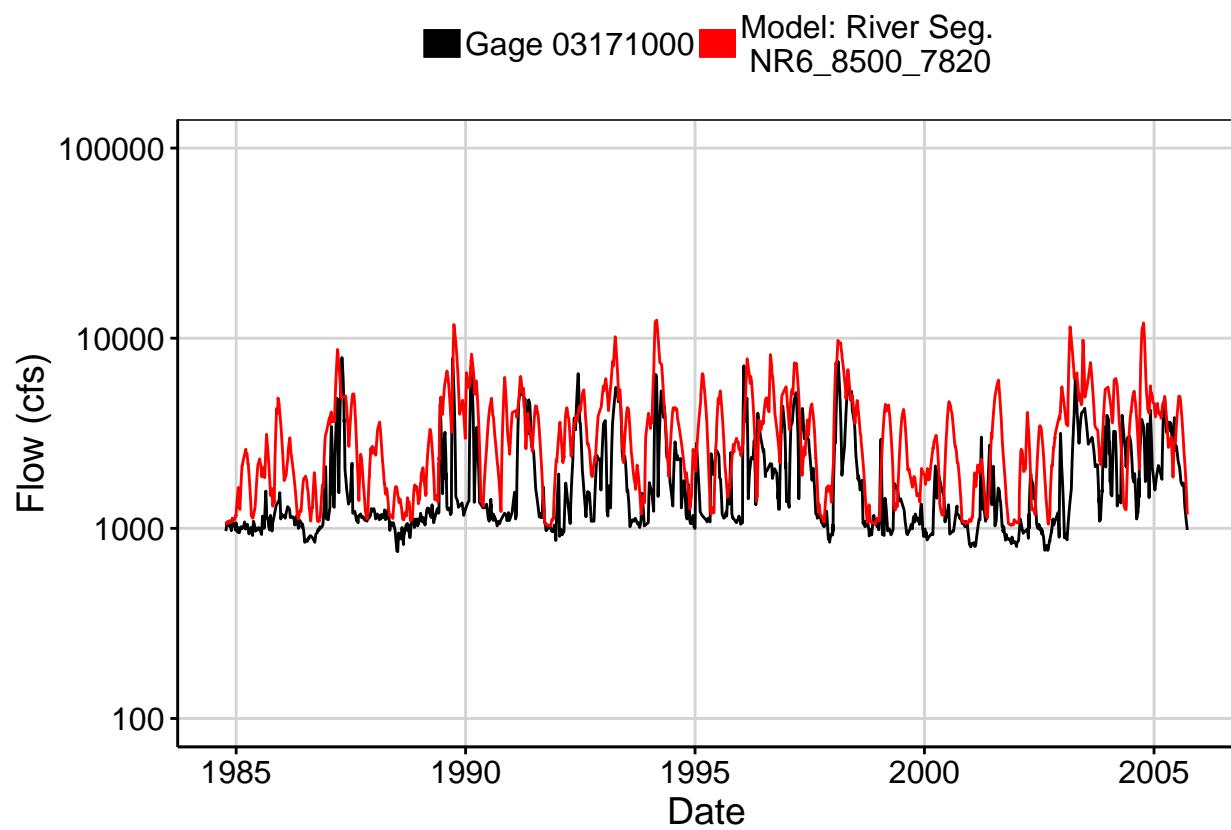


Fig. 5: Combined Baseflow

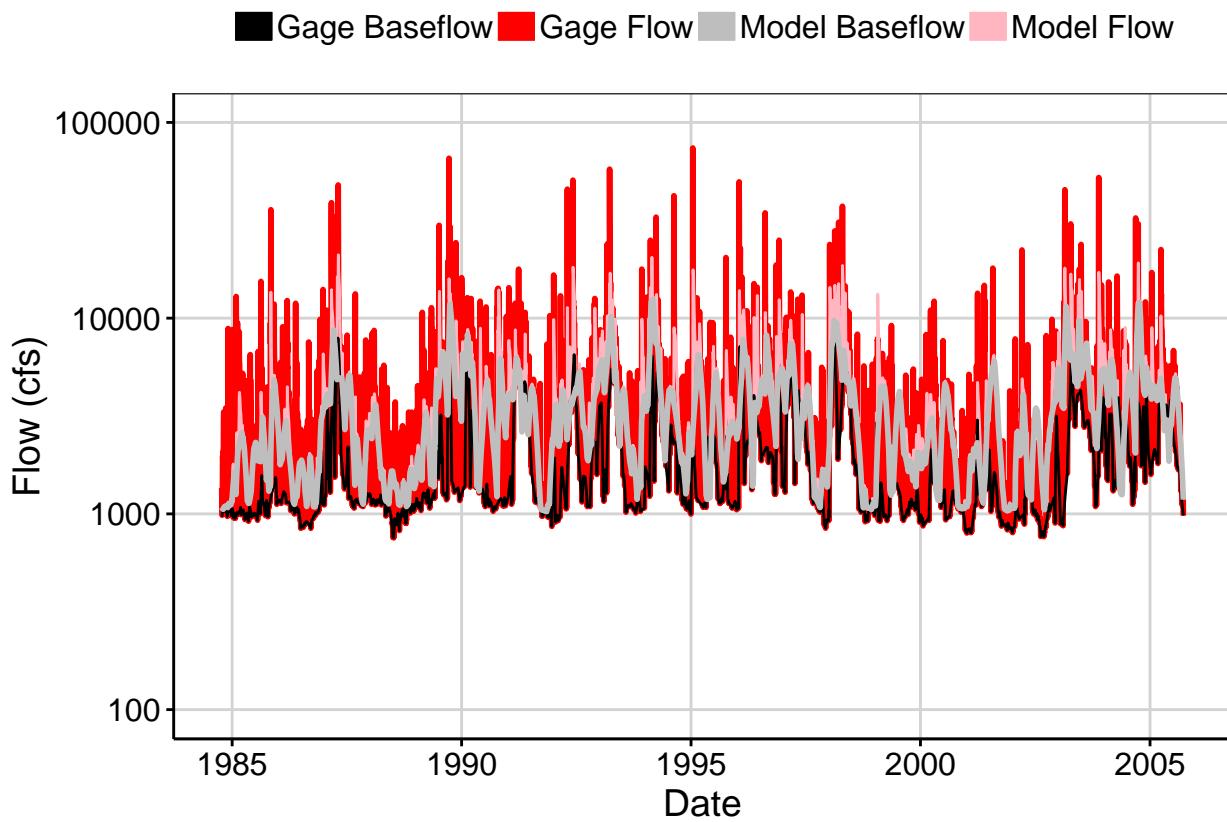


Fig. 6: Largest Error Segment

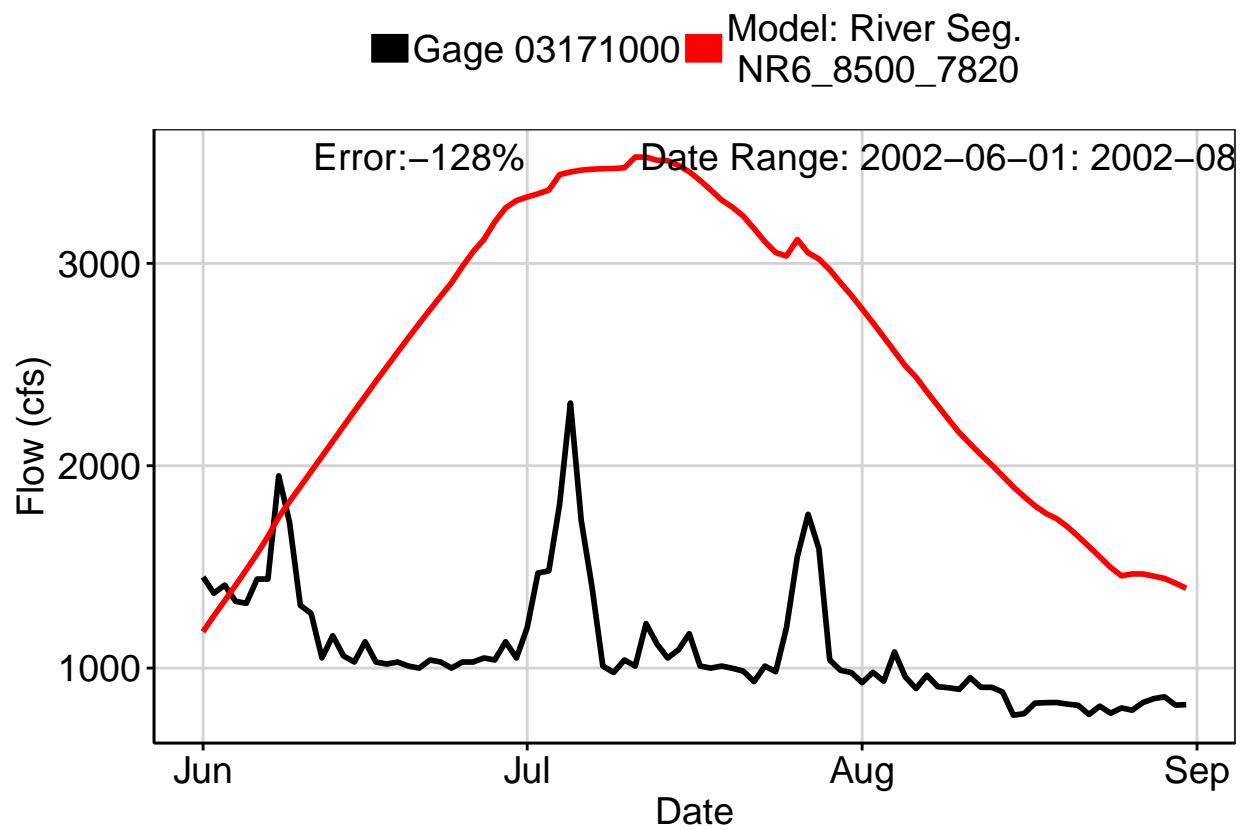


Fig. 7: Second Largest Error Segment

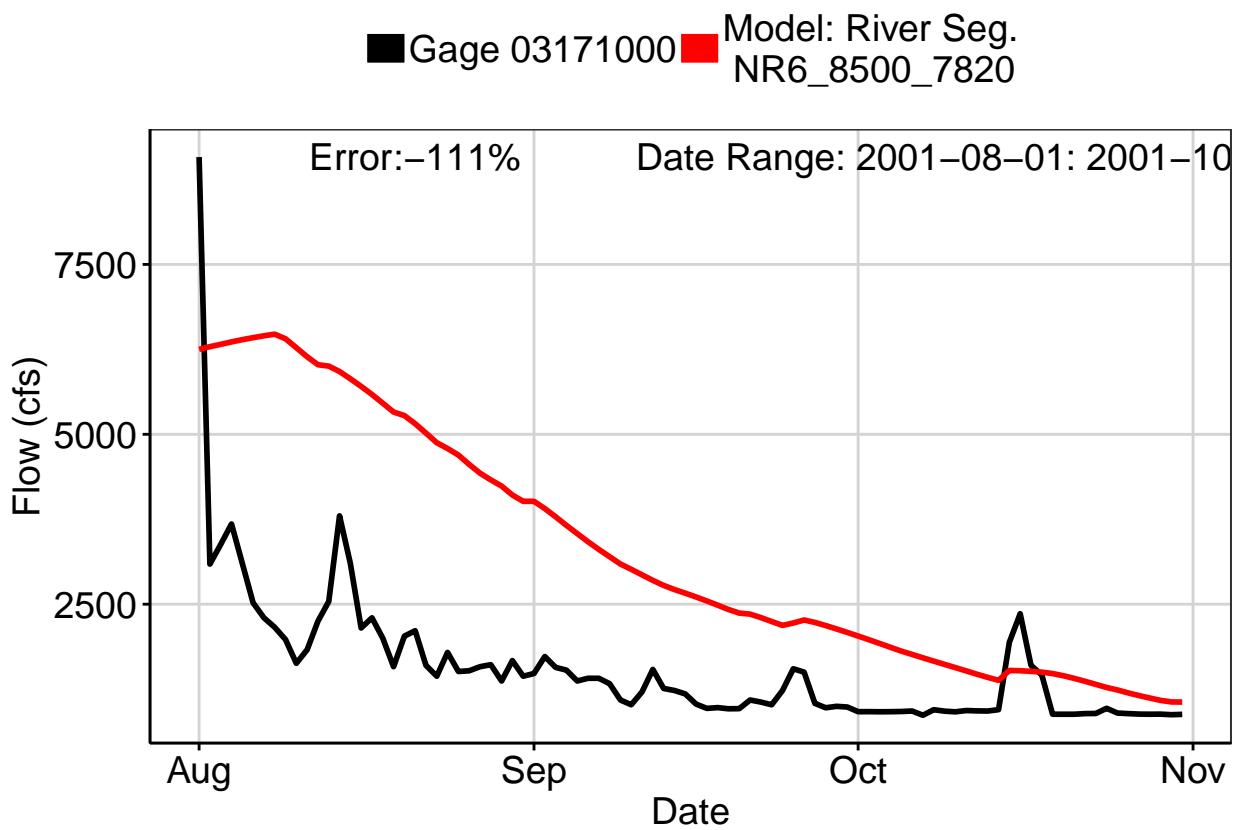


Fig. 8: Third Largest Error Segment

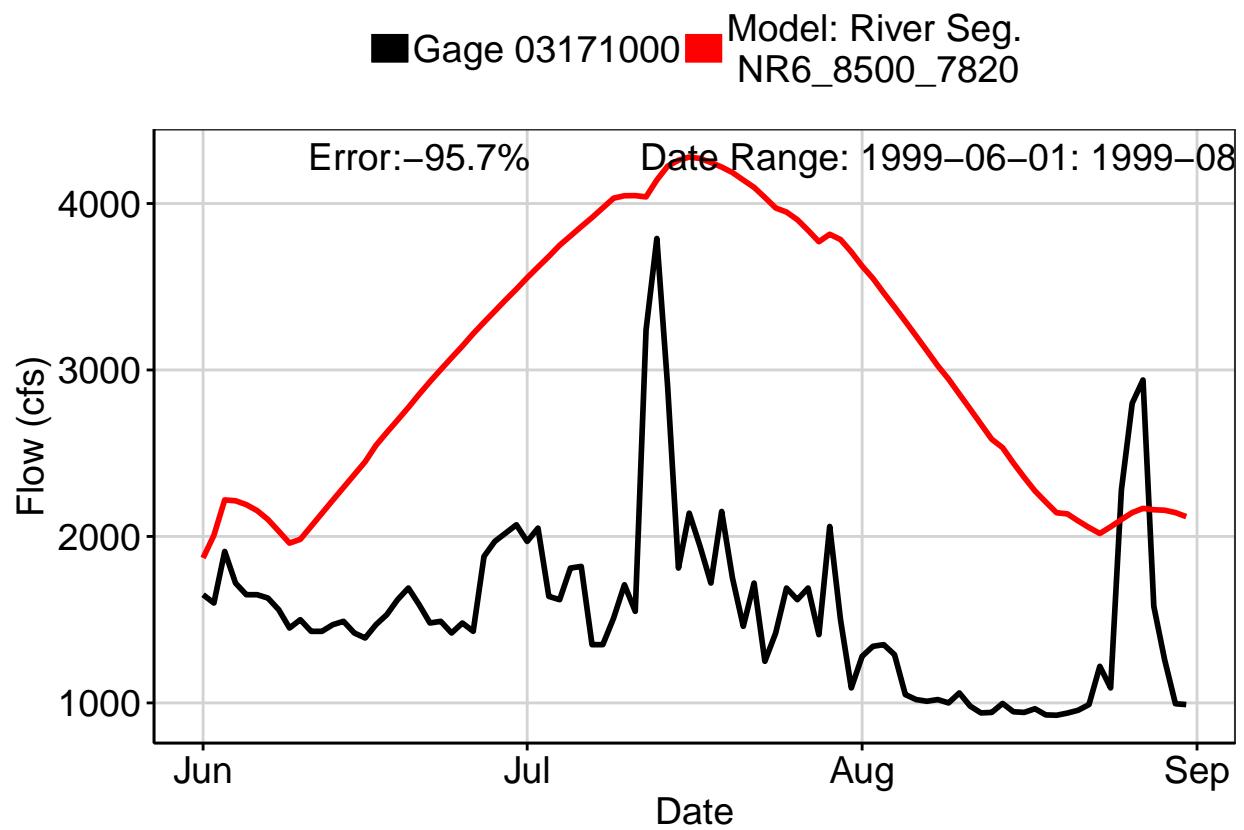
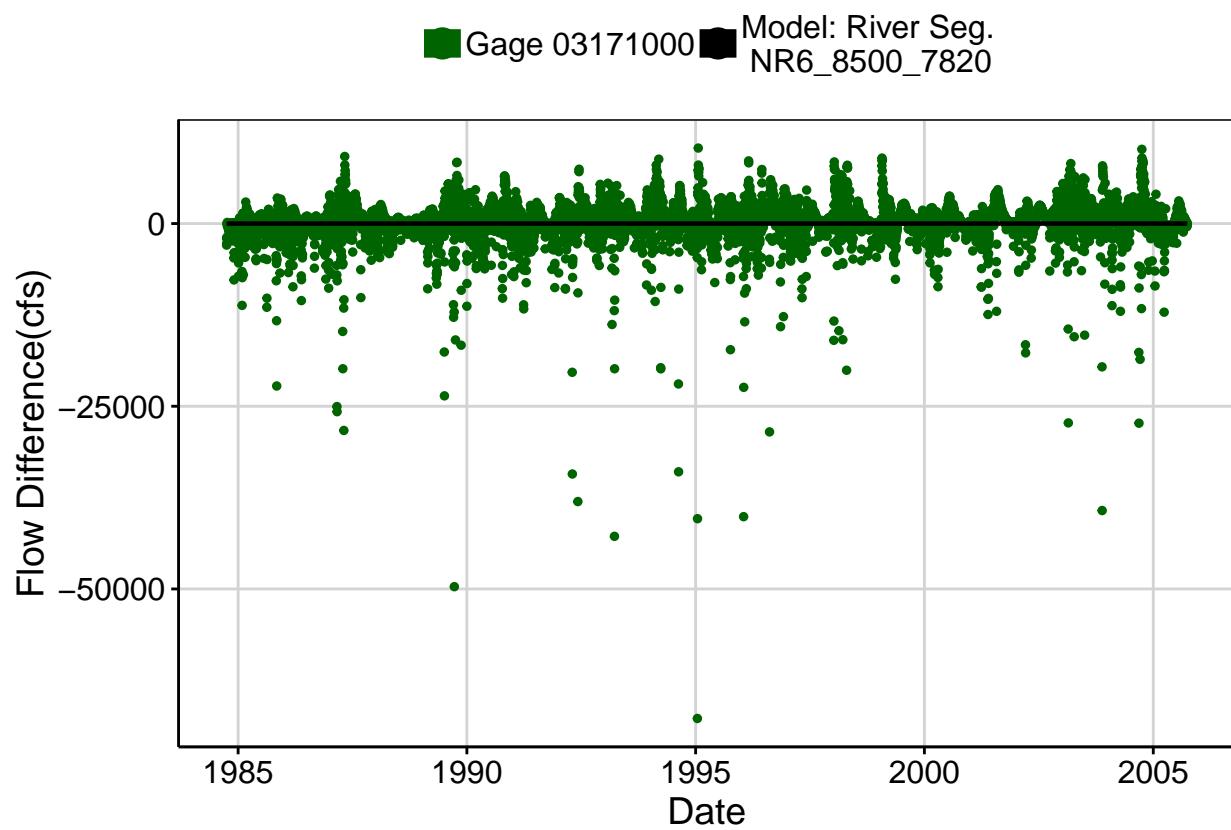
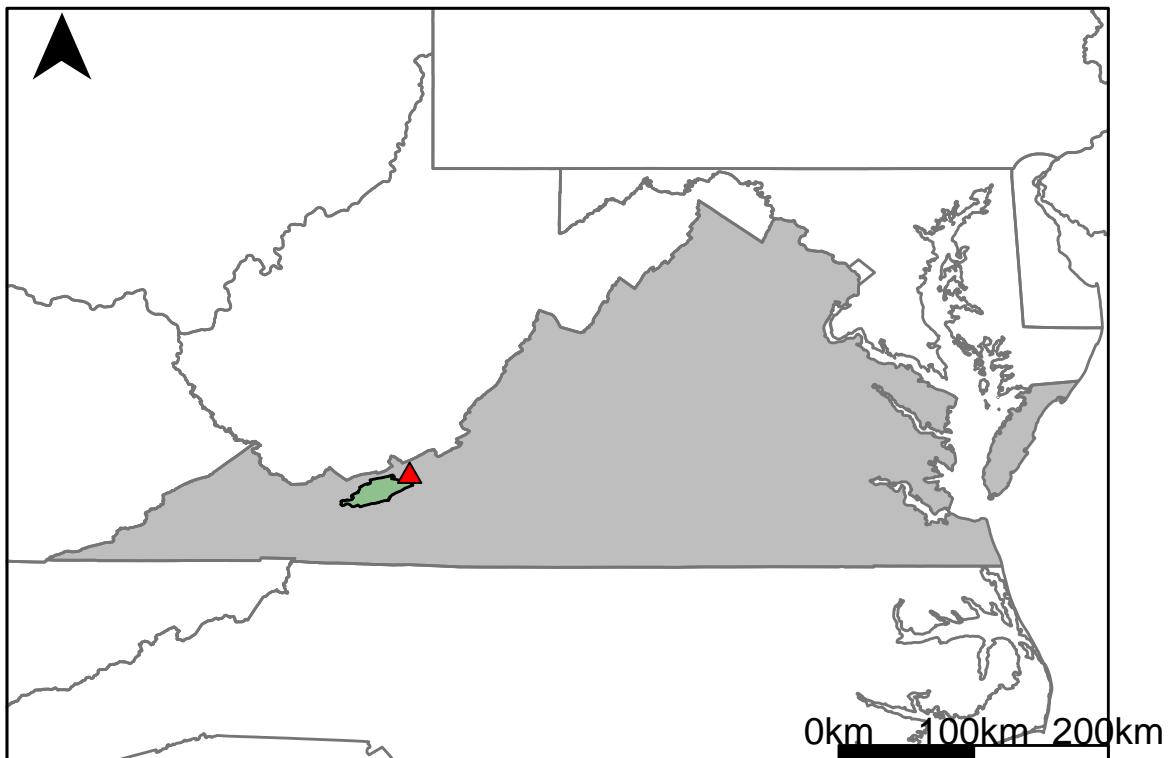


Fig. 9: Residuals Plot



## Appendix F.7: USGS Gage 03173000 vs. NR3\_8290\_8170



This river segment follows part of the flow of the Walker Creek, a tributary of the New River. The gage is located in Giles County, VA (Lat 3716'05", Long 8042'35") approximately 12 miles northwest of Radford, VA. Drainage area is 299 sq. miles. This gage started taking data in 1938 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was -2.48%, with 45.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	44	32	27.3
Feb. Low Flow	53	81	-52.8
Mar. Low Flow	87	126	-44.8
Apr. Low Flow	115	178	-54.8
May Low Flow	177	258	-45.8
Jun. Low Flow	261	304	-16.5
Jul. Low Flow	213	210	1.41
Aug. Low Flow	132	123	6.82
Sep. Low Flow	91	74.3	18.4
Oct. Low Flow	58	33.5	42.2
Nov. Low Flow	51	39.8	22
Dec. Low Flow	43	34.3	20.2

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	323	331	-2.48
Jan. Mean Flow	440	452	-2.73
Feb. Mean Flow	557	604	-8.44
Mar. Mean Flow	641	615	4.06
Apr. Mean Flow	528	468	11.4
May Mean Flow	450	383	14.9
Jun. Mean Flow	276	284	-2.9
Jul. Mean Flow	132	161	-22
Aug. Mean Flow	115	142	-23.5
Sep. Mean Flow	137	174	-27
Oct. Mean Flow	125	174	-39.2
Nov. Mean Flow	198	223	-12.6
Dec. Mean Flow	296	314	-6.08

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	94	125	-33
Feb. High Flow	352	350	0.57
Mar. High Flow	1070	537	49.8
Apr. High Flow	1430	1430	0
May High Flow	1350	1210	10.4
Jun. High Flow	2100	1460	30.5
Jul. High Flow	1150	999	13.1
Aug. High Flow	1310	906	30.8
Sep. High Flow	426	638	-49.8
Oct. High Flow	175	228	-30.3
Nov. High Flow	143	166	-16.1
Dec. High Flow	126	167	-32.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	25	1.47	94.1
Med. 1 Day Min	40	10	75
Min. 3 Day Min	27.1	1.61	94.1
Med. 3 Day Min	40.7	10.5	74.2
Min. 7 Day Min	28.5	2.01	92.9
Med. 7 Day Min	41.3	11.9	71.2
Min. 30 Day Min	33.5	6.39	80.9
Med. 30 Day Min	47.7	27.9	41.5
Min. 90 Day Min	39.3	21.6	45
Med. 90 Day Min	71.1	68.4	3.8
7Q10	31.4	4.56	85.5
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	135	331	-145
Mean Baseflow	156	182	-16.7

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	14100	7340	47.9
Med. 1 Day Max	4560	3740	18
Max. 3 Day Max	6450	4610	28.5
Med. 3 Day Max	3130	2450	21.7
Max. 7 Day Max	3960	2630	33.6
Med. 7 Day Max	1920	1740	9.38
Max. 30 Day Max	1890	1610	14.8
Med. 30 Day Max	903	821	9.08
Max. 90 Day Max	1210	1110	8.26
Med. 90 Day Max	653	606	7.2

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	34	8.87	73.9
5% Non-Exceedance	42	21.3	49.3
50% Non-Exceedance	154	204	-32.5
95% Non-Exceedance	1070	1030	3.74
99% Non-Exceedance	2430	2300	5.35
Sept. 10% Non-Exceedance	18	16.8	6.67

**Fig. 1: Hydrograph**

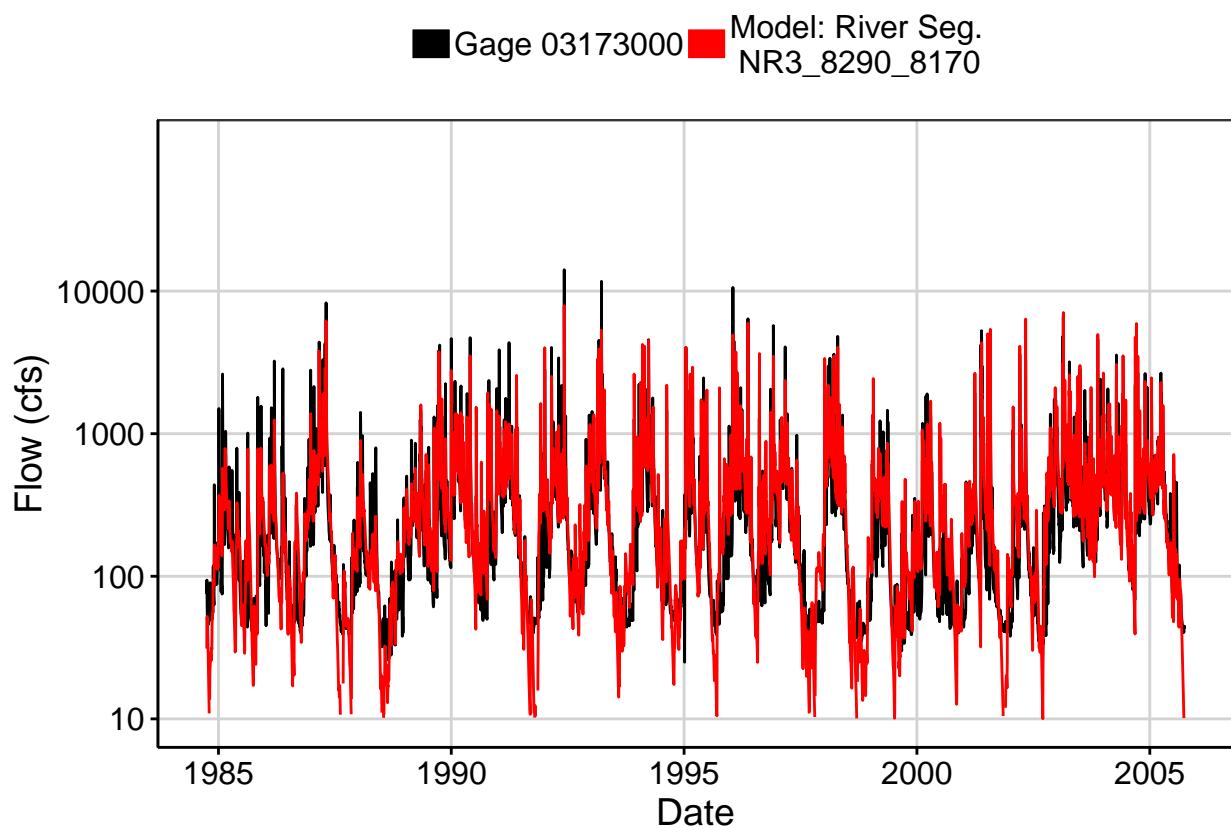


Fig. 2: Zoomed Hydrograph

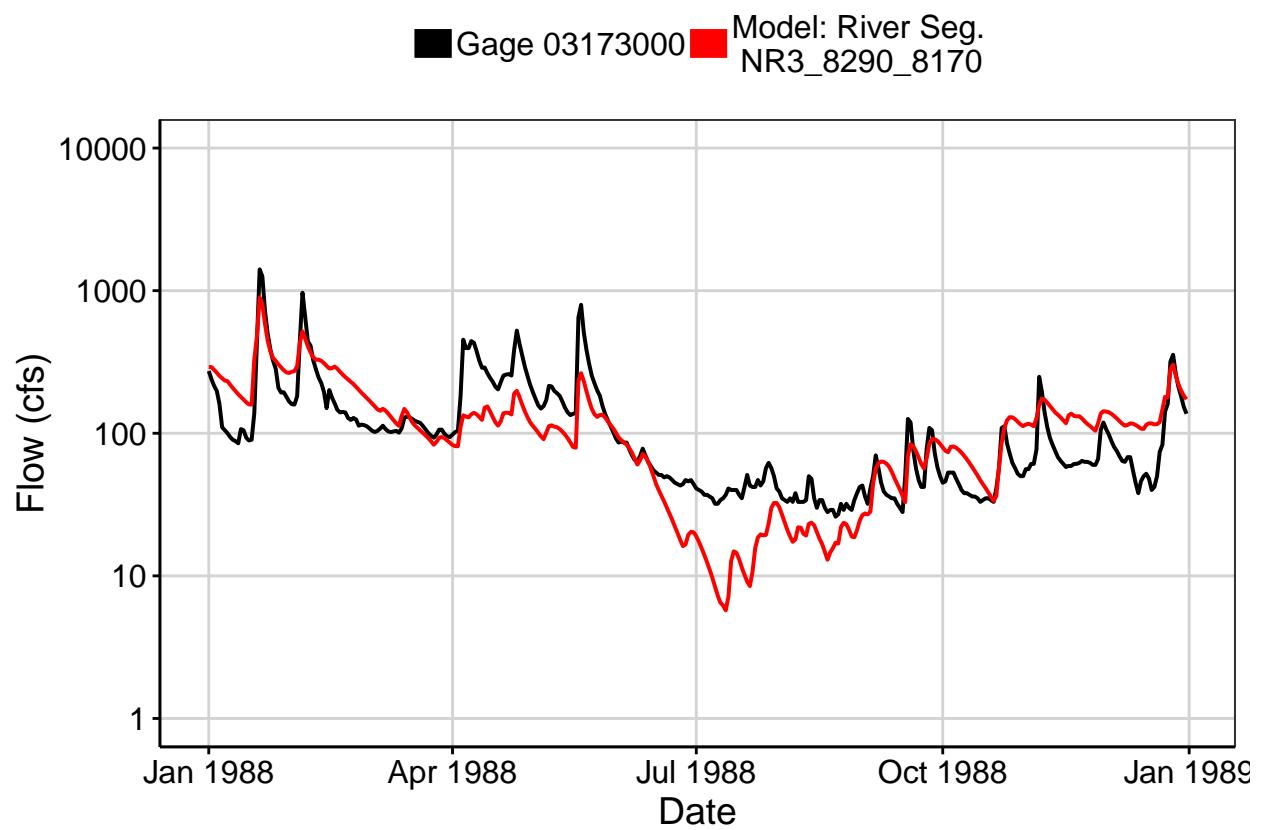


Fig. 3: Flow Exceedance

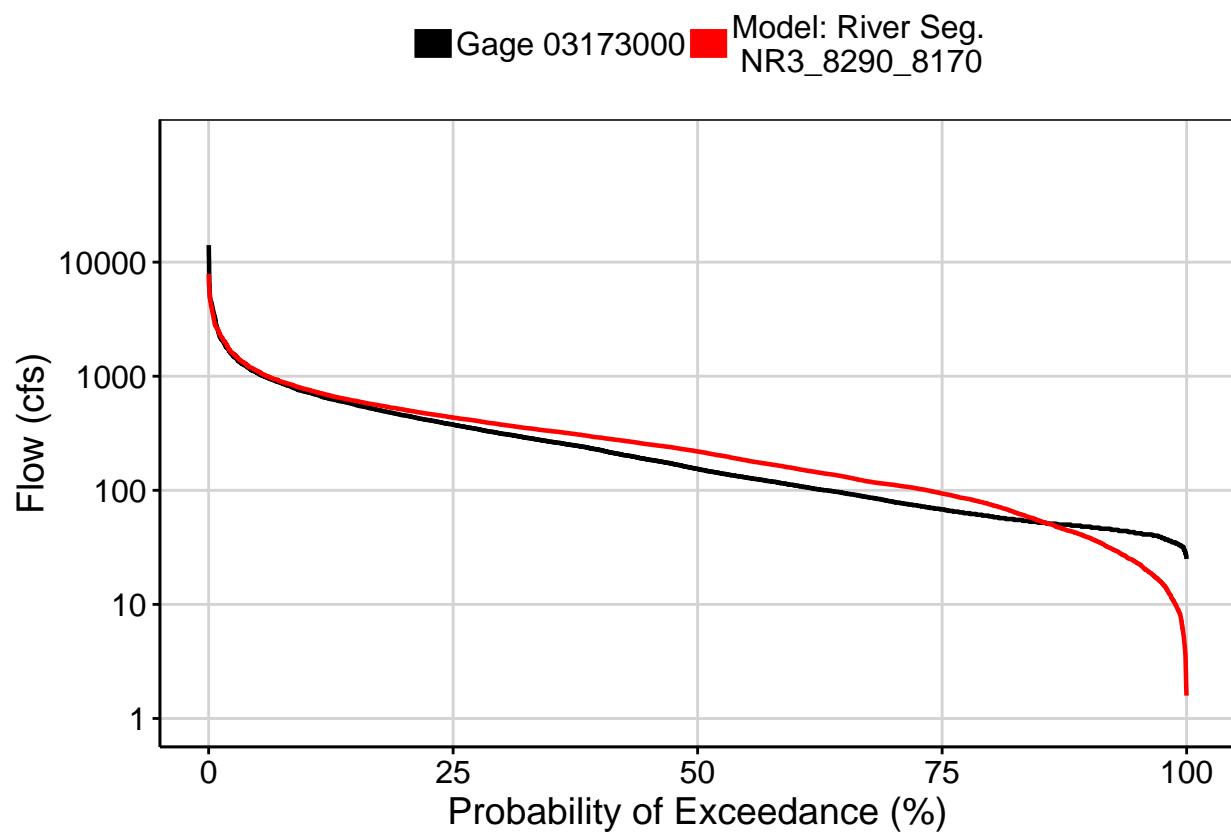


Fig. 4: Baseflow

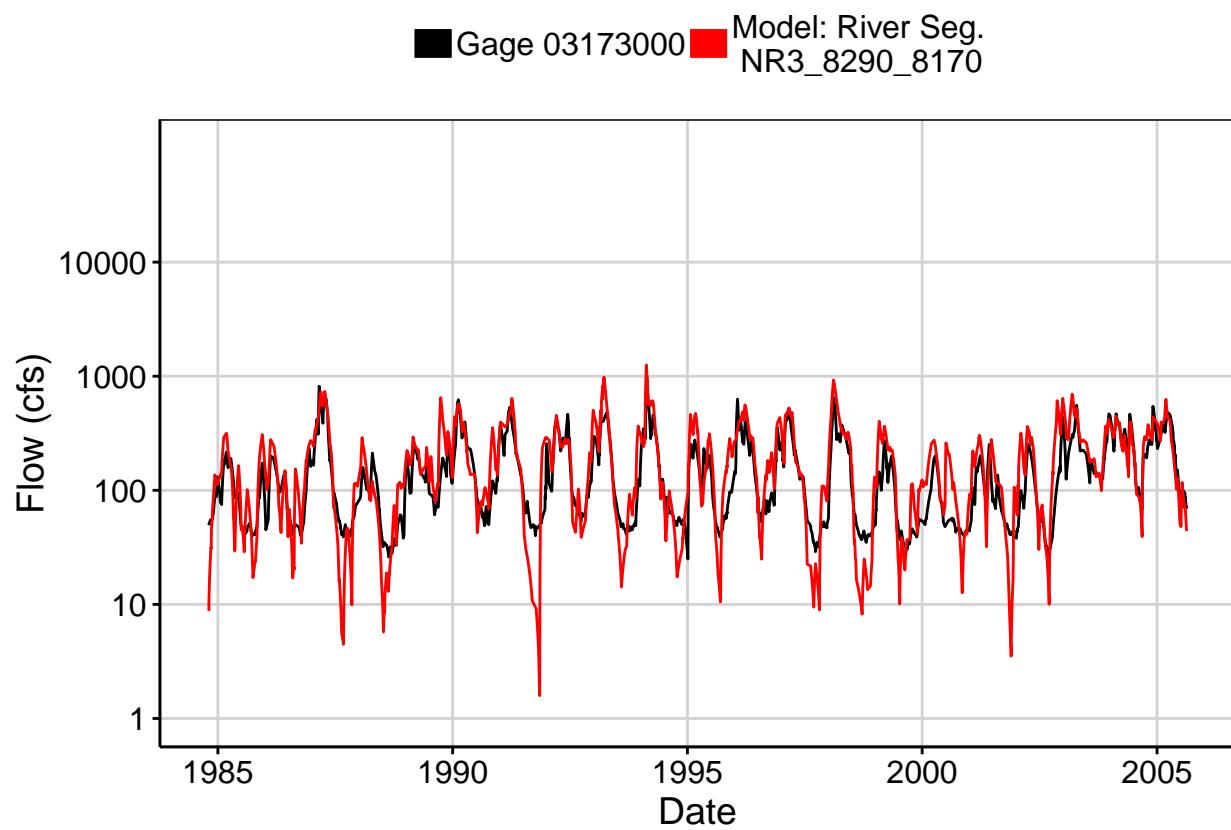


Fig. 5: Combined Baseflow

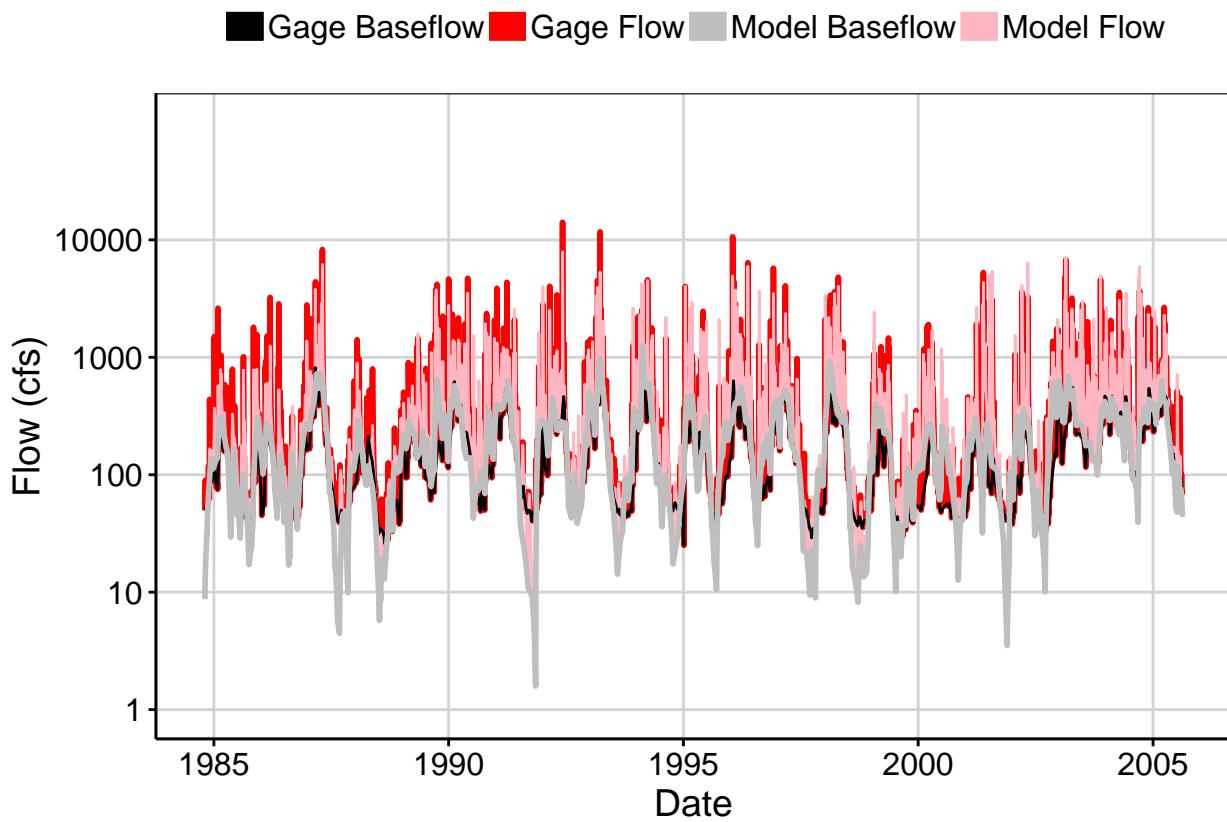


Fig. 6: Largest Error Segment

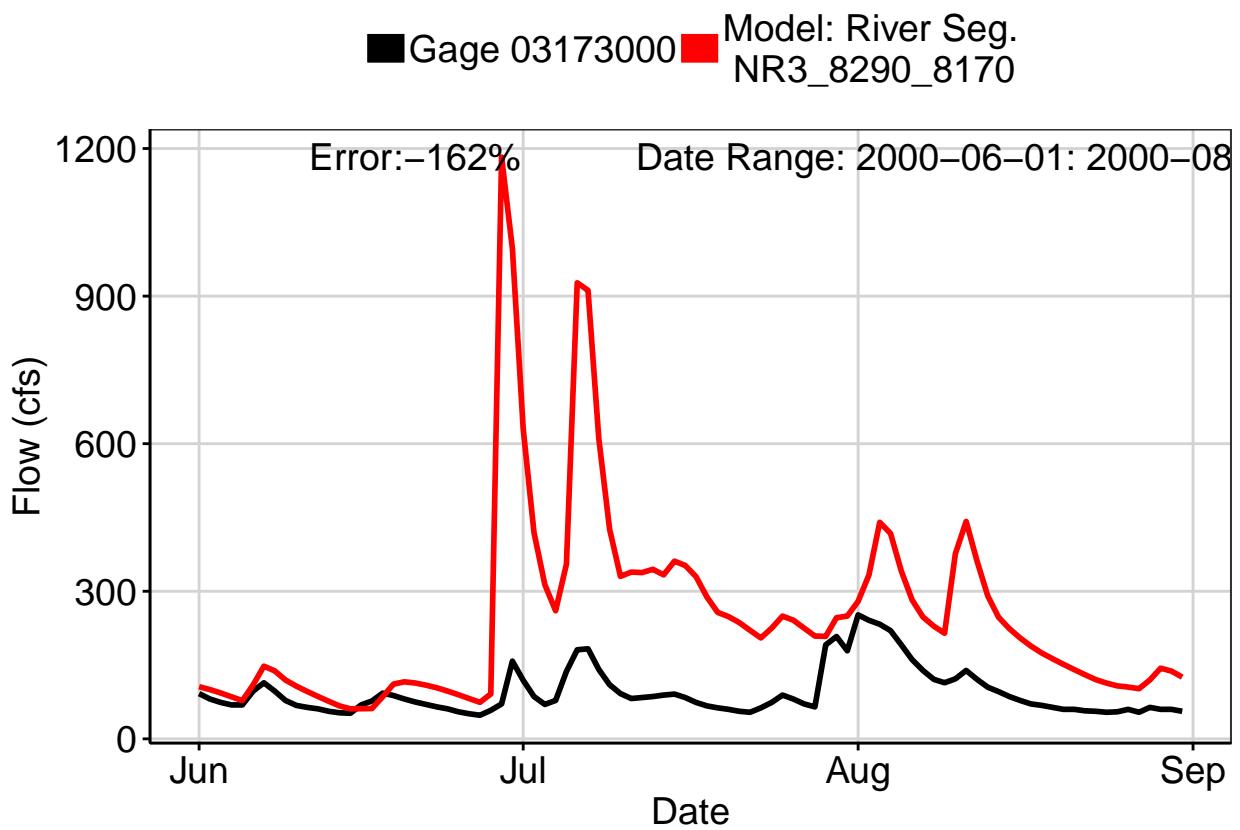


Fig. 7: Second Largest Error Segment

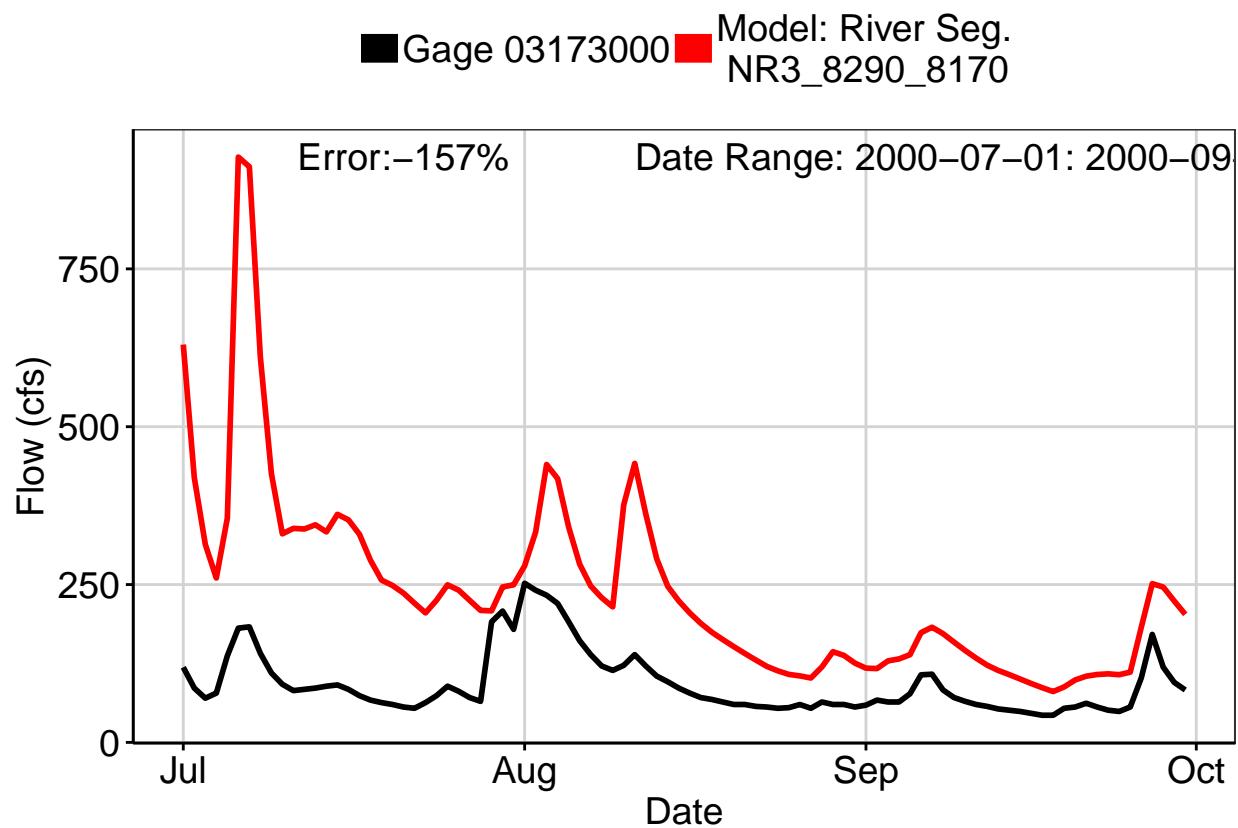


Fig. 8: Third Largest Error Segment

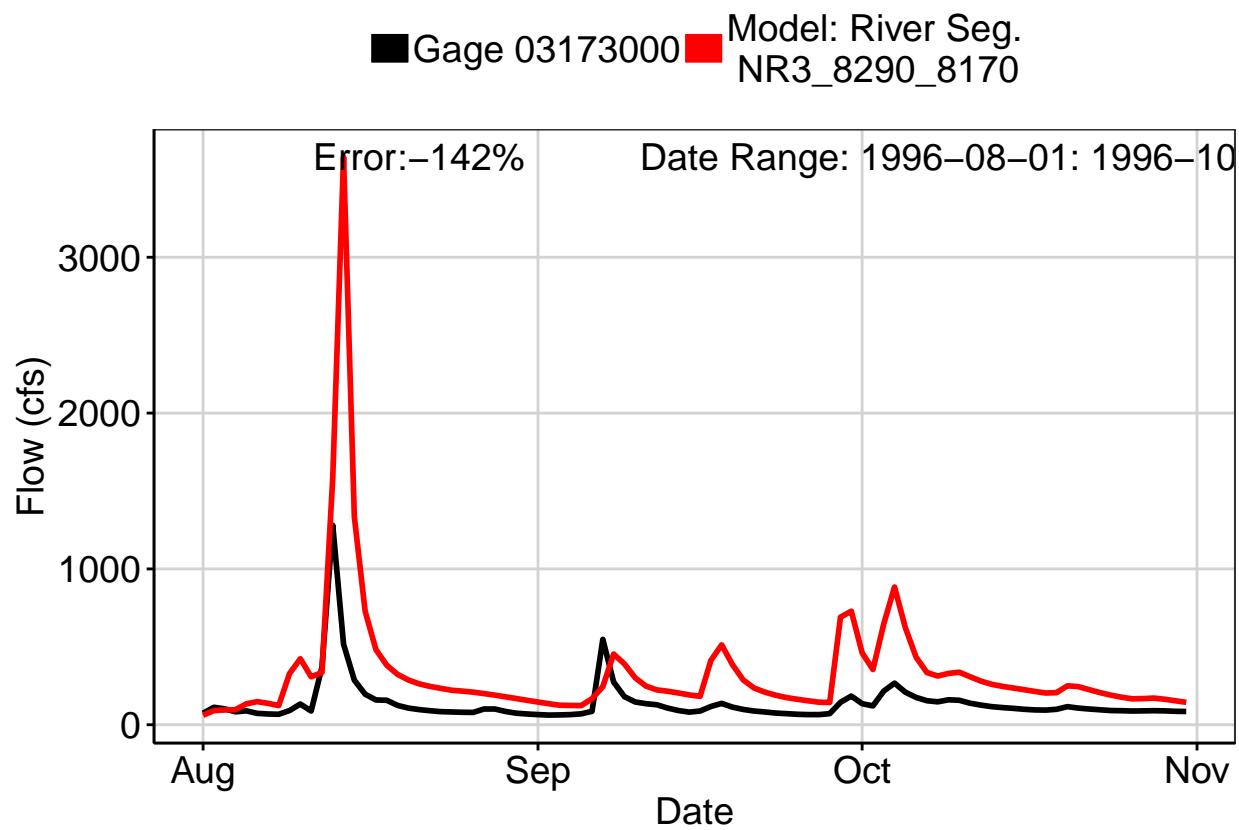
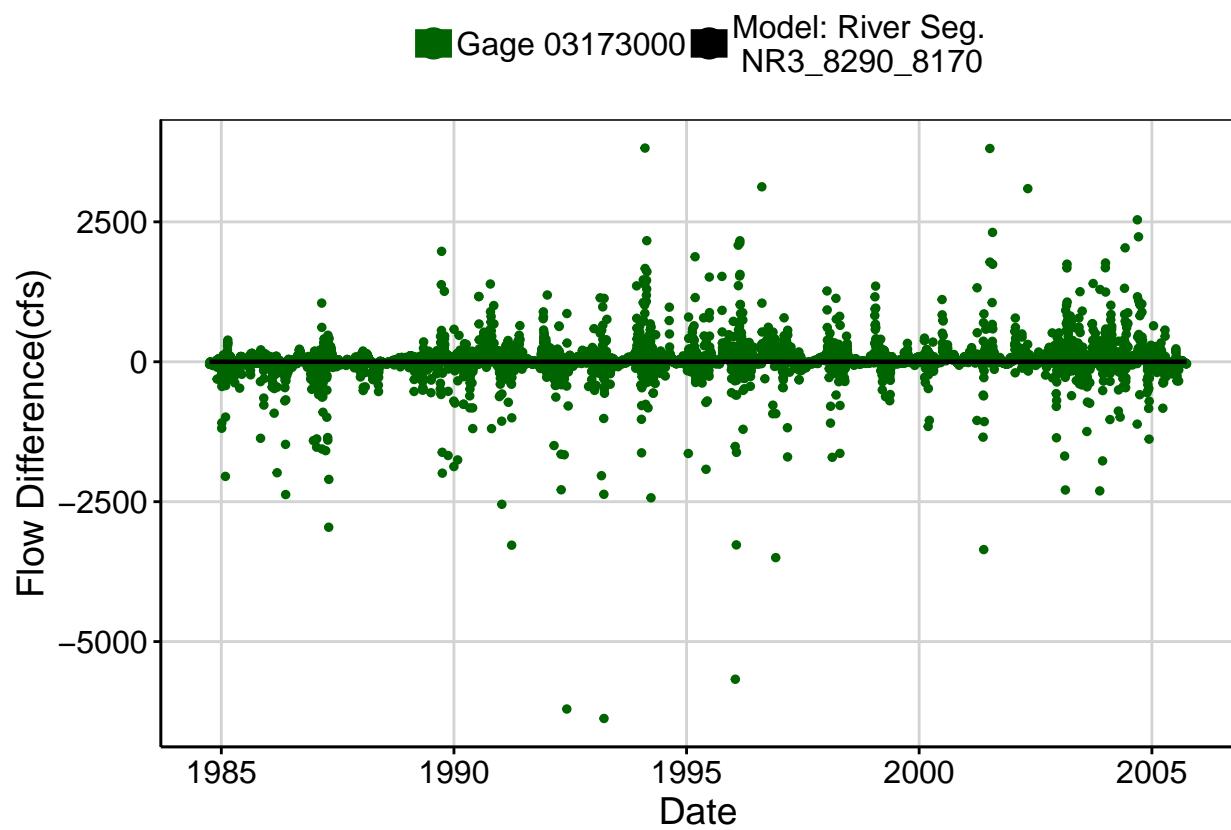
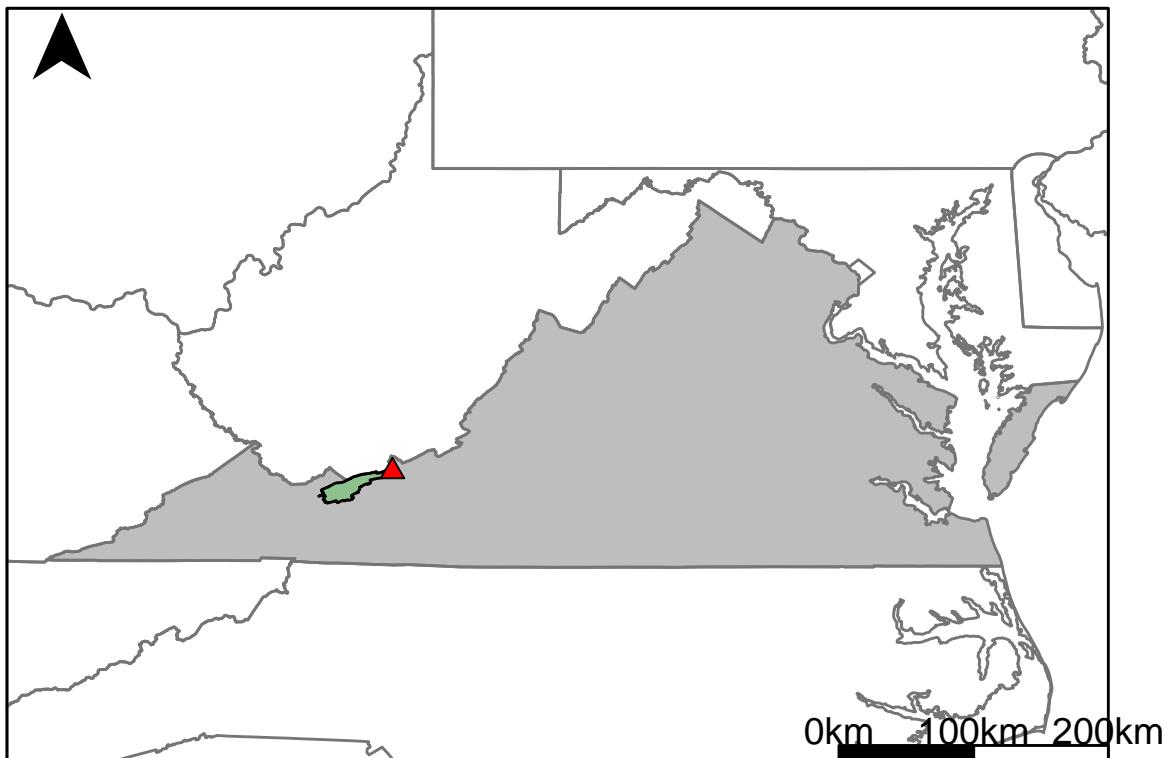


Fig. 9: Residuals Plot



## Appendix F.8: USGS Gage 03175500 vs. NR2\_8210\_8180



This river segment follows part of the flow of the Wolf Creek, a tributary of the New River. The gage is located in Giles County, VA (Lat 37°18'20", Long 80°51'00") approximately 20 miles northwest of Radford, VA. Drainage area is 223 sq. miles. This gage started taking data in 1908 and is still taking data but there is a gap from 1995-10-01 to 1996-09-30. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 2.65%, with 46.7% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	32	31.1	2.81
Feb. Low Flow	45	73.8	-64
Mar. Low Flow	88	97.6	-10.9
Apr. Low Flow	118	153	-29.7
May Low Flow	176	199	-13.1
Jun. Low Flow	244	260	-6.56
Jul. Low Flow	192	173	9.9
Aug. Low Flow	116	94.1	18.9
Sep. Low Flow	76.4	42.4	44.5
Oct. Low Flow	52.7	18.6	64.7
Nov. Low Flow	38	25	34.2
Dec. Low Flow	33.5	19.7	41.2

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	302	294	2.65
Jan. Mean Flow	409	419	-2.44
Feb. Mean Flow	545	560	-2.75
Mar. Mean Flow	594	548	7.74
Apr. Mean Flow	501	398	20.6
May Mean Flow	383	322	15.9
Jun. Mean Flow	237	231	2.53
Jul. Mean Flow	132	133	-0.76
Aug. Mean Flow	102	124	-21.6
Sep. Mean Flow	121	149	-23.1
Oct. Mean Flow	113	154	-36.3
Nov. Mean Flow	199	206	-3.52
Dec. Mean Flow	300	301	-0.33

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	106	137	-29.2
Feb. High Flow	296	400	-35.1
Mar. High Flow	1200	522	56.5
Apr. High Flow	1530	1620	-5.88
May High Flow	1380	1250	9.42
Jun. High Flow	1650	1660	-0.61
Jul. High Flow	871	894	-2.64
Aug. High Flow	958	865	9.71
Sep. High Flow	438	517	-18
Oct. High Flow	312	177	43.3
Nov. High Flow	154	193	-25.3
Dec. High Flow	155	145	6.45

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	10	0	100
Med. 1 Day Min	28	2.75	90.2
Min. 3 Day Min	11.3	0.01	99.9
Med. 3 Day Min	29	4.64	84
Min. 7 Day Min	16	0.45	97.2
Med. 7 Day Min	31.5	5.66	82
Min. 30 Day Min	23.1	3.54	84.7
Med. 30 Day Min	38.2	20.8	45.5
Min. 90 Day Min	33.2	14	57.8
Med. 90 Day Min	64	61.8	3.44
7Q10	20.5	0.96	95.3
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	126	294	-133
Mean Baseflow	146	148	-1.37

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	7910	6620	16.3
Med. 1 Day Max	3810	3760	1.31
Max. 3 Day Max	5630	4150	26.3
Med. 3 Day Max	2590	2310	10.8
Max. 7 Day Max	3080	2370	23.1
Med. 7 Day Max	1630	1640	-0.61
Max. 30 Day Max	1770	1480	16.4
Med. 30 Day Max	850	719	15.4
Max. 90 Day Max	1110	989	10.9
Med. 90 Day Max	632	577	8.7

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	24	2.87	88
5% Non-Exceedance	33	11.8	64.2
50% Non-Exceedance	159	175	-10.1
95% Non-Exceedance	969	937	3.3
99% Non-Exceedance	1930	2140	-10.9
Sept. 10% Non-Exceedance	5.95	6.15	-3.36

**Fig. 1: Hydrograph**

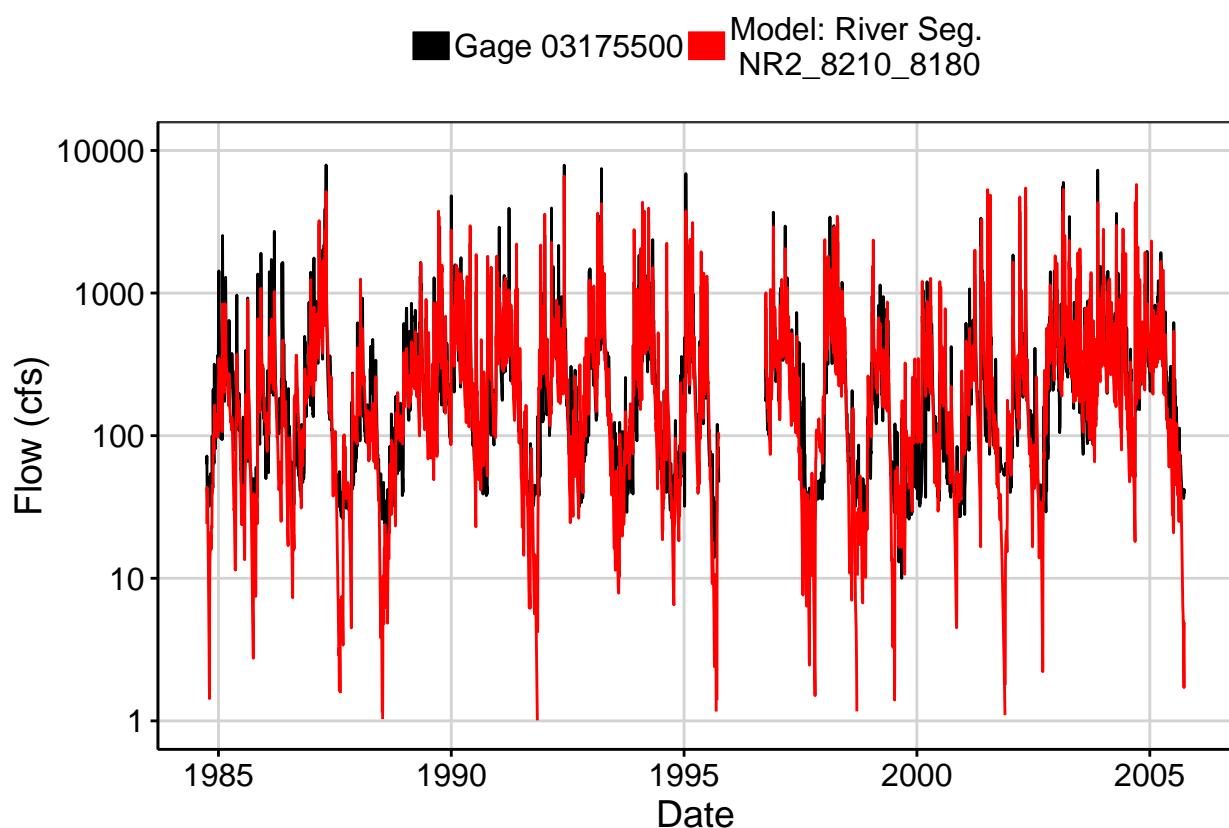


Fig. 2: Zoomed Hydrograph

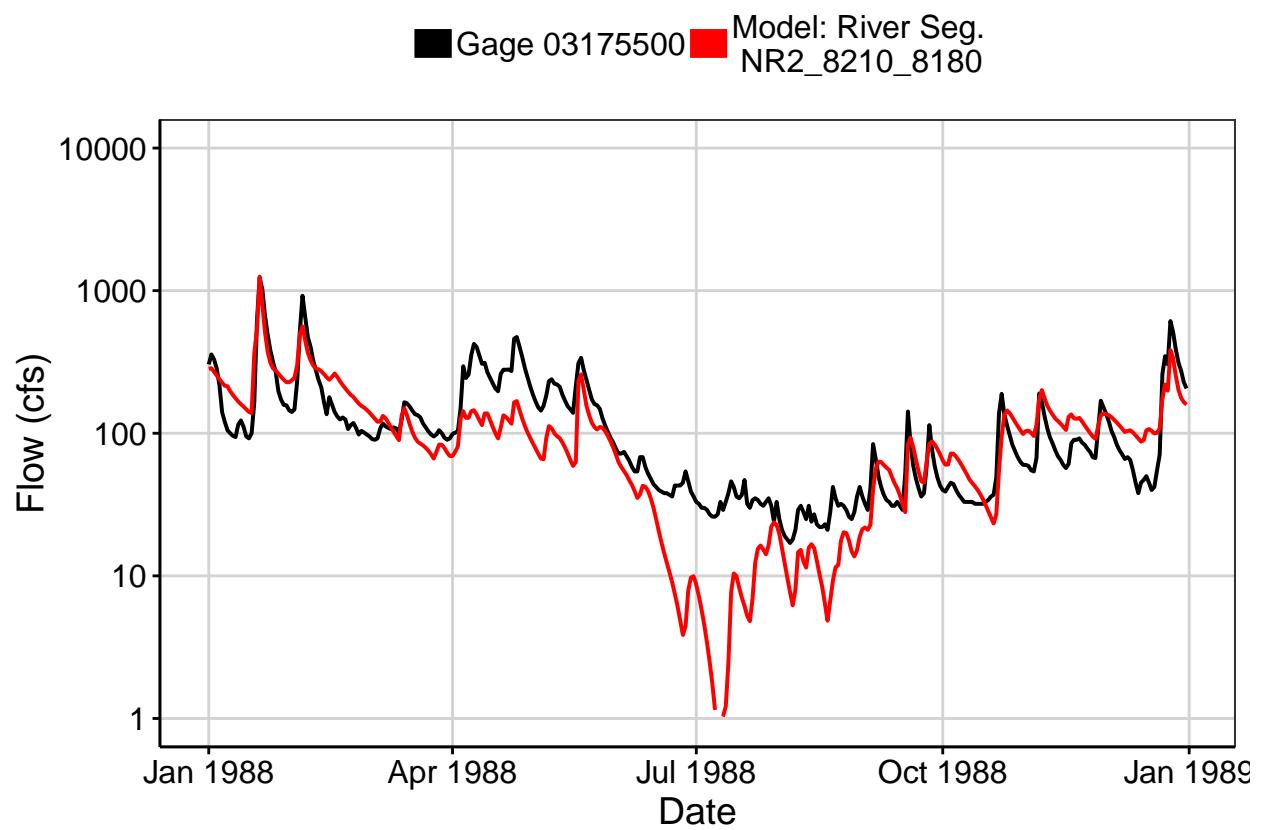


Fig. 3: Flow Exceedance

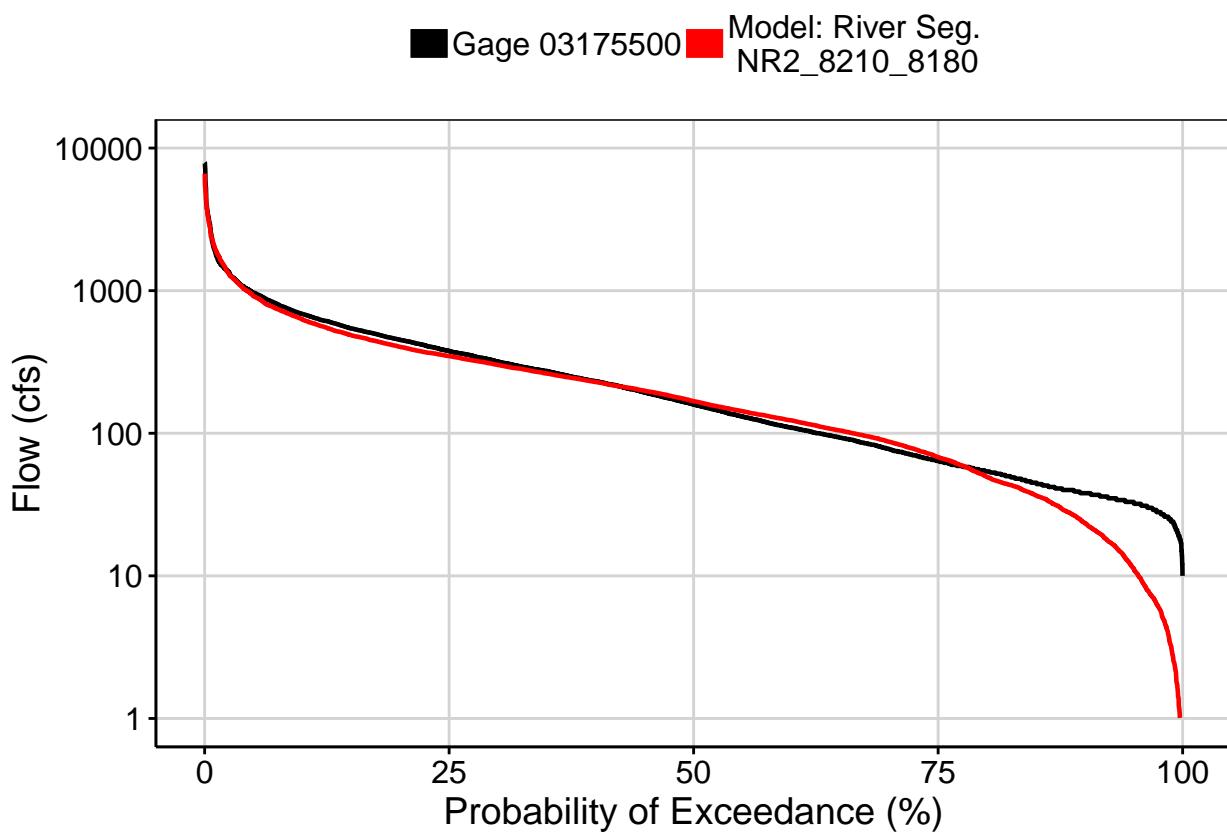


Fig. 4: Baseflow

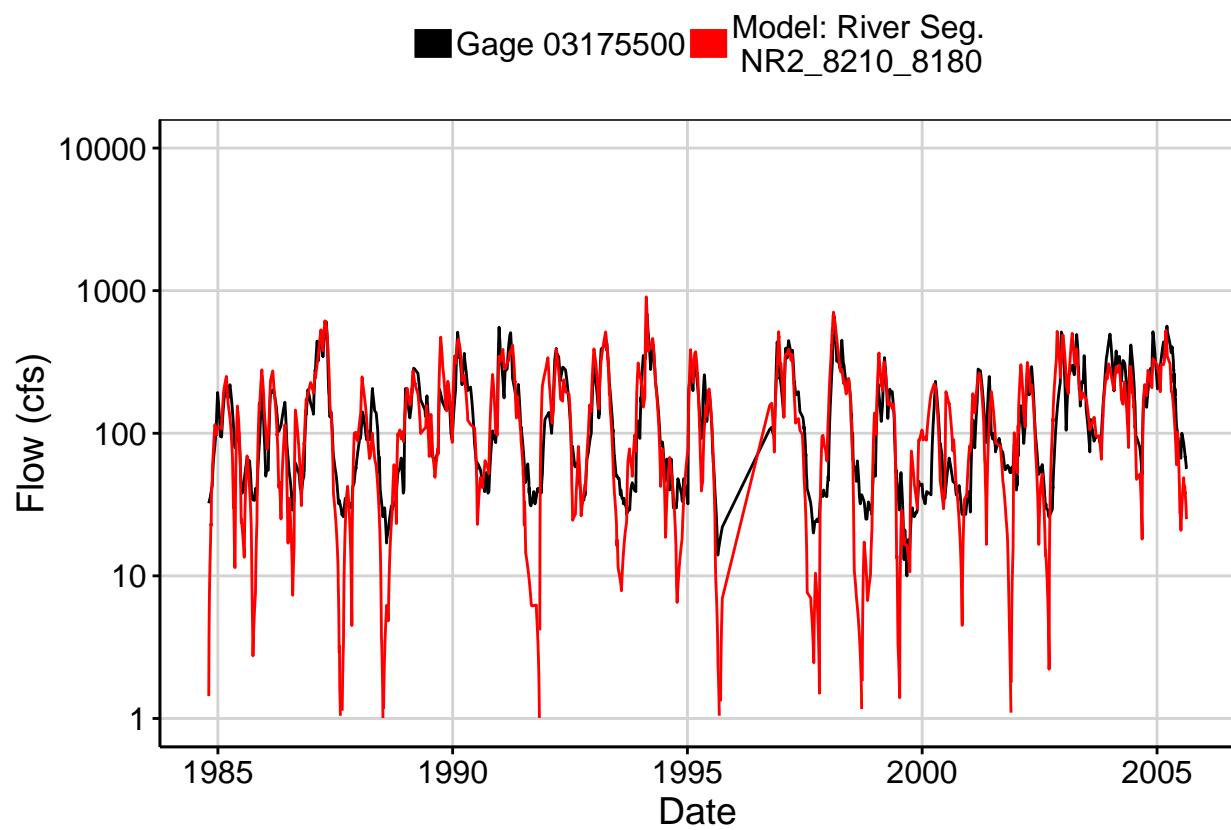


Fig. 5: Combined Baseflow

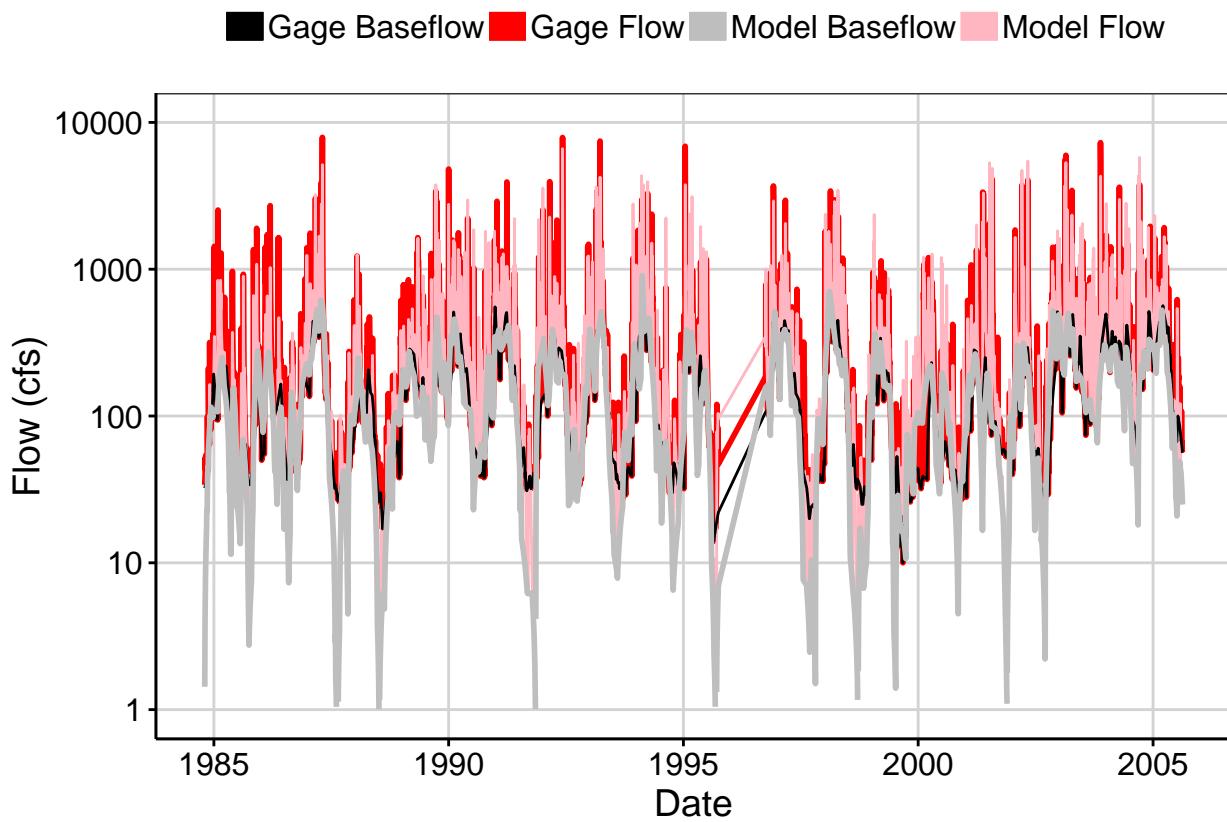


Fig. 6: Largest Error Segment

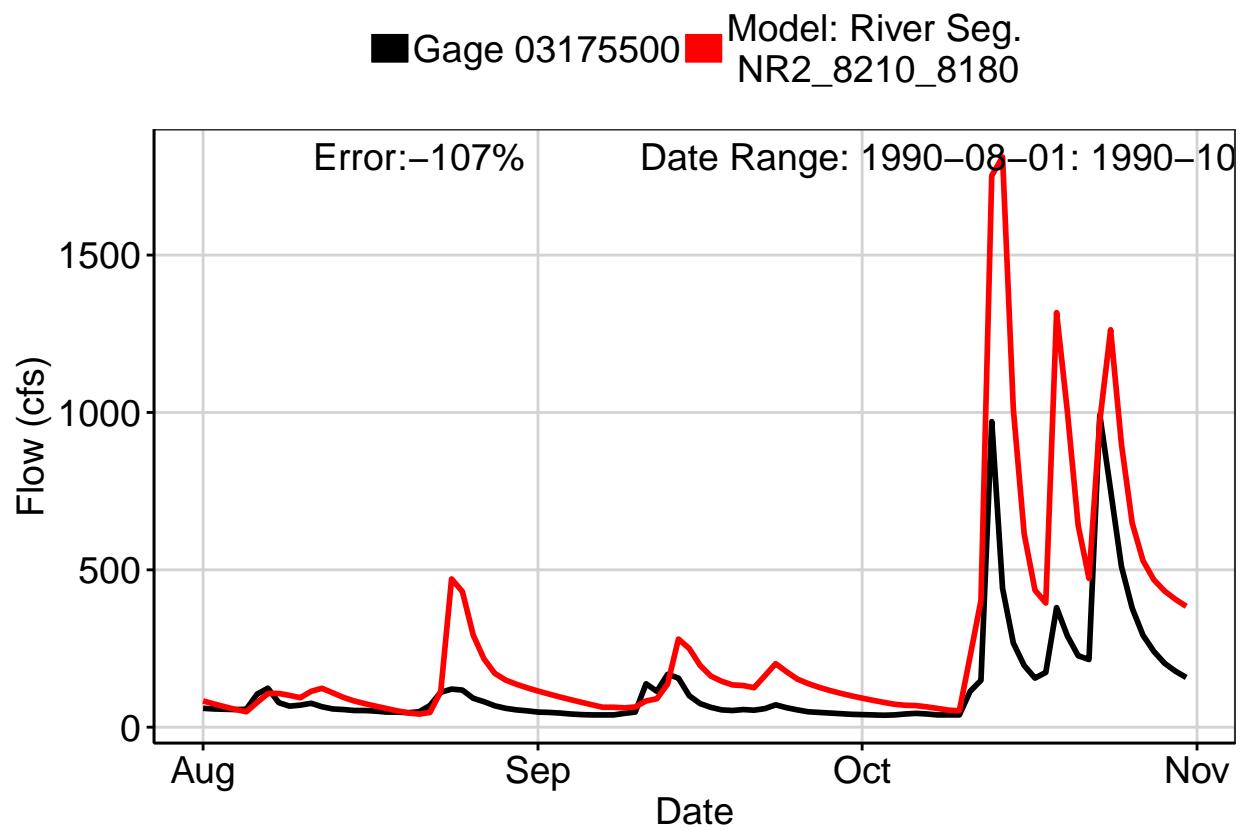


Fig. 7: Second Largest Error Segment

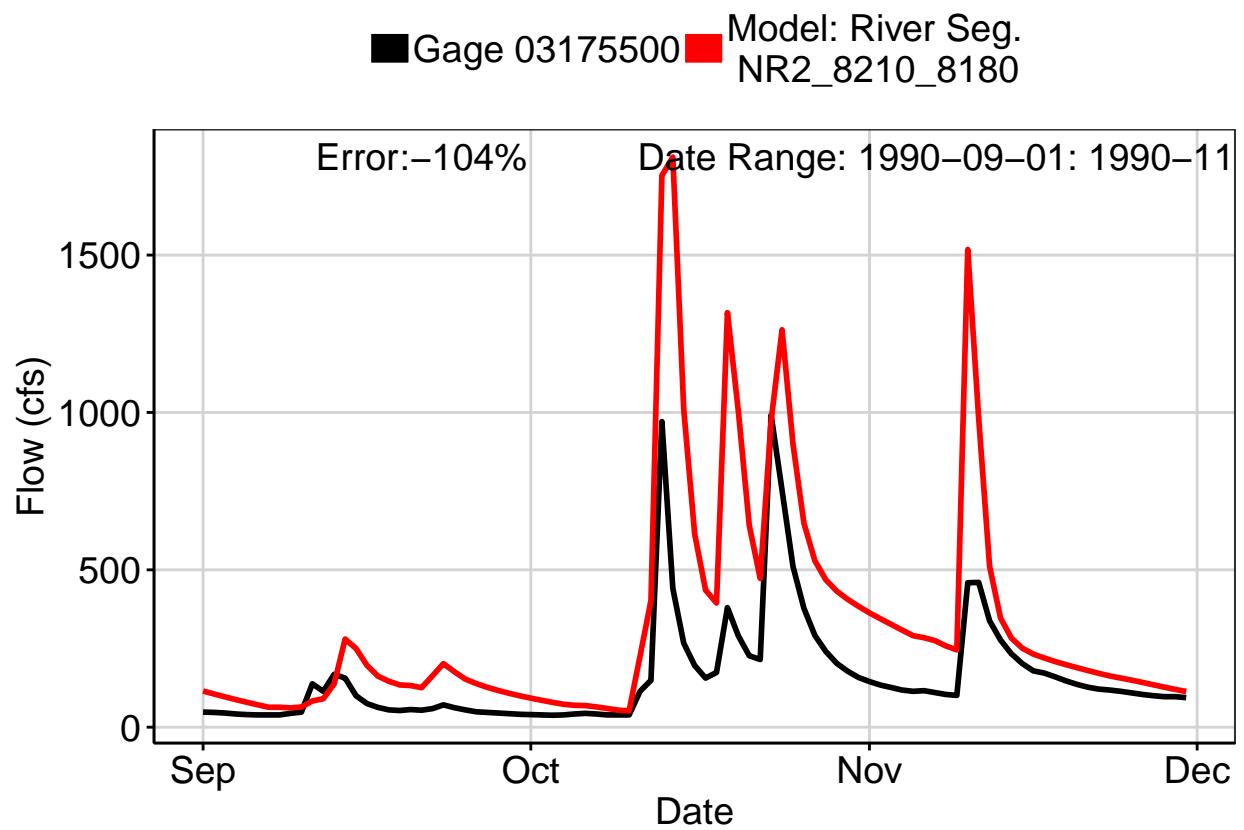


Fig. 8: Third Largest Error Segment

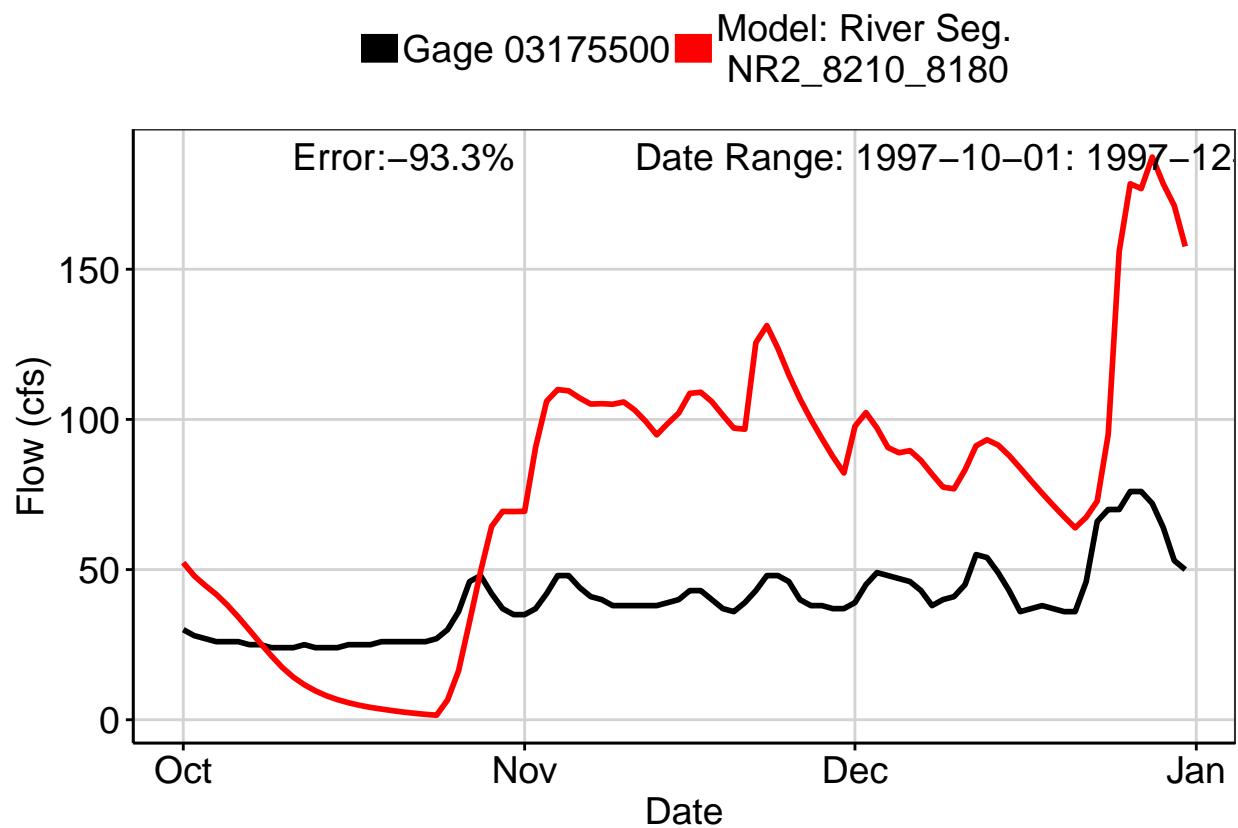
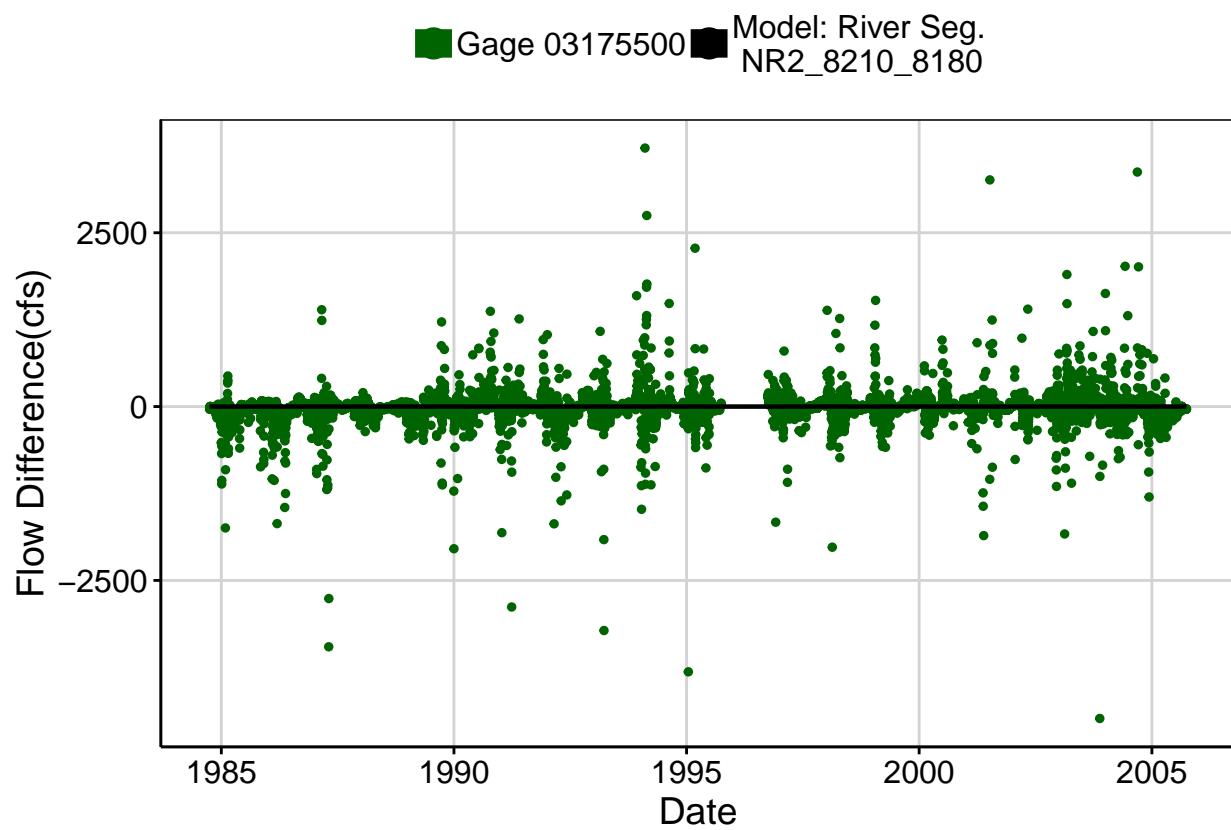
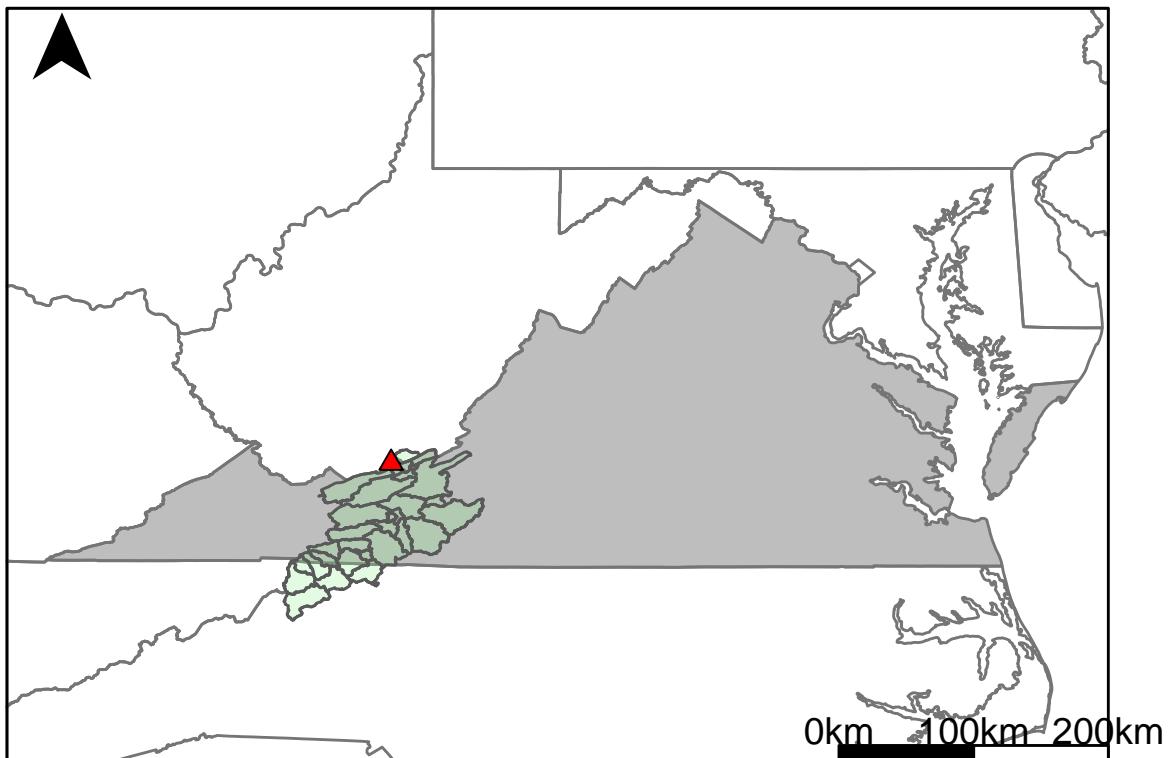


Fig. 9: Residuals Plot



## Appendix F.8: USGS Gage 03176500 vs. NR6\_8051\_8000



This river segment follows part of the flow of the New River. The gage is located in Giles County, VA (Lat 37°22'22", Long 80°51'39") approximately 23 miles northwest of Radford, VA. Drainage area is 3783 sq. miles. This gage started taking data in 1927 and is still taking data. The Claytor dam and American Electric Power Company Power Plant is 55 miles upstream which causes a diversion of water. The water is withdrawn upstream and discharged into the East River just above its confluence with the New River. The average daily discharge error between the model and gage data for the 20 year timespan was -0.6%, with 36.7% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	1190	1310	-10.1
Feb. Low Flow	1310	1420	-8.4
Mar. Low Flow	1500	2740	-82.7
Apr. Low Flow	1710	3170	-85.4
May Low Flow	2050	4790	-134
Jun. Low Flow	2920	5060	-73.3
Jul. Low Flow	2440	2890	-18.4
Aug. Low Flow	2990	2170	27.4
Sep. Low Flow	2280	2630	-15.4
Oct. Low Flow	1520	3860	-154
Nov. Low Flow	1310	2540	-93.9
Dec. Low Flow	1250	1600	-28

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	4980	5010	-0.6
Jan. Mean Flow	6110	5880	3.76
Feb. Mean Flow	7230	7130	1.38
Mar. Mean Flow	8050	7850	2.48
Apr. Mean Flow	7280	6240	14.3
May Mean Flow	5980	4540	24.1
Jun. Mean Flow	4710	4800	-1.91
Jul. Mean Flow	3230	4740	-46.7
Aug. Mean Flow	2960	4040	-36.5
Sep. Mean Flow	3110	3430	-10.3
Oct. Mean Flow	2900	3470	-19.7
Nov. Mean Flow	4010	3760	6.23
Dec. Mean Flow	4440	4400	0.9

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	4800	2690	44
Feb. High Flow	7460	3140	57.9
Mar. High Flow	8320	5750	30.9
Apr. High Flow	13000	12300	5.38
May High Flow	13700	10300	24.8
Jun. High Flow	17600	11800	33
Jul. High Flow	14600	8750	40.1
Aug. High Flow	12400	9540	23.1
Sep. High Flow	7530	6590	12.5
Oct. High Flow	5620	5510	1.96
Nov. High Flow	5500	4950	10
Dec. High Flow	4630	3310	28.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	557	896	-60.9
Med. 1 Day Min	1130	1060	6.19
Min. 3 Day Min	618	896	-45
Med. 3 Day Min	1180	1070	9.32
Min. 7 Day Min	646	898	-39
Med. 7 Day Min	1250	1130	9.6
Min. 30 Day Min	947	918	3.06
Med. 30 Day Min	1540	1360	11.7
Min. 90 Day Min	1280	1150	10.2
Med. 90 Day Min	2240	2370	-5.8
7Q10	852	926	-8.69
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	2510	5010	-99.6
Mean Baseflow	2560	3900	-52.3

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	89400	41300	53.8
Med. 1 Day Max	40000	23300	41.8
Max. 3 Day Max	58600	34800	40.6
Med. 3 Day Max	29500	20400	30.8
Max. 7 Day Max	39100	27100	30.7
Med. 7 Day Max	20100	16900	15.9
Max. 30 Day Max	21100	19200	9
Med. 30 Day Max	11300	11800	-4.42
Max. 90 Day Max	14300	14200	0.7
Med. 90 Day Max	8850	8200	7.34

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	954	976	-2.31
5% Non-Exceedance	1210	1210	0
50% Non-Exceedance	3480	3930	-12.9
95% Non-Exceedance	13200	12900	2.27
99% Non-Exceedance	25200	19600	22.2
Sept. 10% Non-Exceedance	1250	1250	0

**Fig. 1: Hydrograph**

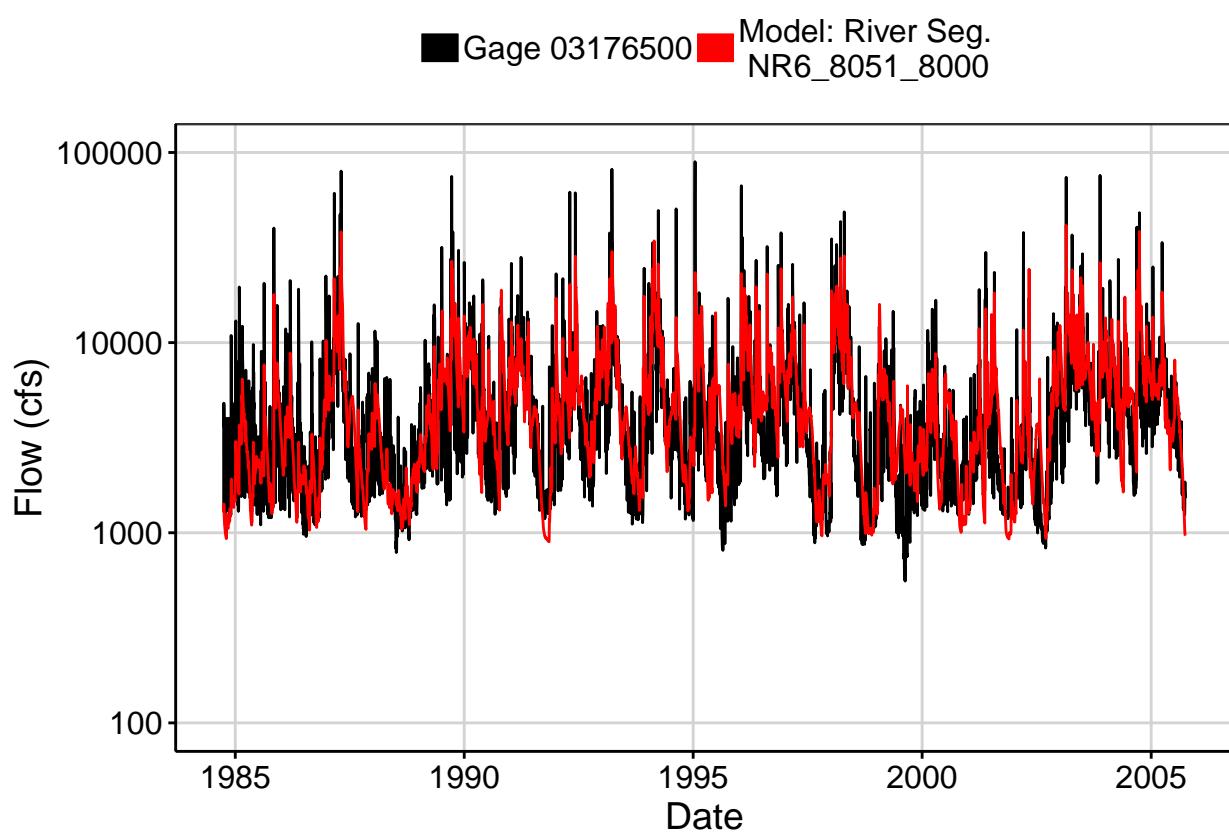


Fig. 2: Zoomed Hydrograph

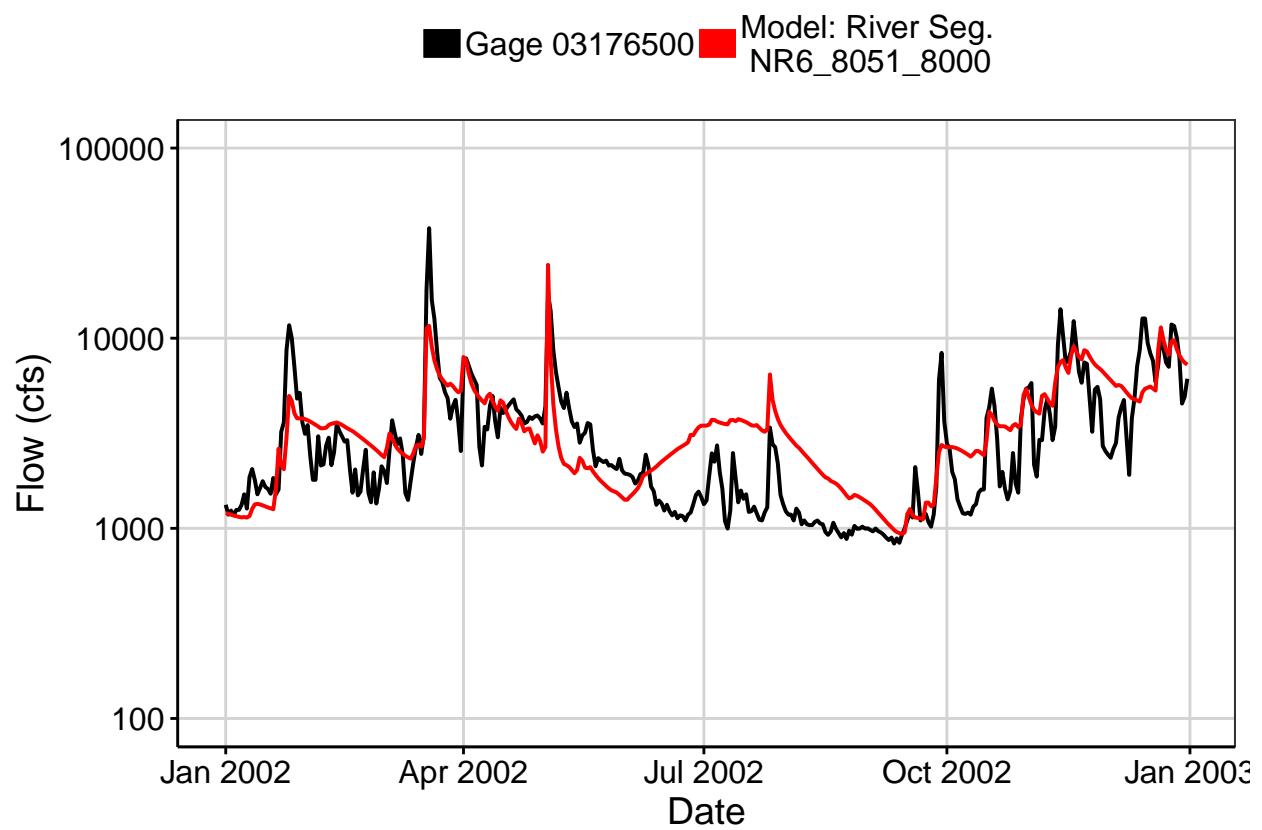


Fig. 3: Flow Exceedance

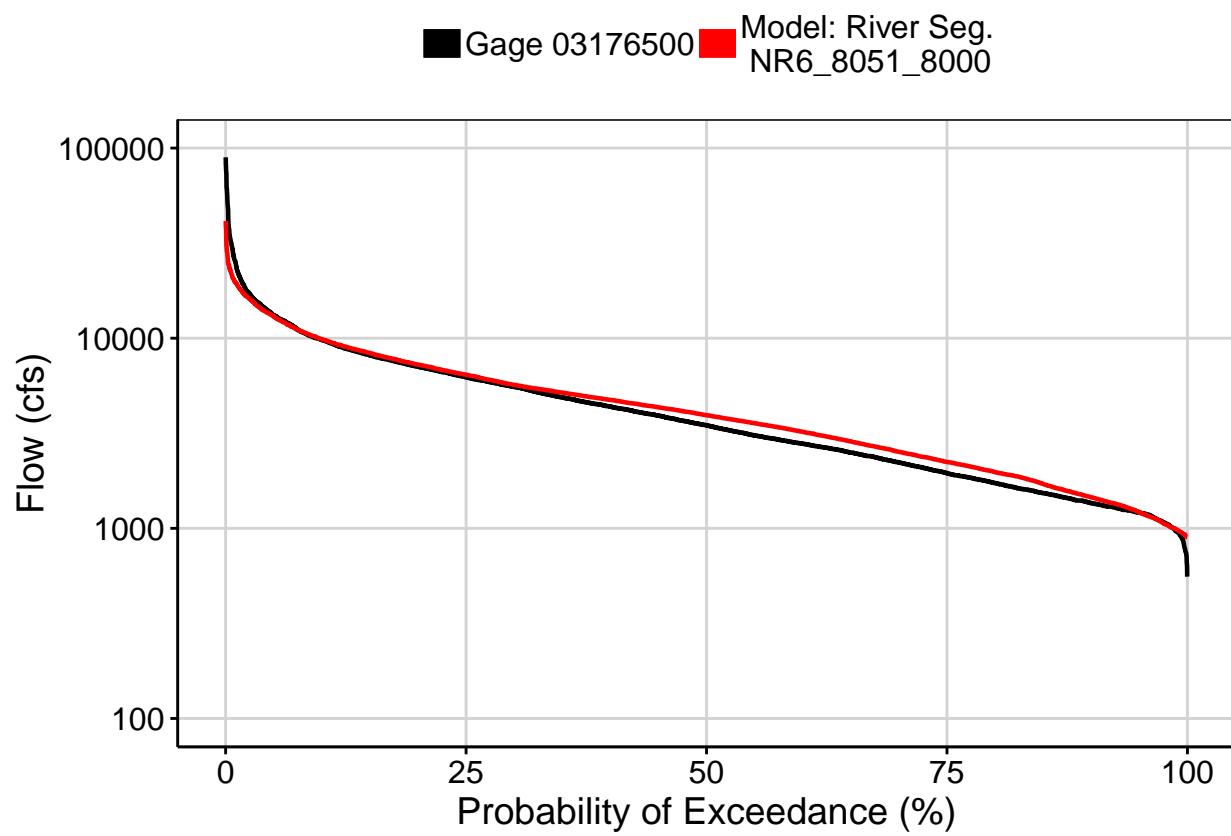


Fig. 4: Baseflow

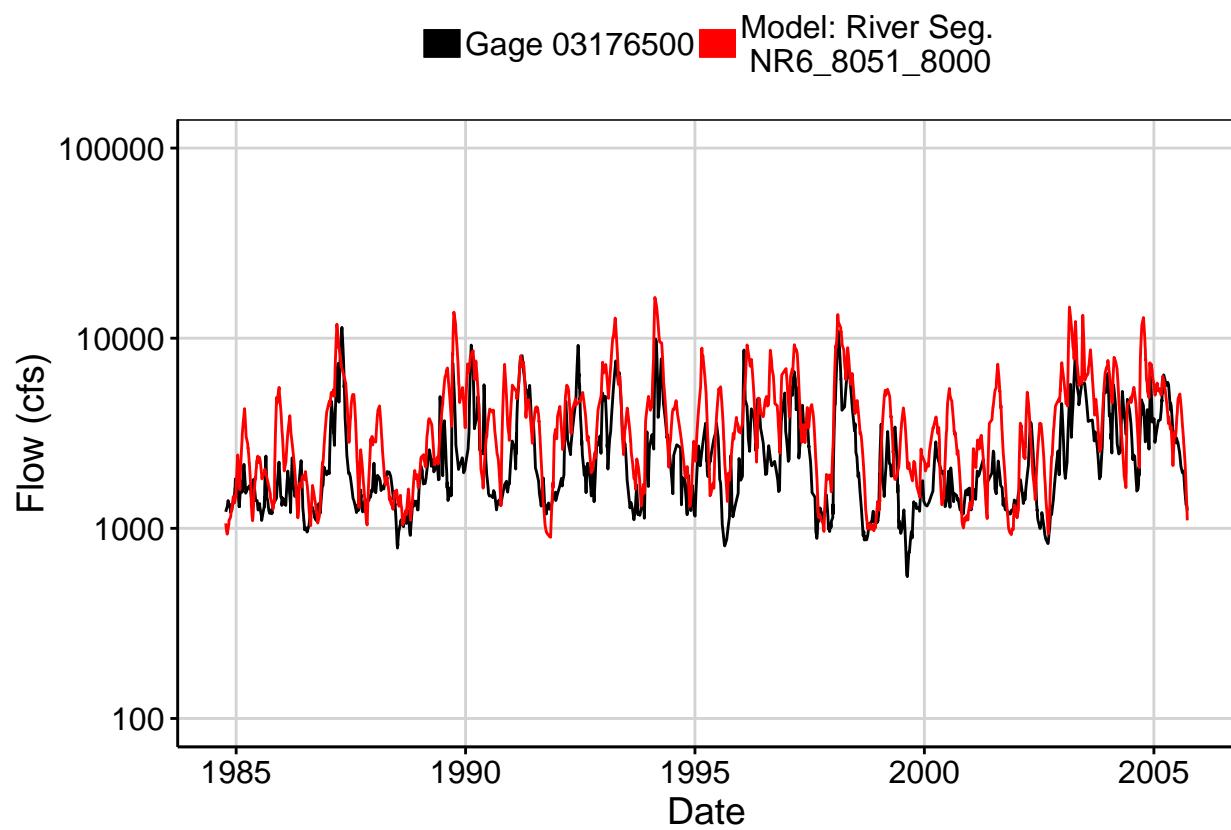


Fig. 5: Combined Baseflow

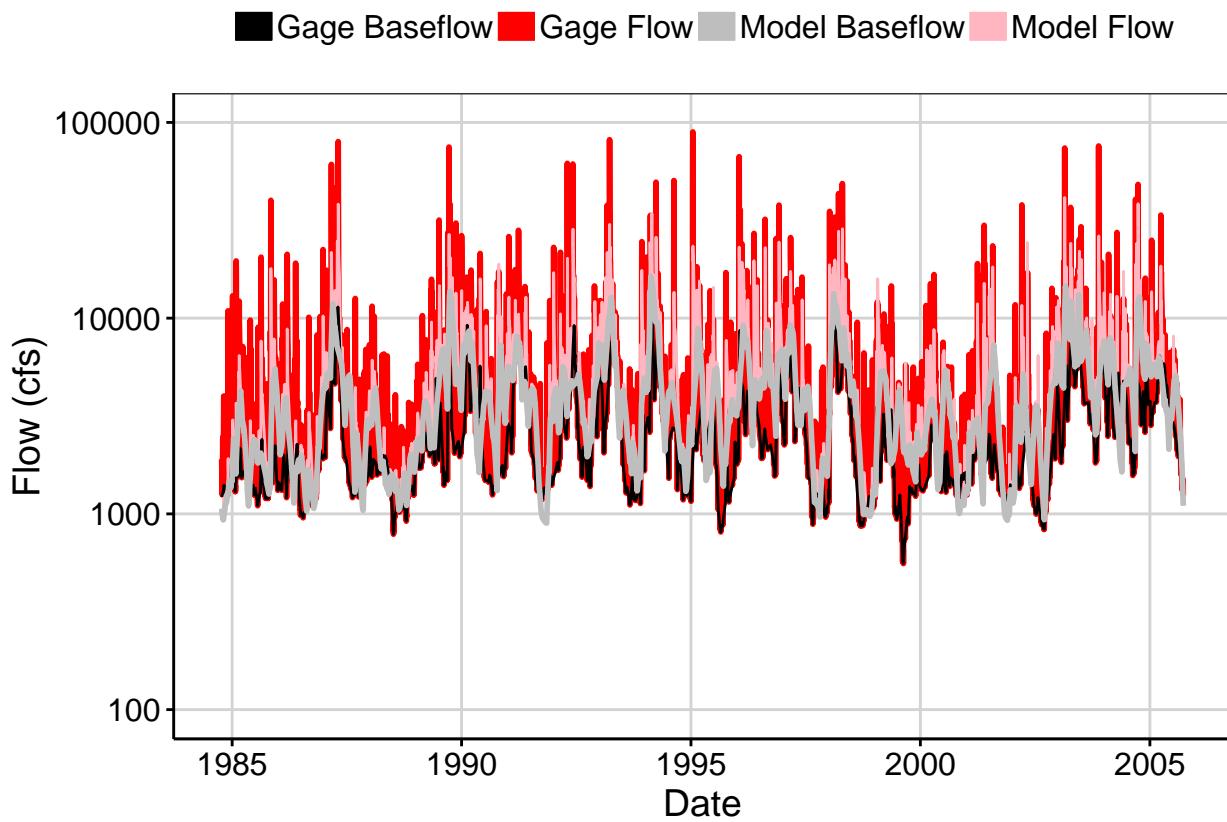


Fig. 6: Largest Error Segment

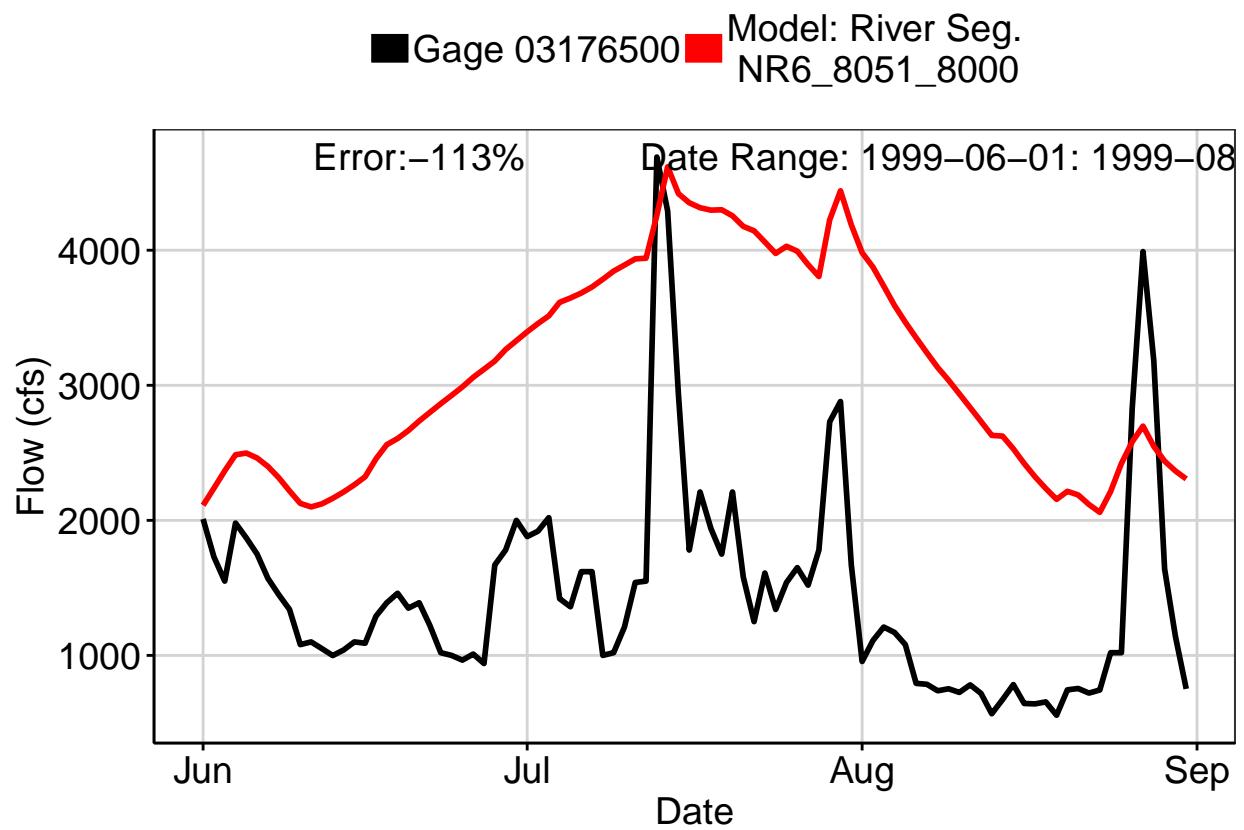


Fig. 7: Second Largest Error Segment

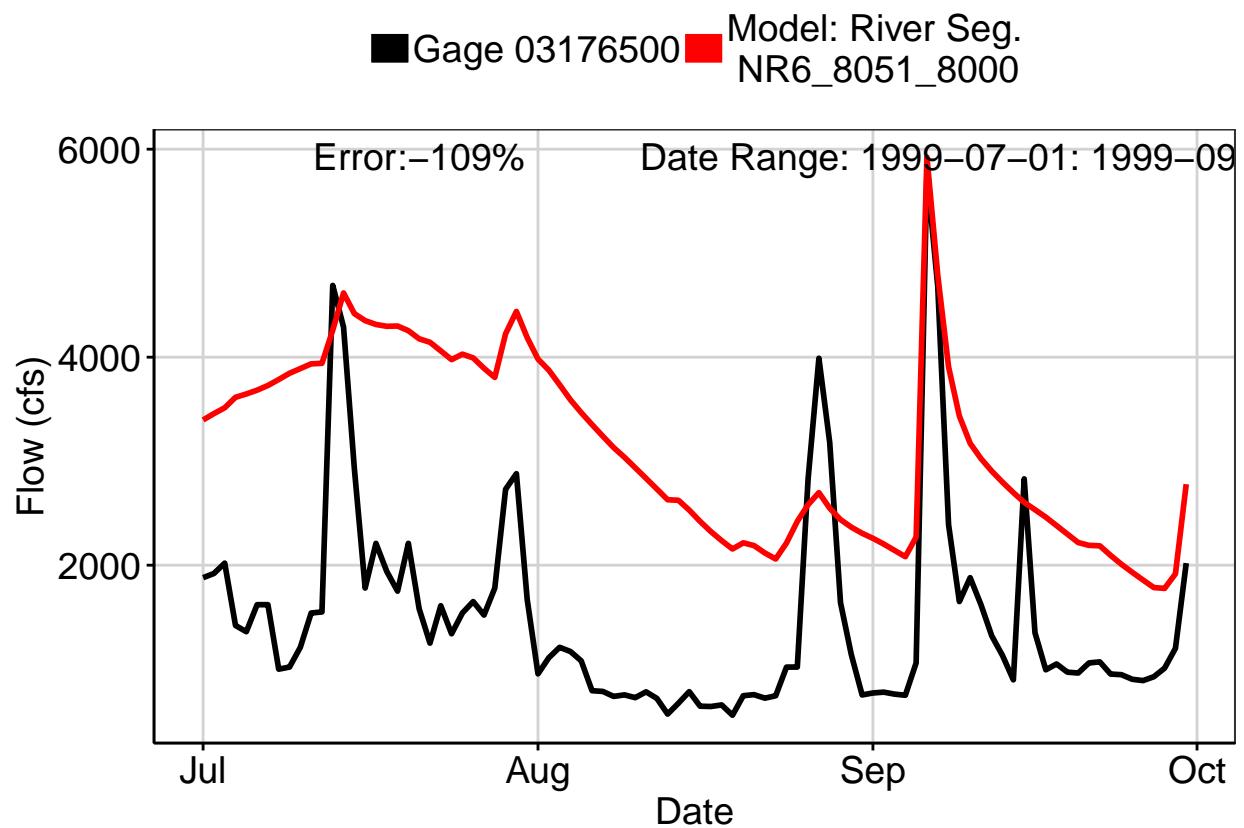


Fig. 8: Third Largest Error Segment

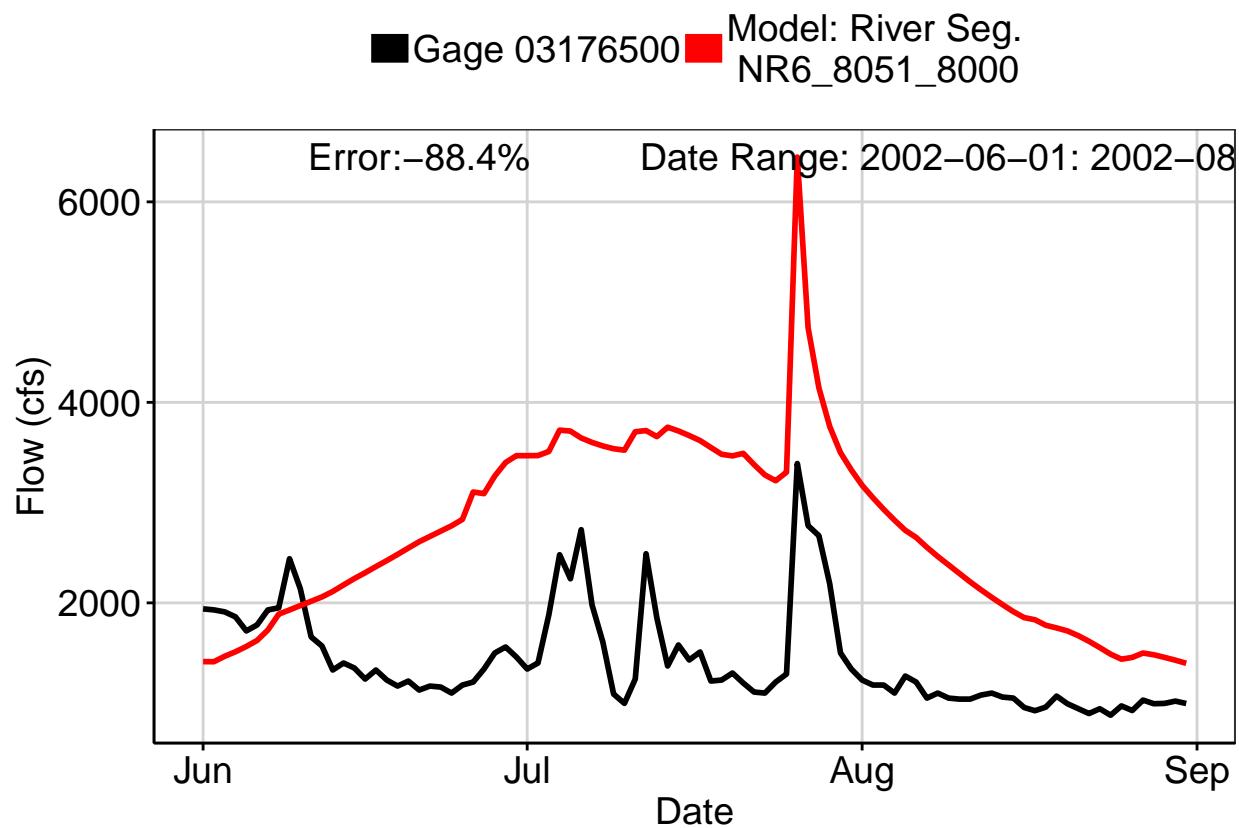
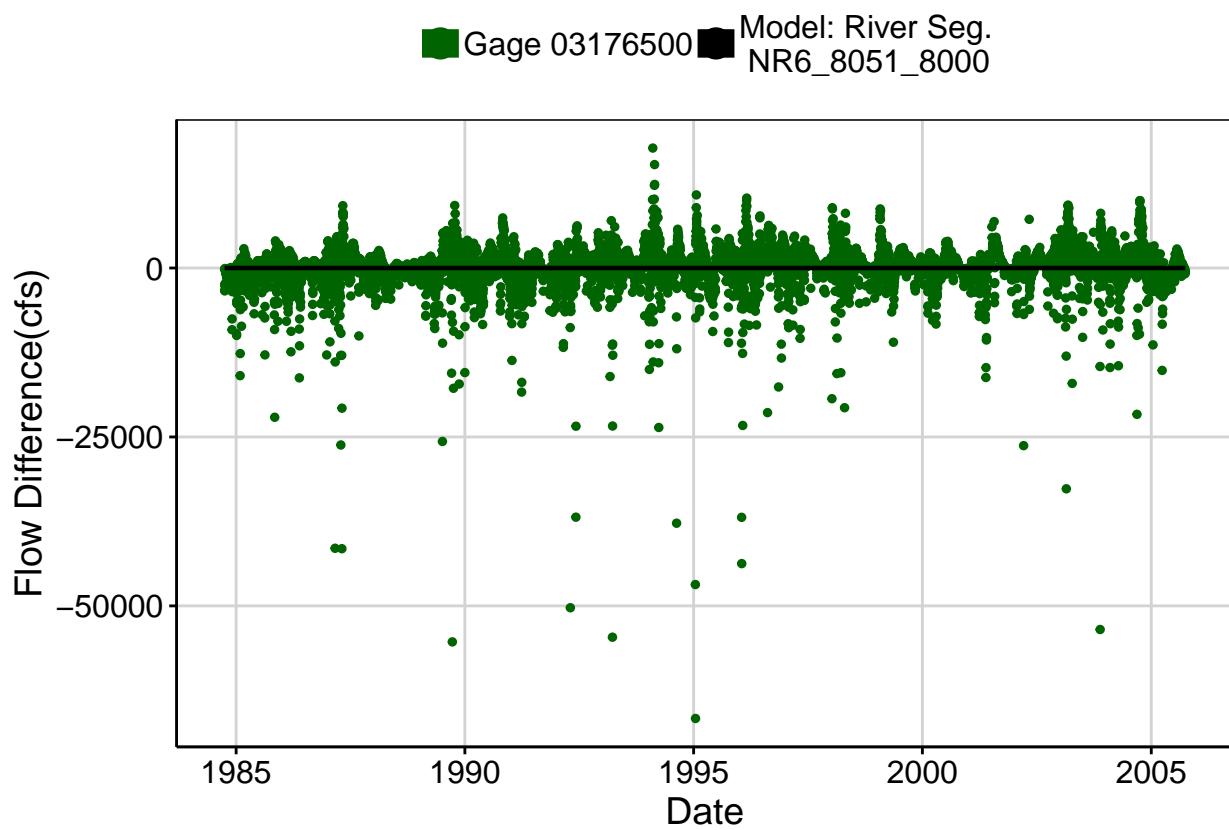
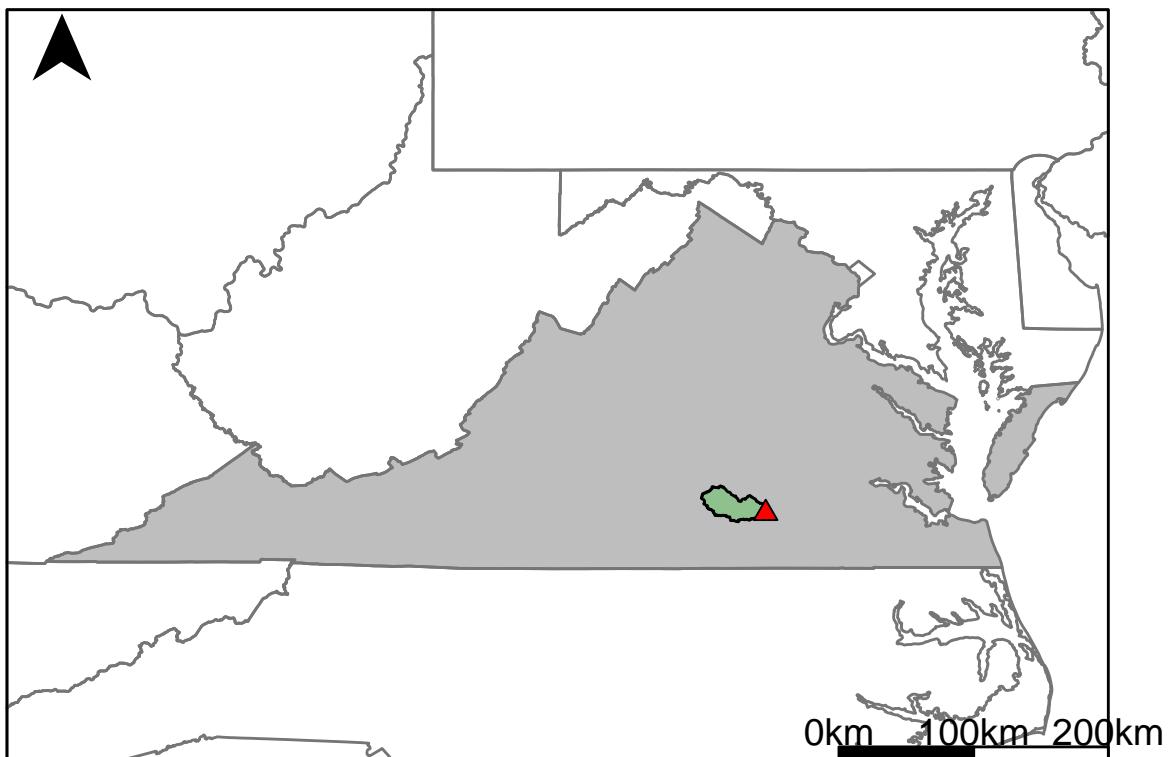


Fig. 9: Residuals Plot



## Appendix G: Nottoway River Gages

### Appendix G.1: USGS Gage 02044500 vs. MN3\_7770\_7930



This river segment follows part of the flow of the Nottoway River, a tributary of the Meherrin River. The gage is located in Brunswick County, VA (Lat 3659'00", Long 7748'00") approximately 25 miles northwest of Emporia, VA. Drainage area is 317 sq. miles. This gage started taking data in 1950 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 1.01%, with 45.4% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	32	15.3	52.2
Feb. Low Flow	93	50.4	45.8
Mar. Low Flow	104	65.3	37.2
Apr. Low Flow	139	118	15.1
May Low Flow	229	217	5.24
Jun. Low Flow	217	170	21.7
Jul. Low Flow	208	122	41.3
Aug. Low Flow	137	67.2	50.9
Sep. Low Flow	70	41.8	40.3
Oct. Low Flow	35	20.8	40.6
Nov. Low Flow	30	23.7	21
Dec. Low Flow	22	20.9	5

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	297	294	1.01
Jan. Mean Flow	380	396	-4.21
Feb. Mean Flow	429	505	-17.7
Mar. Mean Flow	567	639	-12.7
Apr. Mean Flow	451	435	3.55
May Mean Flow	341	263	22.9
Jun. Mean Flow	208	158	24
Jul. Mean Flow	134	99.8	25.5
Aug. Mean Flow	151	144	4.64
Sep. Mean Flow	231	260	-12.6
Oct. Mean Flow	131	137	-4.58
Nov. Mean Flow	270	246	8.89
Dec. Mean Flow	286	268	6.29

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	205	159	22.4
Feb. High Flow	747	595	20.3
Mar. High Flow	669	493	26.3
Apr. High Flow	1120	1170	-4.46
May High Flow	1150	1410	-22.6
Jun. High Flow	1780	2600	-46.1
Jul. High Flow	1470	1250	15
Aug. High Flow	830	688	17.1
Sep. High Flow	620	166	73.2
Oct. High Flow	311	236	24.1
Nov. High Flow	341	202	40.8
Dec. High Flow	189	156	17.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	0.58	0	100
Med. 1 Day Min	16	8.92	44.2
Min. 3 Day Min	0.59	0	100
Med. 3 Day Min	16.7	9.41	43.7
Min. 7 Day Min	0.68	0.01	97.9
Med. 7 Day Min	18.1	11.9	34.3
Min. 30 Day Min	2.12	1.85	12.7
Med. 30 Day Min	30.7	27.7	9.77
Min. 90 Day Min	10.8	14	-29.6
Med. 90 Day Min	81.5	52.7	35.3
7Q10	4.54	0.77	83.1
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	71.6	294	-311
Mean Baseflow	139	127	8.63

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	17000	26800	-57.6
Med. 1 Day Max	4940	6350	-28.5
Max. 3 Day Max	12200	11200	8.2
Med. 3 Day Max	3420	3820	-11.7
Max. 7 Day Max	6100	6260	-2.62
Med. 7 Day Max	1810	2040	-12.7
Max. 30 Day Max	2150	1720	20
Med. 30 Day Max	783	914	-16.7
Max. 90 Day Max	1330	1270	4.51
Med. 90 Day Max	525	541	-3.05

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	7.48	3.97	46.9
5% Non-Exceedance	21.9	14.5	33.8
50% Non-Exceedance	168	139	17.3
95% Non-Exceedance	848	926	-9.2
99% Non-Exceedance	2570	2770	-7.78
Sept. 10% Non-Exceedance	14.1	14.6	-3.55

**Fig. 1: Hydrograph**

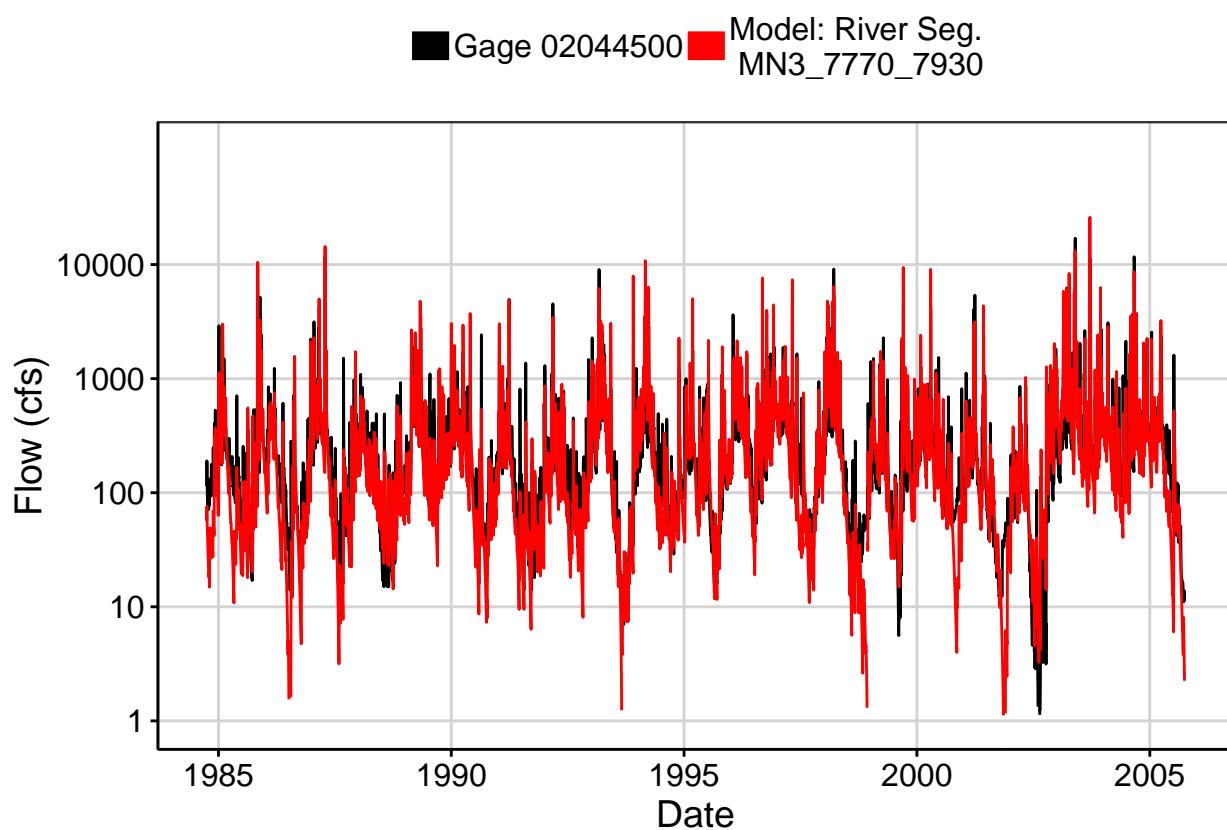


Fig. 2: Zoomed Hydrograph

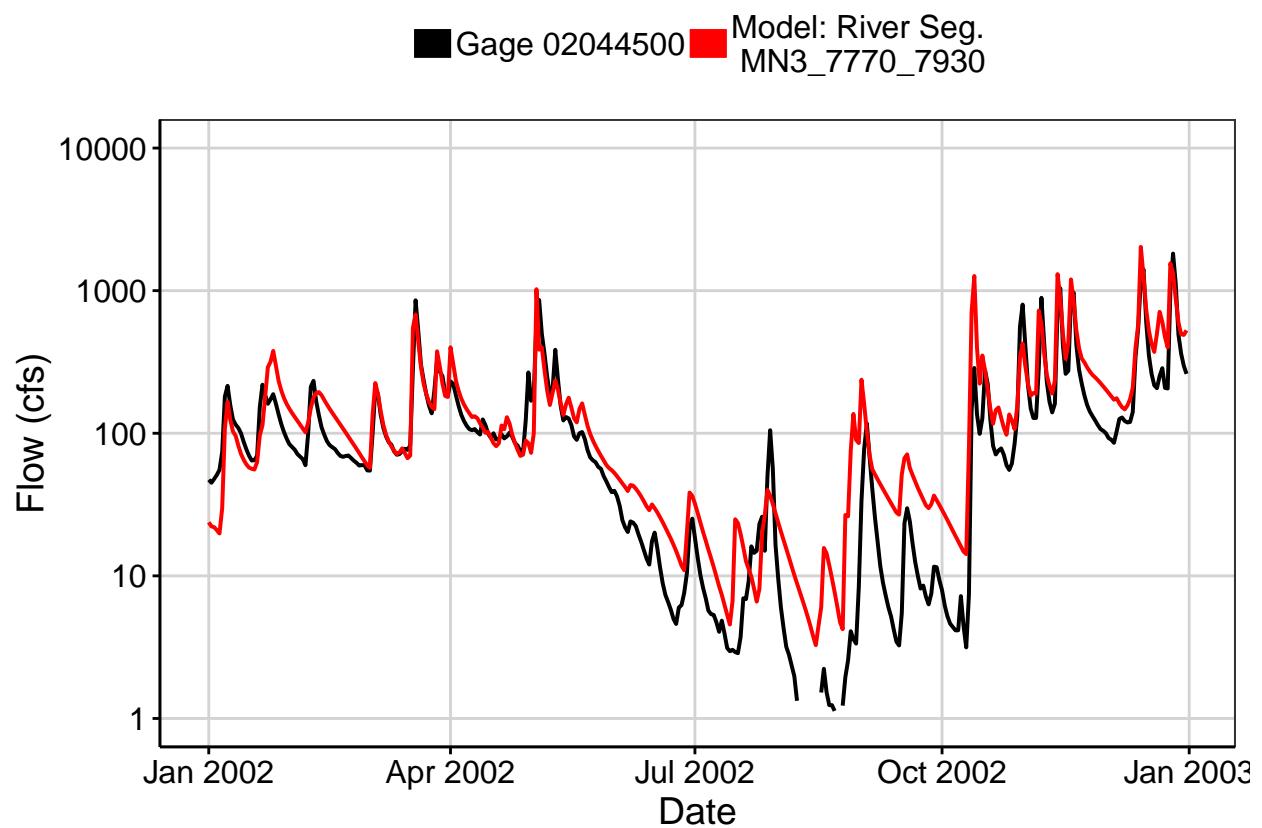


Fig. 3: Flow Exceedance

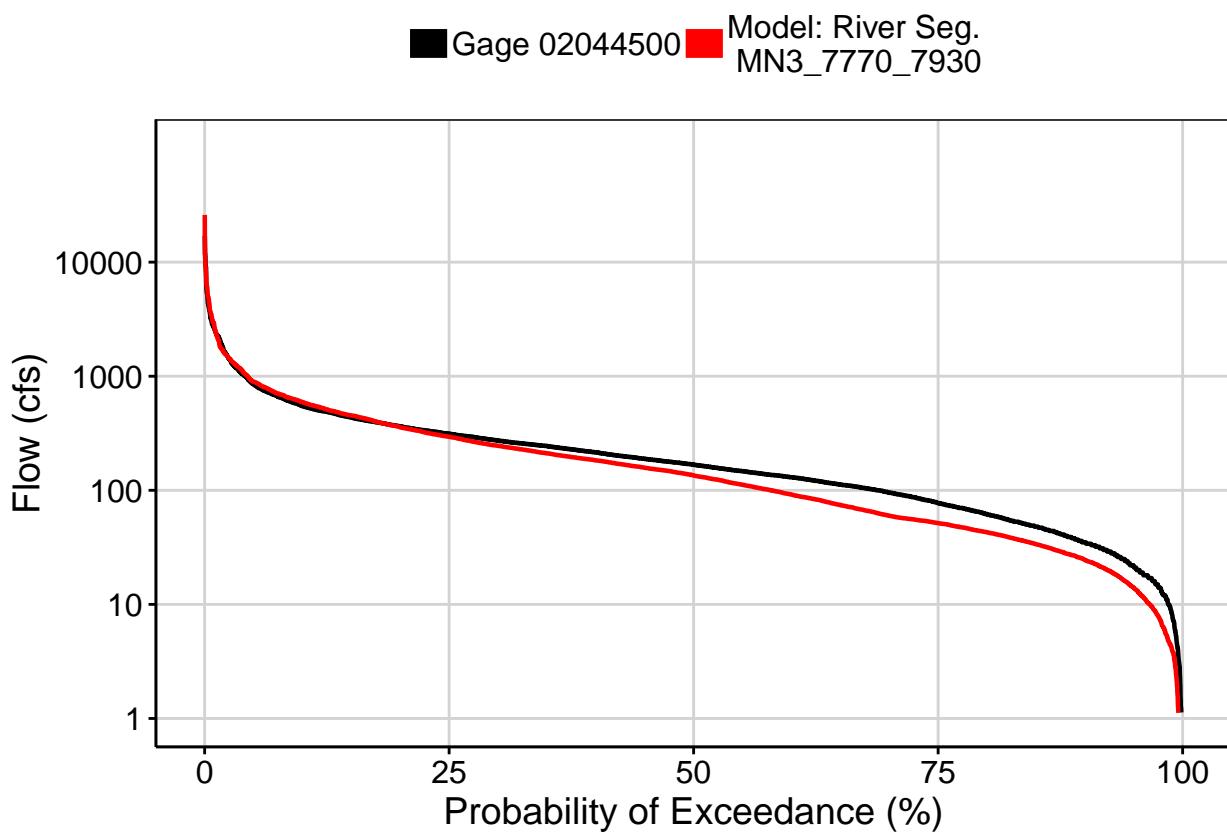


Fig. 4: Baseflow

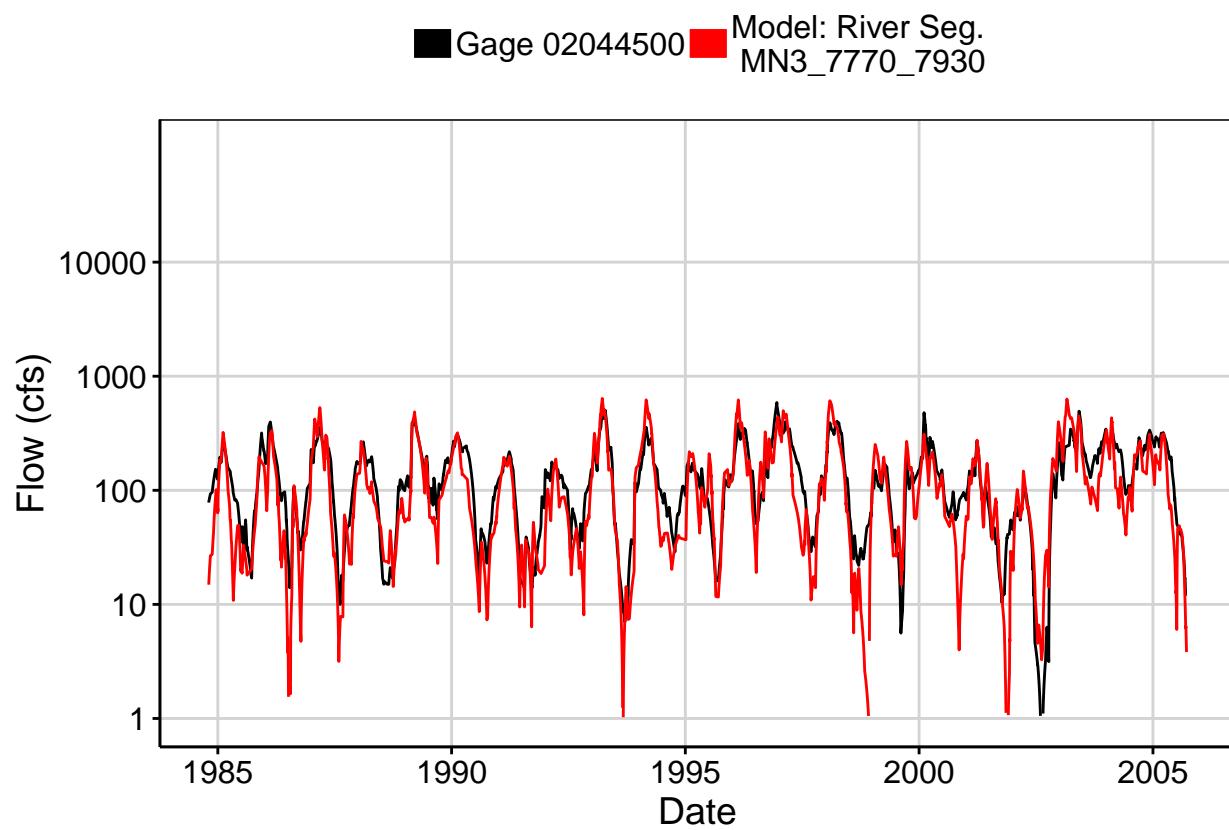


Fig. 5: Combined Baseflow

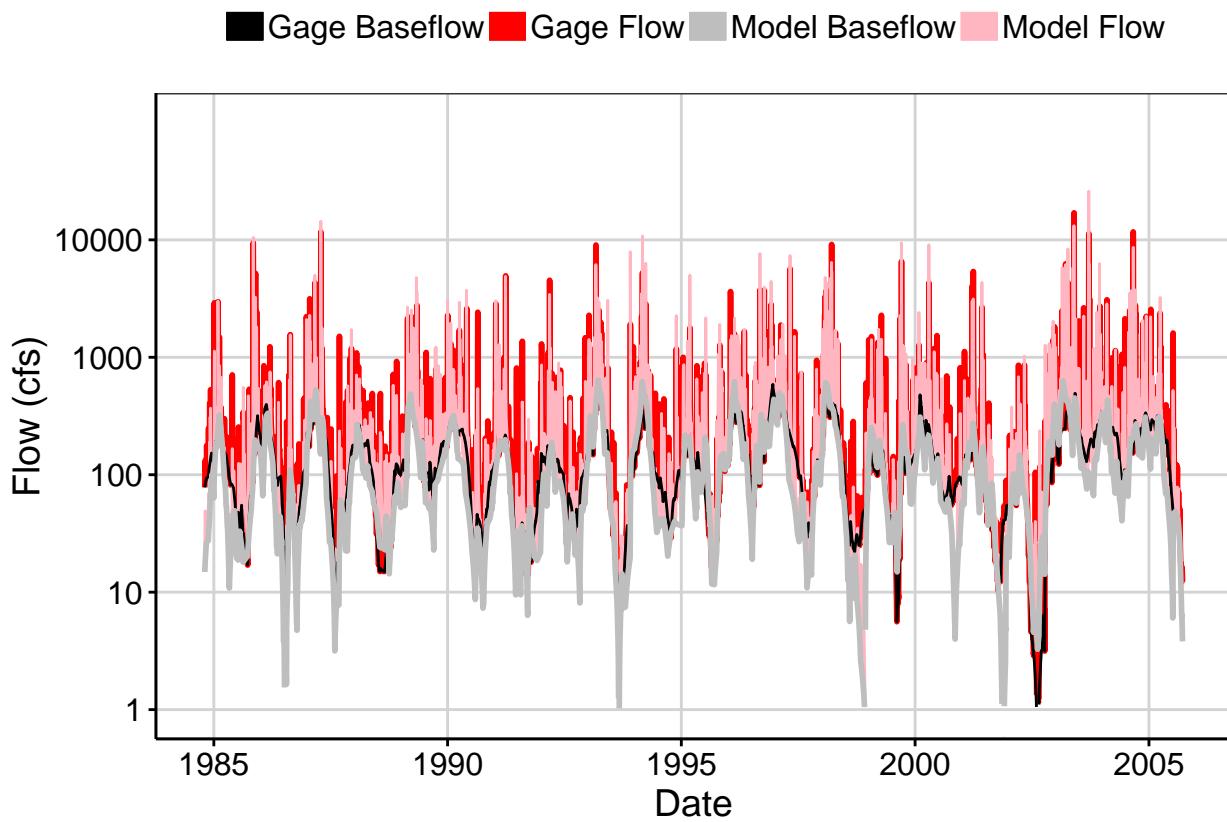


Fig. 6: Largest Error Segment

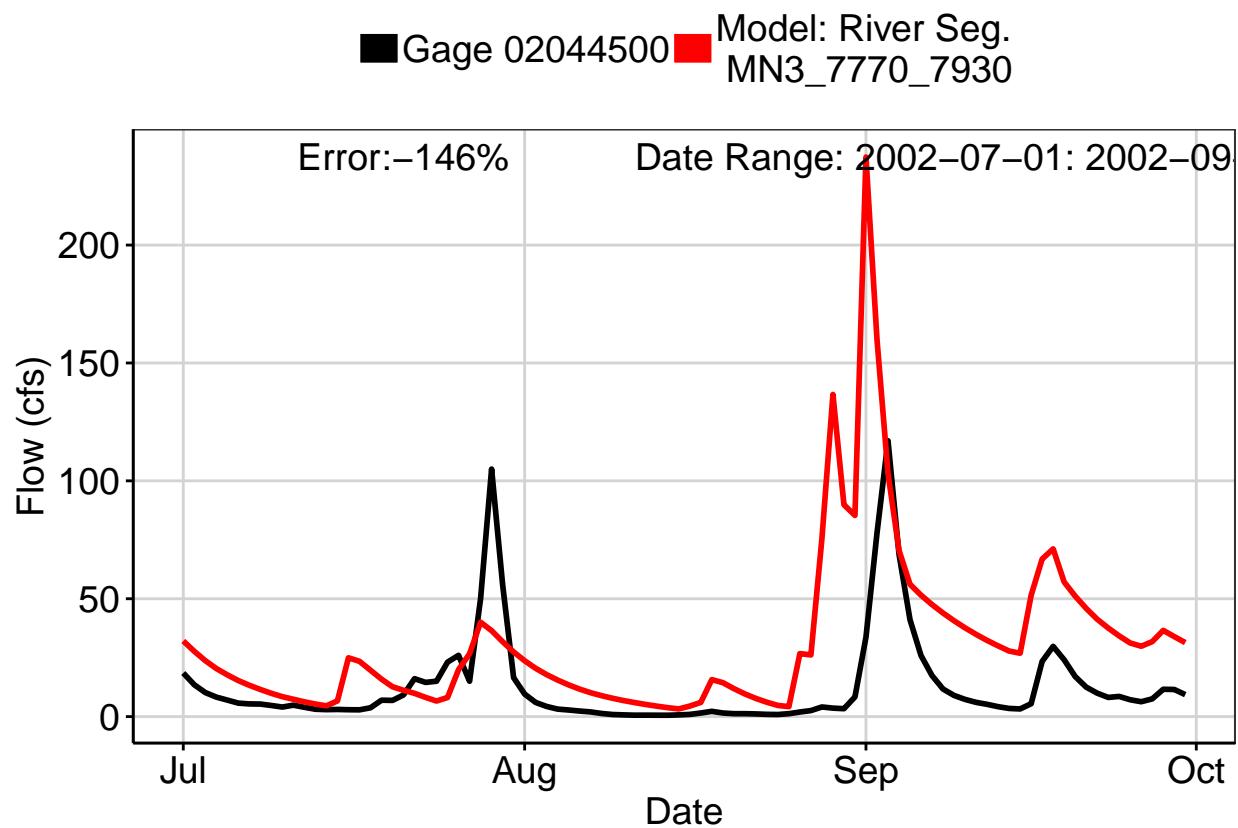


Fig. 7: Second Largest Error Segment

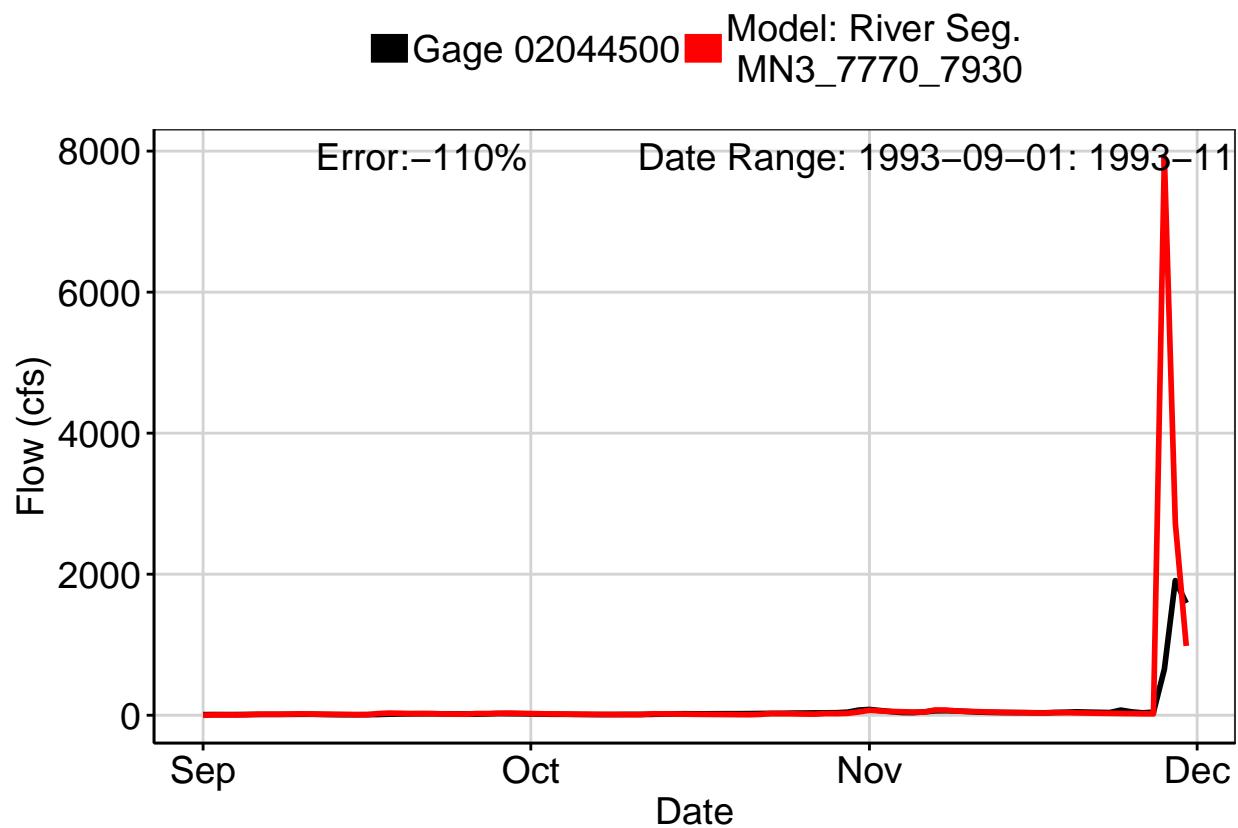


Fig. 8: Third Largest Error Segment

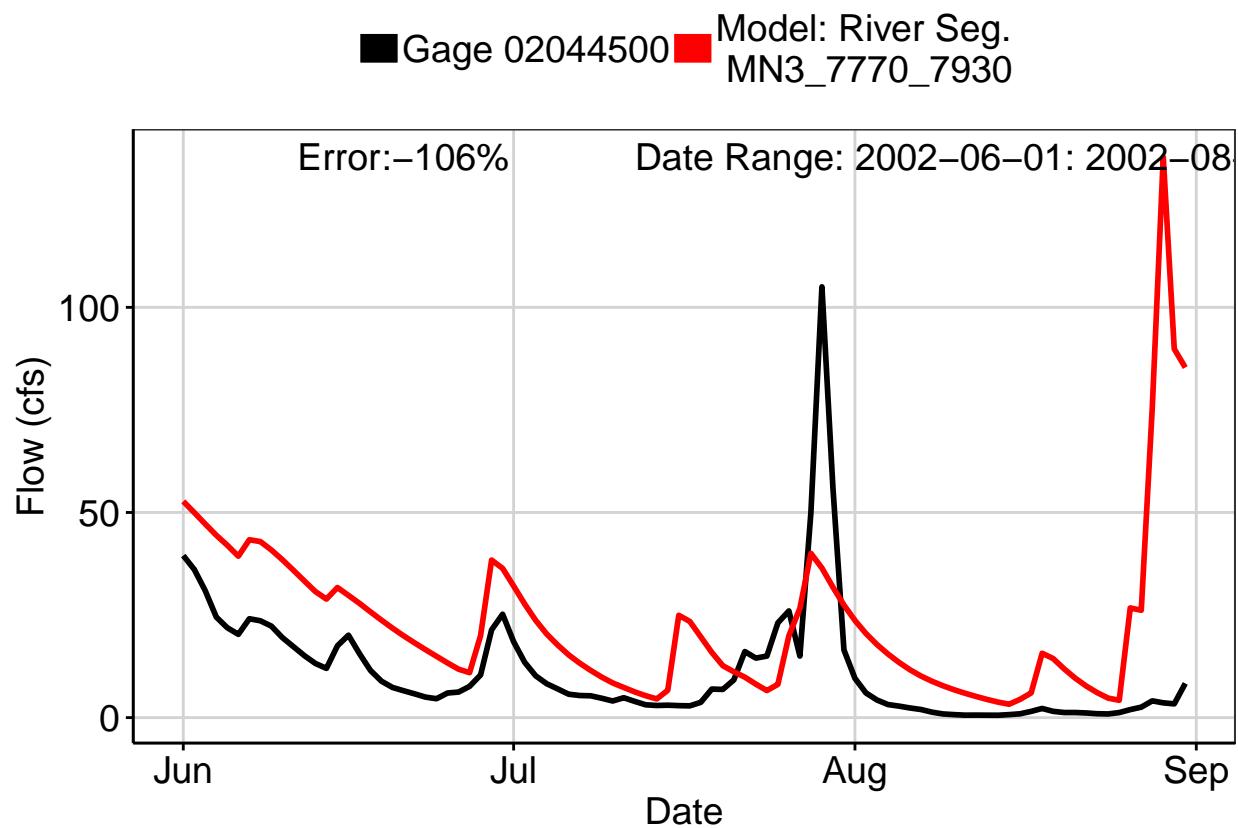
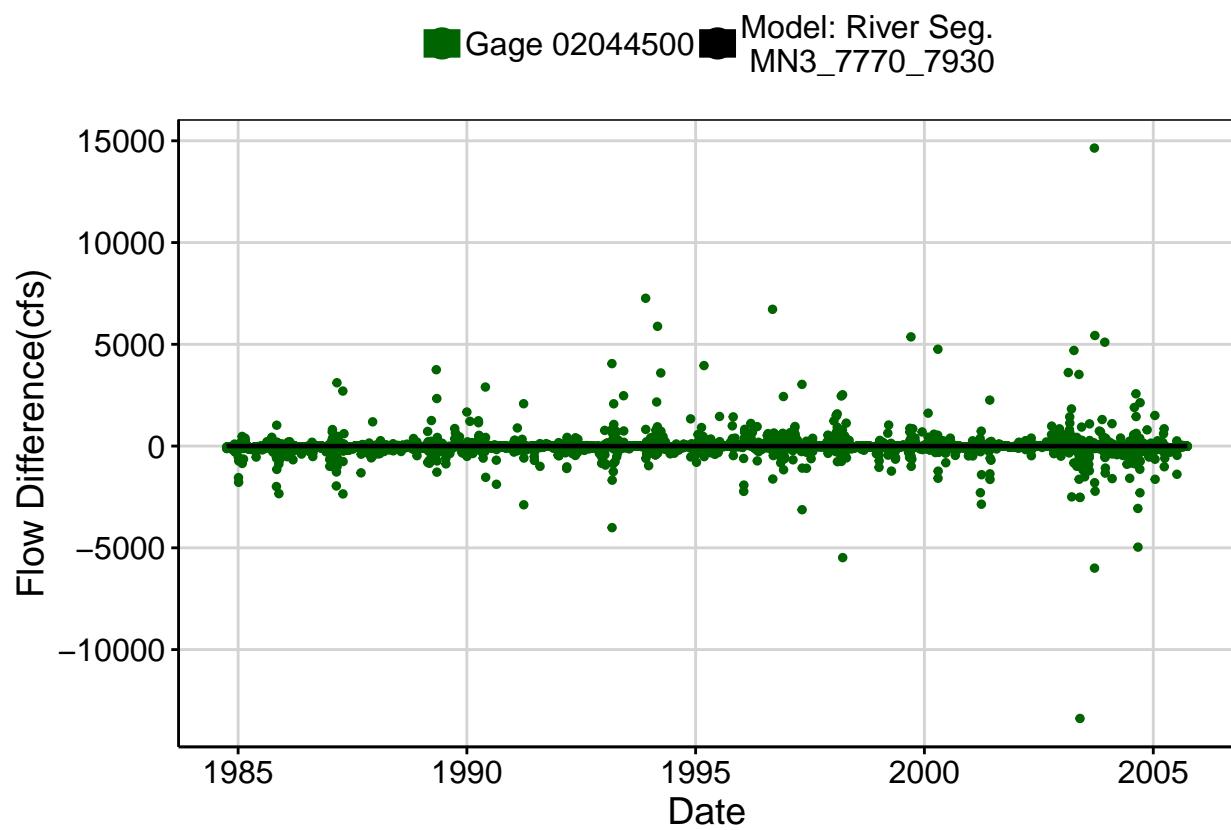
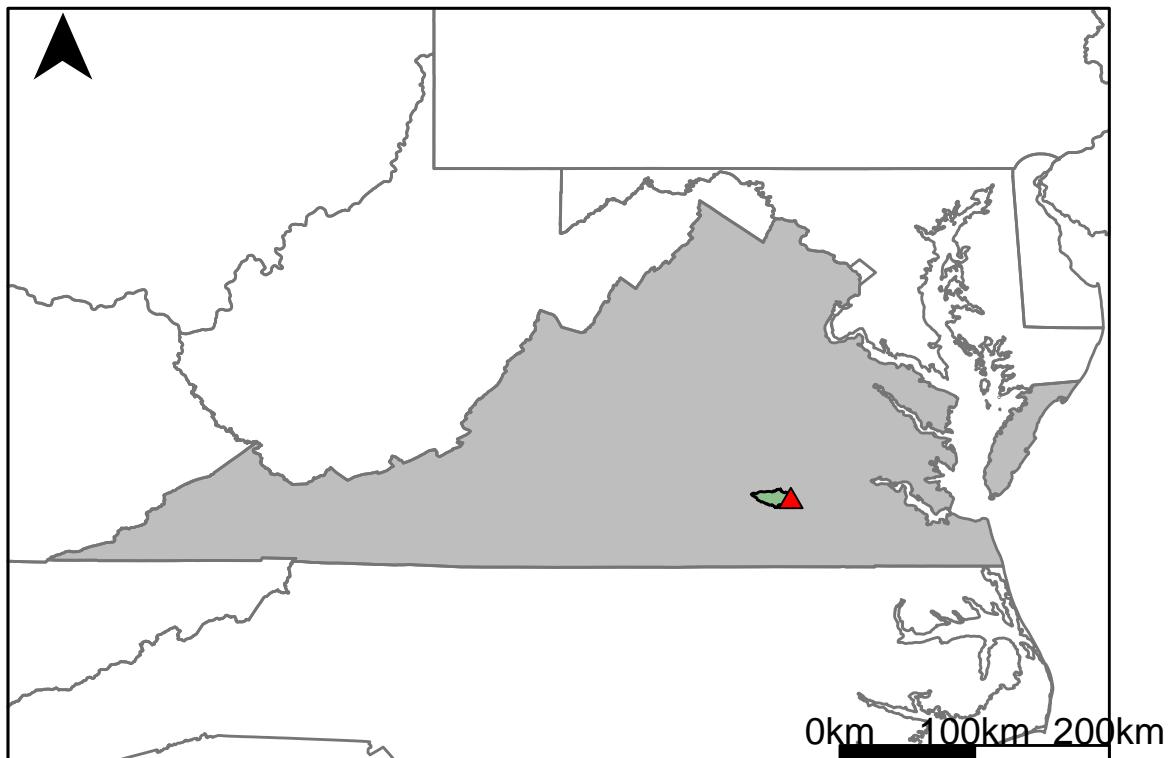


Fig. 9: Residuals Plot



## Appendix G.2: USGS Gage 02046000 vs. MN2\_7720\_7830



This river segment follows part of the flow of the Stony Creek, a tributary of the Meherrin River. The gage is located in Dinwiddie County, VA (Lat 37°04'01", Long 77°36'10") approximately 15 miles southwest of Petersburg, VA. Drainage area is 113 sq. miles. This gage started taking data in 1946 and is still taking data. A few times a year there is a small increase in flow due to a release from a large pond just upstream of the gage. The average daily discharge error between the model and gage data for the 20 year timespan was 1.92%, with 53.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	3	4.84	-61.3
Feb. Low Flow	14	16.1	-15
Mar. Low Flow	22	20.7	5.91
Apr. Low Flow	34	35.9	-5.59
May Low Flow	66	64.1	2.88
Jun. Low Flow	68	57.3	15.7
Jul. Low Flow	46	34.7	24.6
Aug. Low Flow	23	21.4	6.96
Sep. Low Flow	10	11.3	-13
Oct. Low Flow	4.5	5.29	-17.6
Nov. Low Flow	2.8	6.43	-130
Dec. Low Flow	1.4	5.11	-265

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	104	102	1.92
Jan. Mean Flow	140	142	-1.43
Feb. Mean Flow	167	170	-1.8
Mar. Mean Flow	210	214	-1.9
Apr. Mean Flow	167	144	13.8
May Mean Flow	111	88.4	20.4
Jun. Mean Flow	63.1	46	27.1
Jul. Mean Flow	36.7	31.8	13.4
Aug. Mean Flow	52.4	66.6	-27.1
Sep. Mean Flow	81.6	104	-27.5
Oct. Mean Flow	49	48.6	0.82
Nov. Mean Flow	79.6	75.2	5.53
Dec. Mean Flow	93.2	96.8	-3.86

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	55	74	-34.5
Feb. High Flow	153	156	-1.96
Mar. High Flow	227	200	11.9
Apr. High Flow	530	341	35.7
May High Flow	595	402	32.4
Jun. High Flow	770	1080	-40.3
Jul. High Flow	558	360	35.5
Aug. High Flow	292	236	19.2
Sep. High Flow	170	53.4	68.6
Oct. High Flow	86	56.6	34.2
Nov. High Flow	52	63.8	-22.7
Dec. High Flow	26	66.3	-155

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	0	0.03	-Inf
Med. 1 Day Min	0.89	1.51	-69.7
Min. 3 Day Min	0	0.03	-Inf
Med. 3 Day Min	0.93	1.78	-91.4
Min. 7 Day Min	0.03	0.04	-41.3
Med. 7 Day Min	1.08	2.4	-122
Min. 30 Day Min	0.35	0.46	-34.4
Med. 30 Day Min	2.25	5.3	-136
Min. 90 Day Min	1.94	5.07	-161
Med. 90 Day Min	18.9	18.8	0.53
7Q10	0.15	0.38	-146
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	15.5	102	-558
Mean Baseflow	37.4	39.8	-6.42

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	8400	12900	-53.6
Med. 1 Day Max	1970	2470	-25.4
Max. 3 Day Max	4220	4770	-13
Med. 3 Day Max	1390	1220	12.2
Max. 7 Day Max	2110	2310	-9.48
Med. 7 Day Max	737	698	5.29
Max. 30 Day Max	832	707	15
Med. 30 Day Max	346	326	5.78
Max. 90 Day Max	527	444	15.7
Med. 90 Day Max	224	207	7.59

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	0.47	1.12	-138
5% Non-Exceedance	1.7	3.87	-128
50% Non-Exceedance	45	43.7	2.89
95% Non-Exceedance	365	314	14
99% Non-Exceedance	996	972	2.41
Sept. 10% Non-Exceedance	3.65	3.61	1.1

**Fig. 1: Hydrograph**

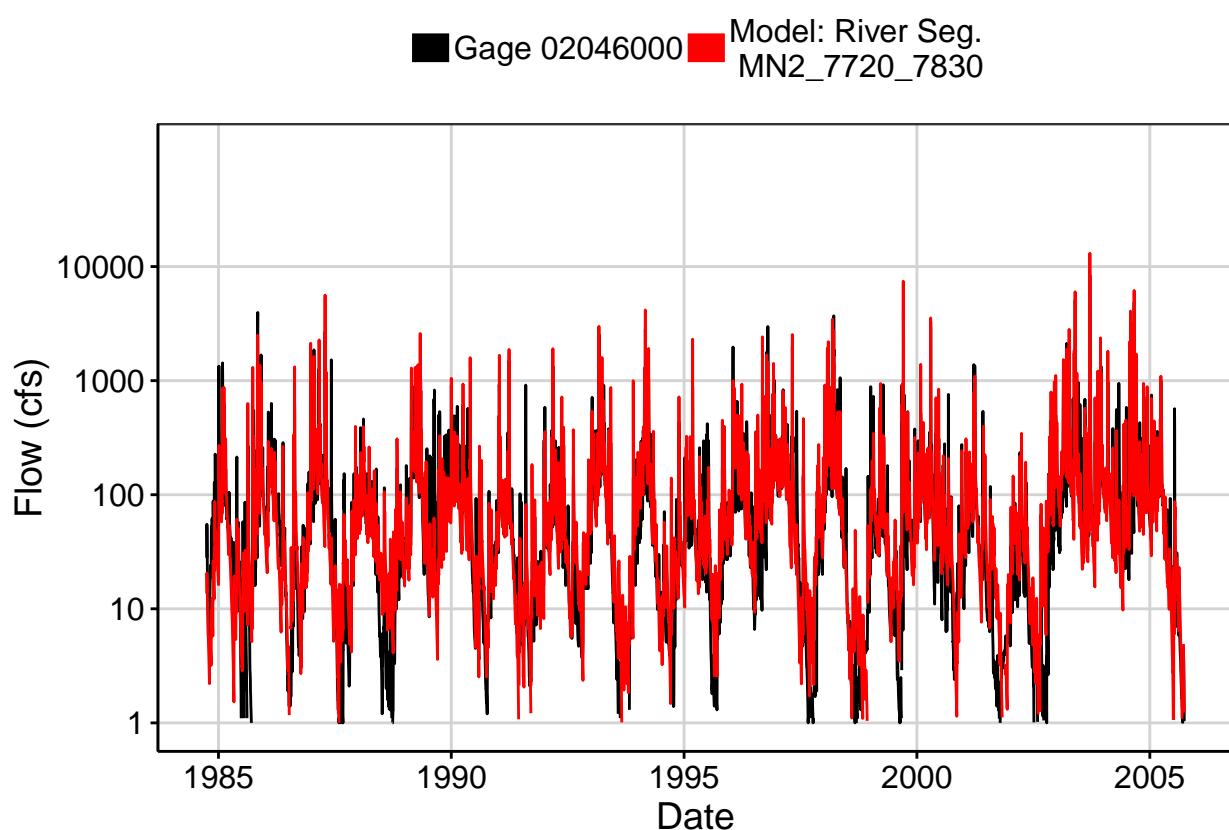


Fig. 2: Zoomed Hydrograph

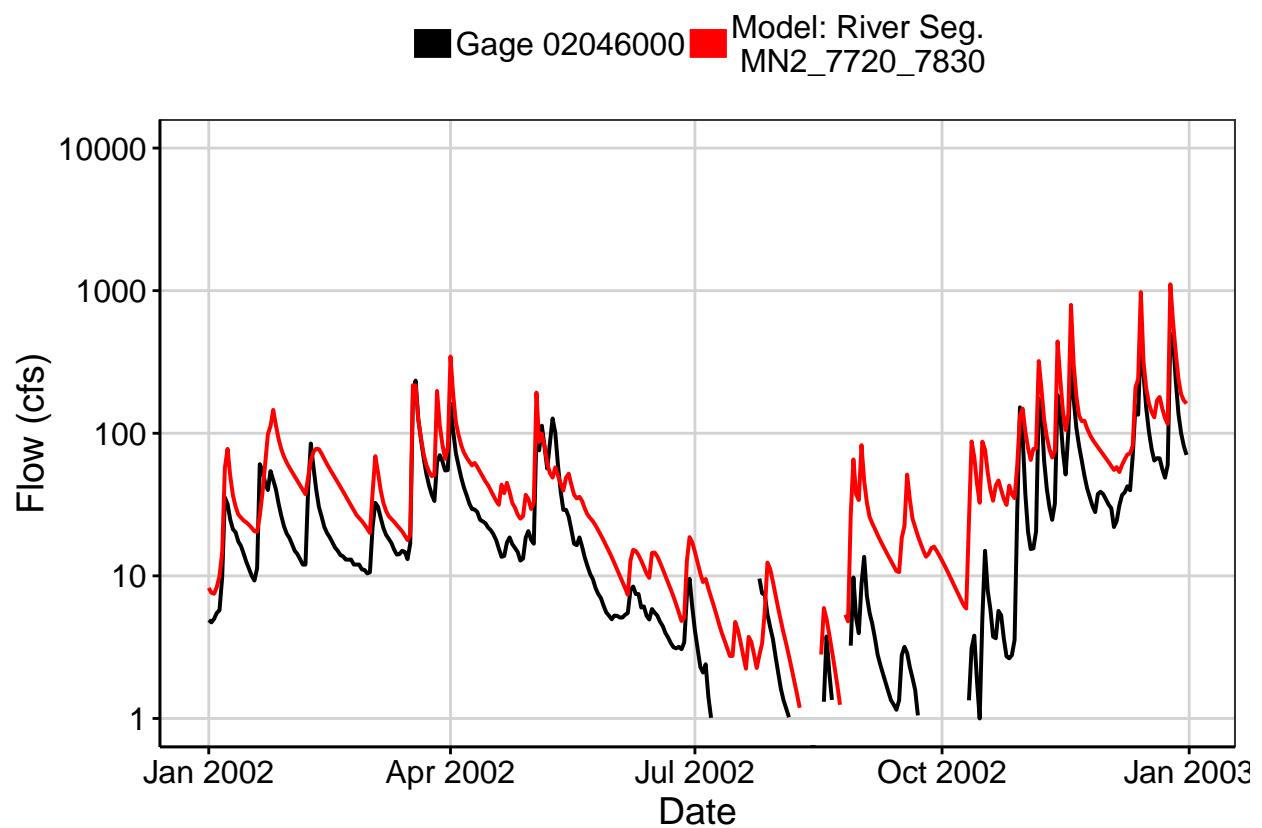


Fig. 3: Flow Exceedance

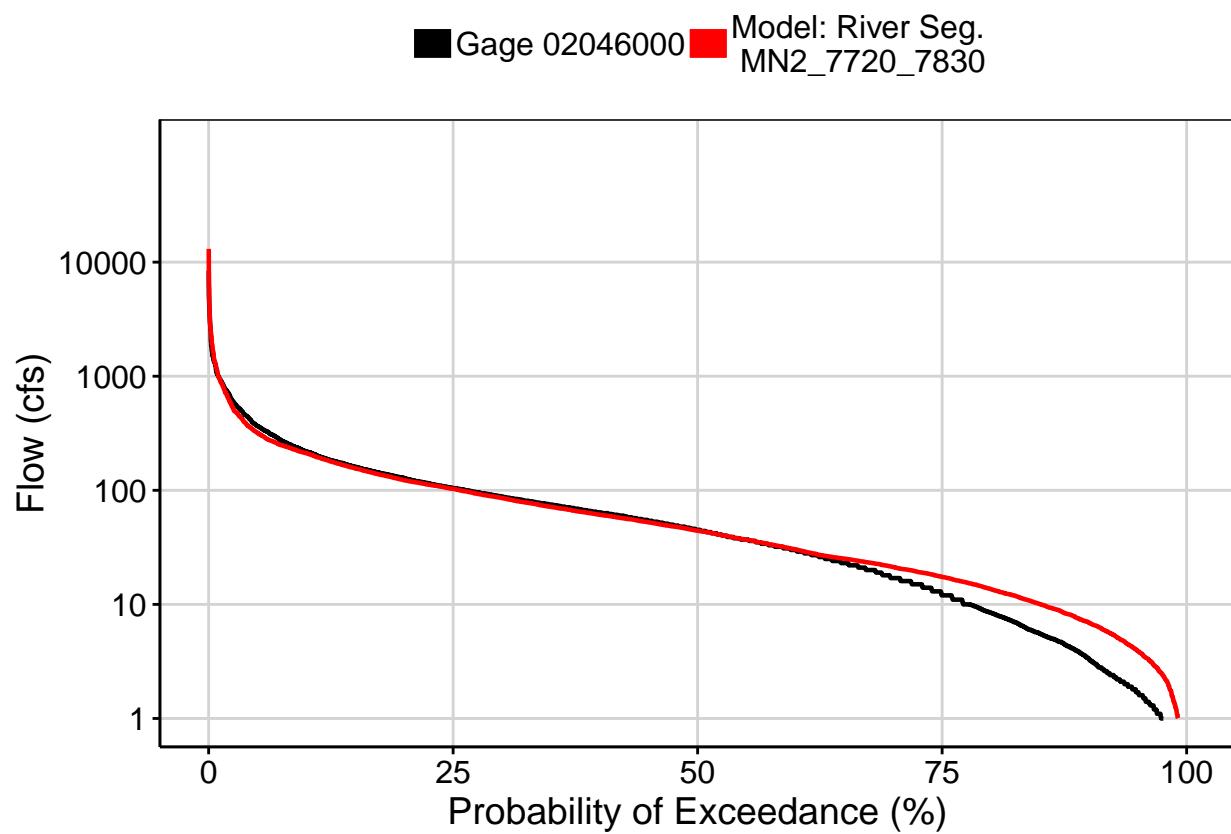


Fig. 4: Baseflow

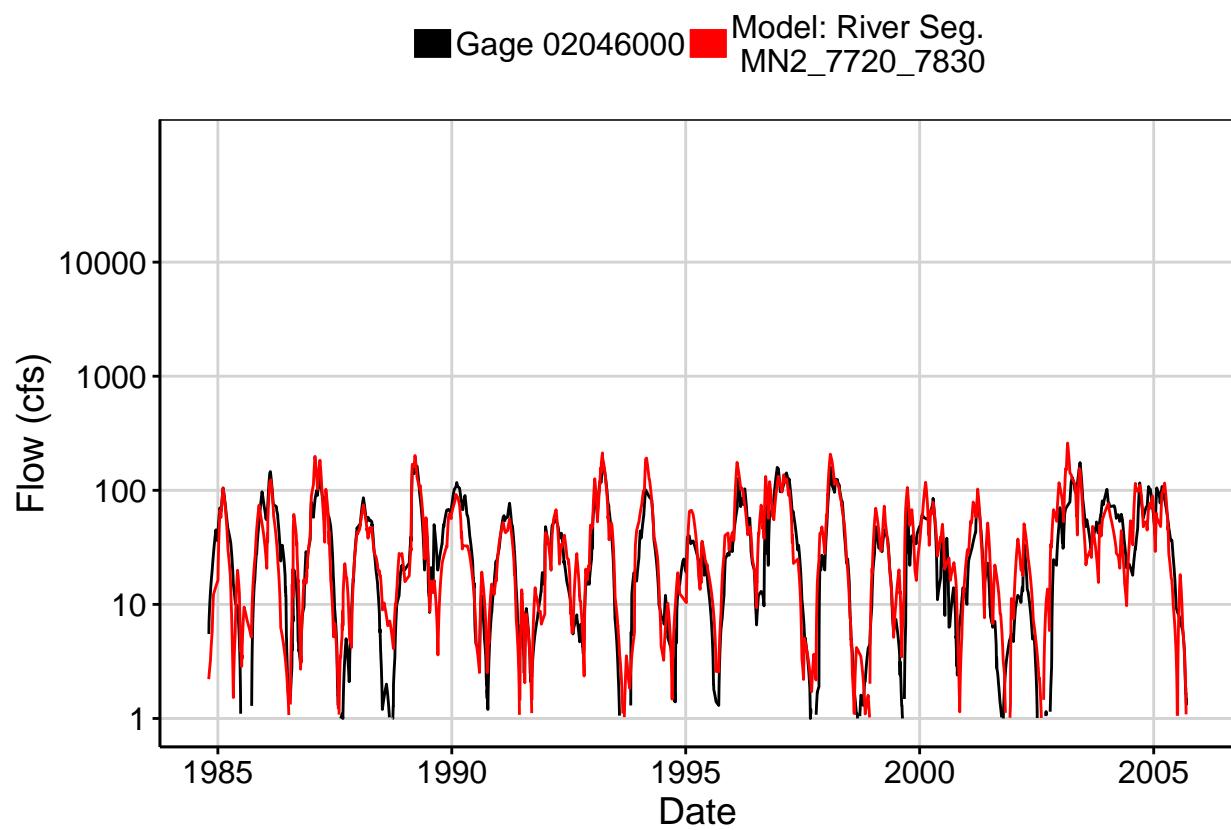


Fig. 5: Combined Baseflow

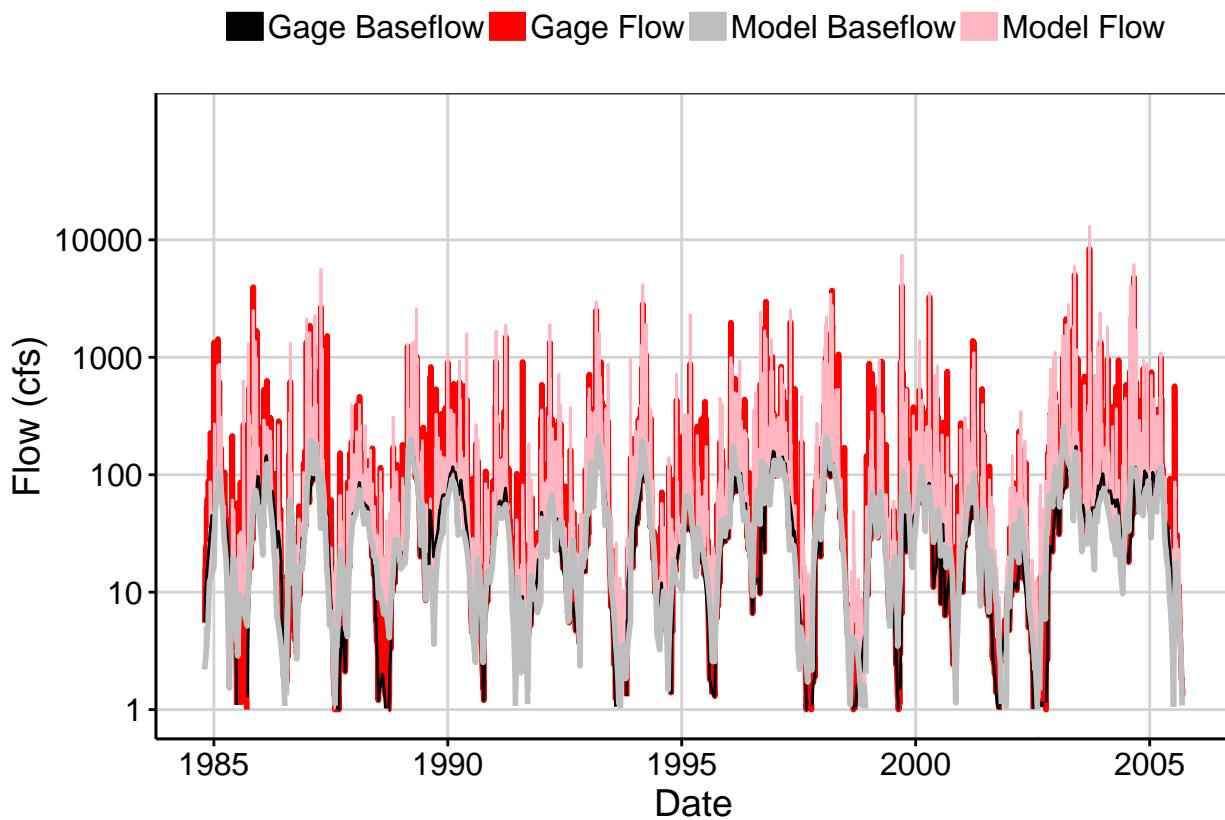


Fig. 6: Largest Error Segment

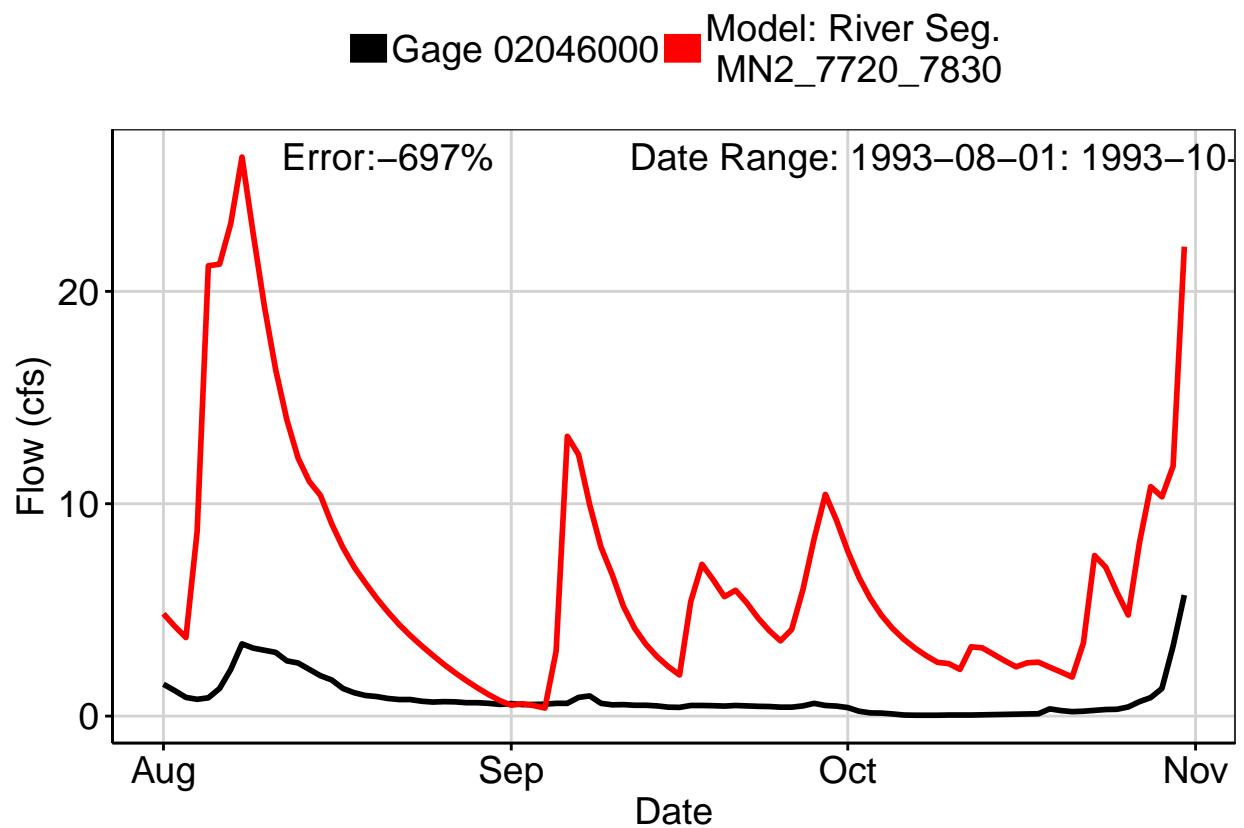


Fig. 7: Second Largest Error Segment

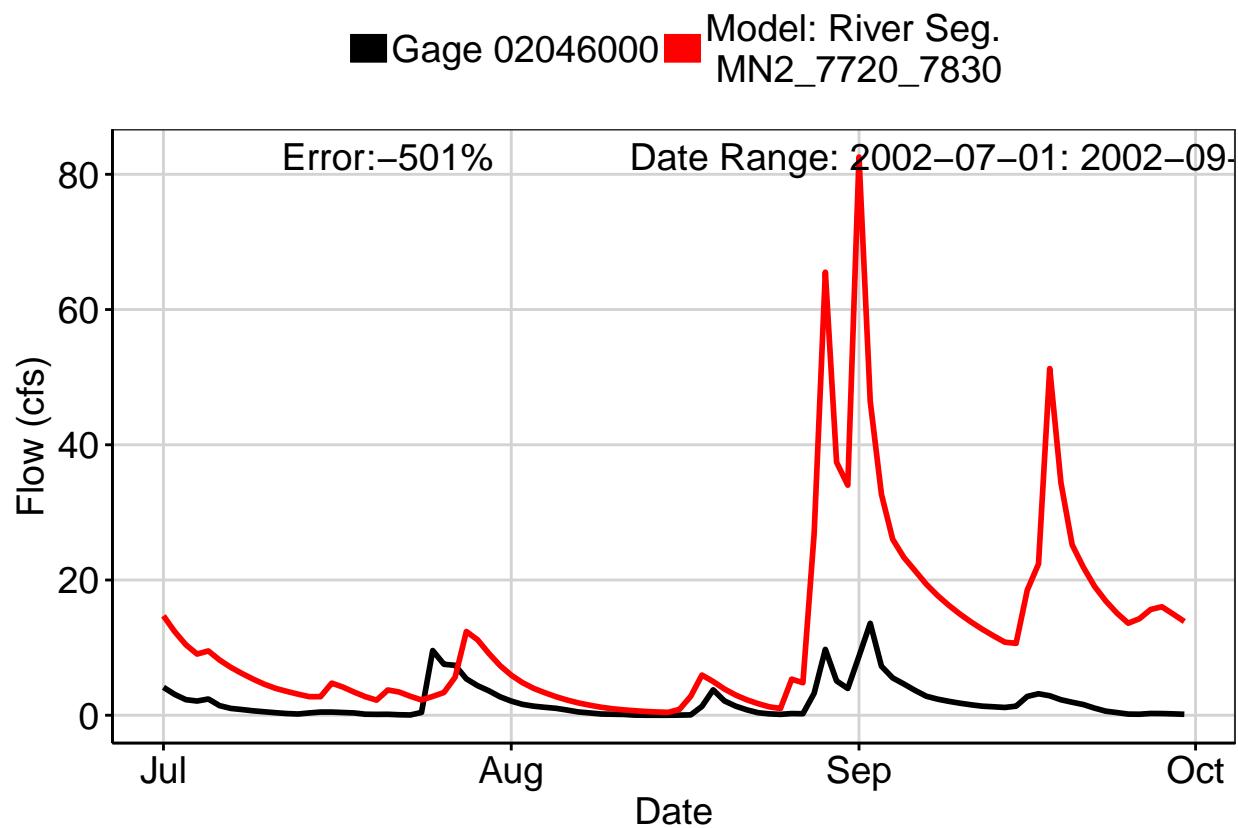


Fig. 8: Third Largest Error Segment

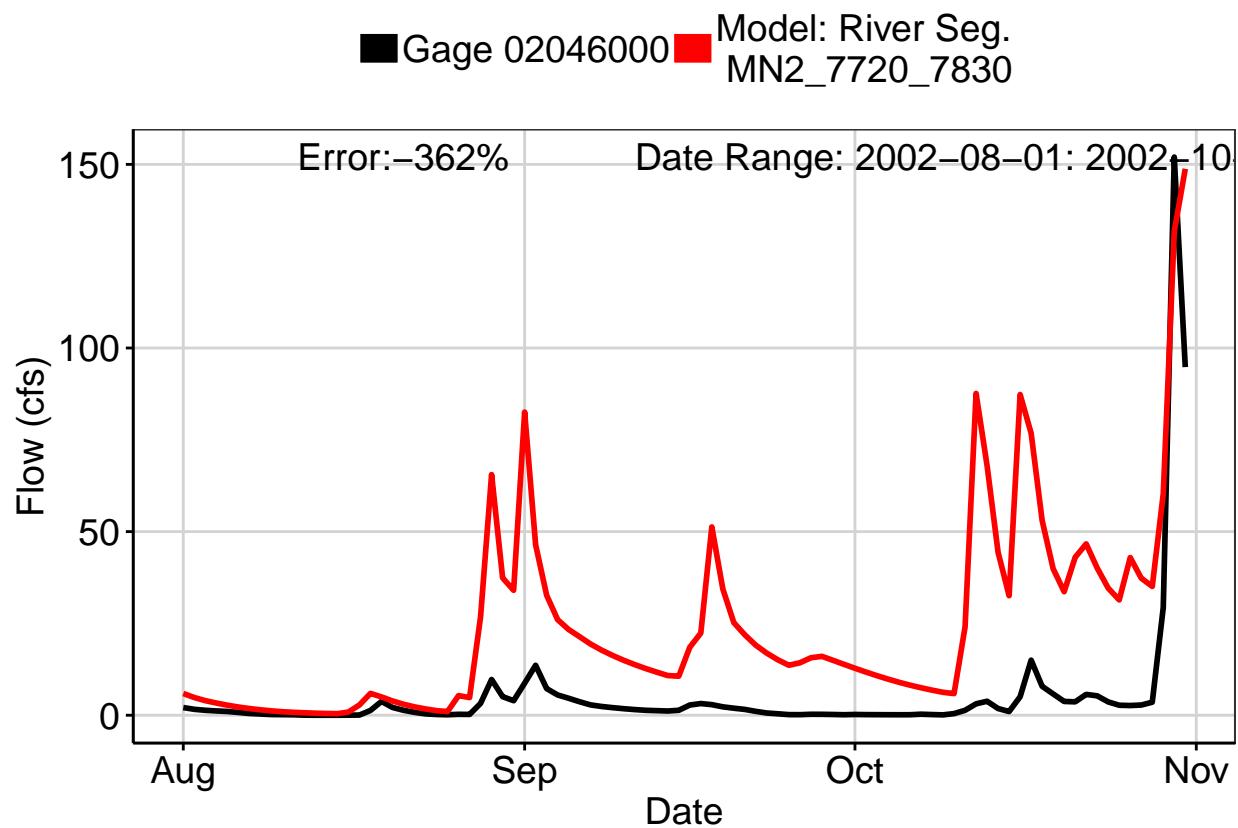
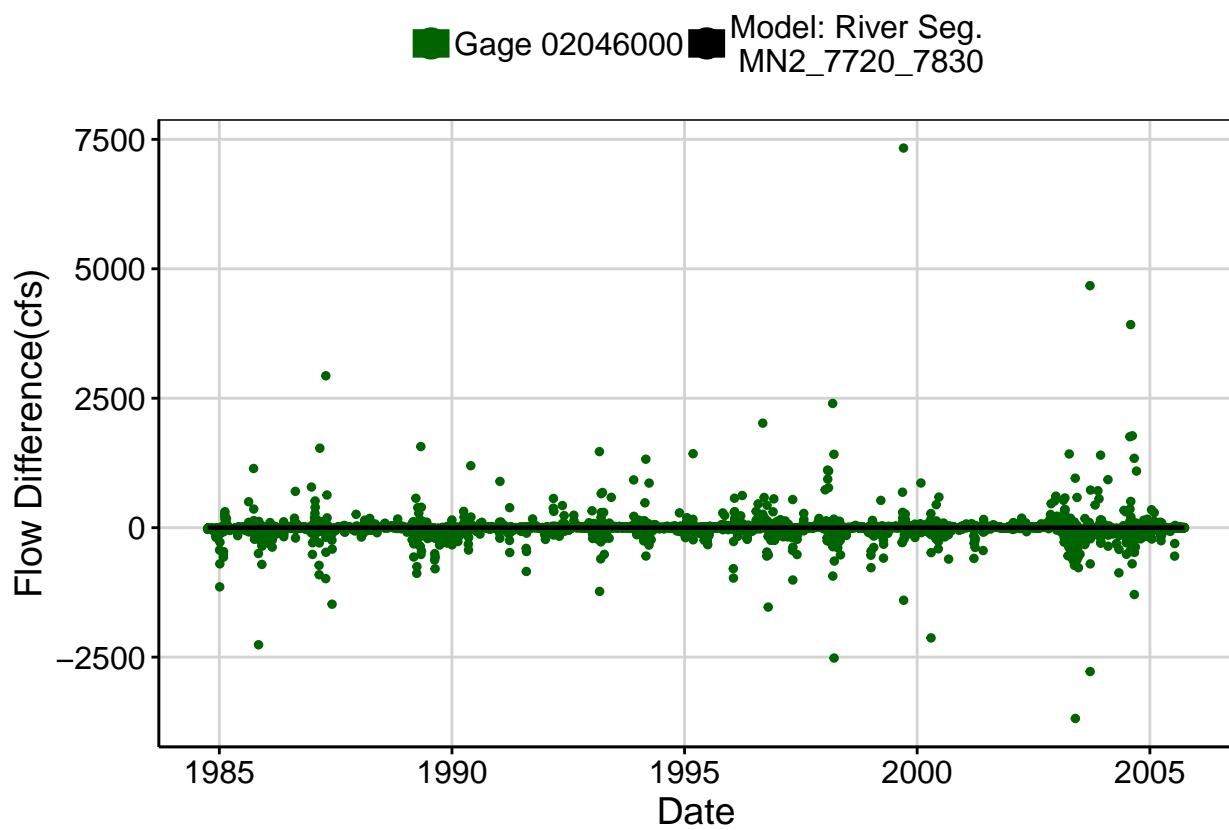
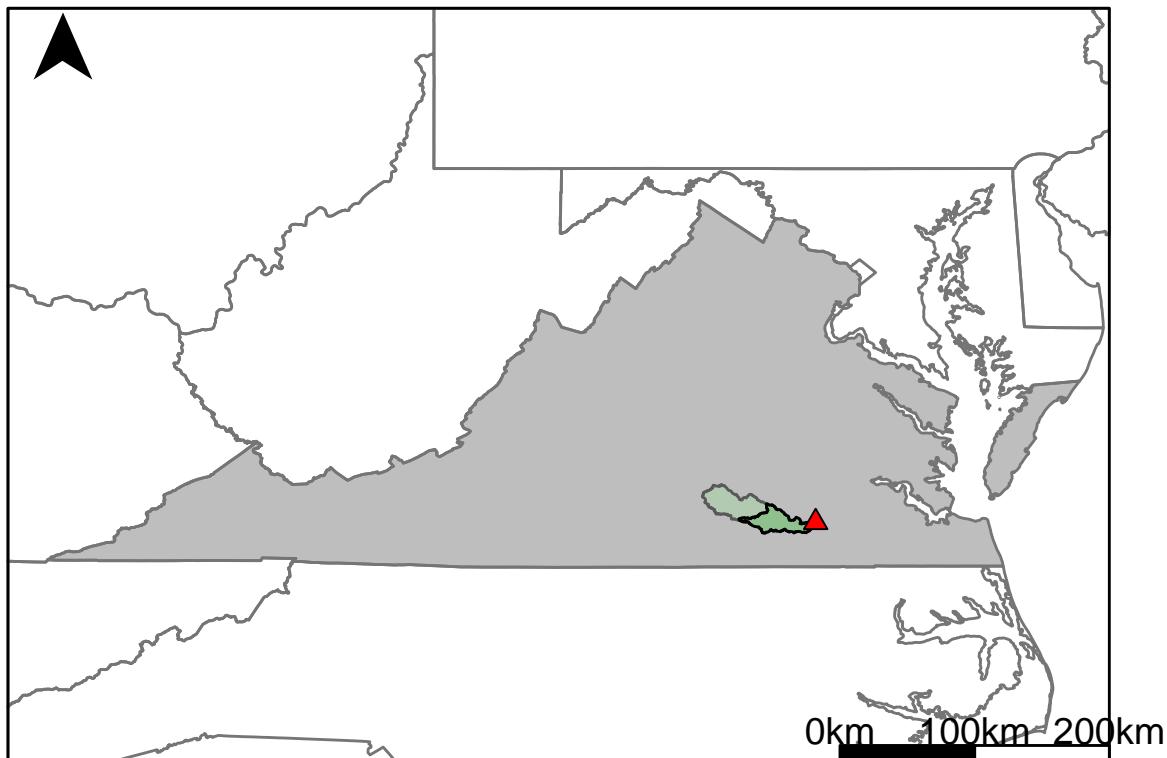


Fig. 9: Residuals Plot



## Appendix G.3: USGS Gage 02045500 vs. MN3\_7930\_8010



This river segment follows part of the flow of the Nottoway River, a tributary of the Meherrin River. The gage is located in Sussex County, VA (Lat 36°54'00", Long 77°24'00") approximately 16 miles northeast of Emporia, VA. Drainage area is 577 sq. miles. This gage started taking data in 1930 and it is still taking data. In the summer months there are occasional diversions of unknown amounts that are used to irrigate local farms. The average daily discharge error between the model and gage data for the 20 year timespan was 3.6%, with 39.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	39	29.1	25.4
Feb. Low Flow	109	109	0
Mar. Low Flow	160	150	6.25
Apr. Low Flow	245	244	0.41
May Low Flow	383	390	-1.83
Jun. Low Flow	411	298	27.5
Jul. Low Flow	284	223	21.5
Aug. Low Flow	160	115	28.1
Sep. Low Flow	99	80.1	19.1
Oct. Low Flow	50	36.5	27
Nov. Low Flow	41	40.7	0.73
Dec. Low Flow	31	32.5	-4.84

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	555	535	3.6
Jan. Mean Flow	758	731	3.56
Feb. Mean Flow	853	911	-6.8
Mar. Mean Flow	1080	1130	-4.63
Apr. Mean Flow	872	792	9.17
May Mean Flow	556	456	18
Jun. Mean Flow	356	270	24.2
Jul. Mean Flow	225	185	17.8
Aug. Mean Flow	264	283	-7.2
Sep. Mean Flow	482	528	-9.54
Oct. Mean Flow	240	257	-7.08
Nov. Mean Flow	457	410	10.3
Dec. Mean Flow	537	498	7.26

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	376	218	42
Feb. High Flow	957	760	20.6
Mar. High Flow	1390	861	38.1
Apr. High Flow	2090	1950	6.7
May High Flow	1770	1970	-11.3
Jun. High Flow	2910	3020	-3.78
Jul. High Flow	2560	2180	14.8
Aug. High Flow	1310	974	25.6
Sep. High Flow	875	313	64.2
Oct. High Flow	680	277	59.3
Nov. High Flow	535	511	4.49
Dec. High Flow	315	295	6.35

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	1.48	0.67	55
Med. 1 Day Min	20	18.7	6.5
Min. 3 Day Min	1.73	0.74	56.9
Med. 3 Day Min	20.7	19.4	6.28
Min. 7 Day Min	3.17	1.18	62.8
Med. 7 Day Min	24.3	22.9	5.76
Min. 30 Day Min	11.2	4.8	57.1
Med. 30 Day Min	41.7	39.6	5.04
Min. 90 Day Min	21.4	23.6	-10.3
Med. 90 Day Min	130	97.4	25.1
7Q10	8.68	4.64	46.5
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	134	535	-299
Mean Baseflow	233	235	-0.86

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	14300	24600	-72
Med. 1 Day Max	5860	6230	-6.31
Max. 3 Day Max	12200	18500	-51.6
Med. 3 Day Max	5340	5590	-4.68
Max. 7 Day Max	7870	11000	-39.8
Med. 7 Day Max	3410	3620	-6.16
Max. 30 Day Max	3070	3030	1.3
Med. 30 Day Max	1590	1560	1.89
Max. 90 Day Max	2240	2200	1.79
Med. 90 Day Max	1070	1070	0

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	13	11	15.4
5% Non-Exceedance	31	23.2	25.2
50% Non-Exceedance	282	255	9.57
95% Non-Exceedance	1970	1900	3.55
99% Non-Exceedance	4860	4840	0.41
Sept. 10% Non-Exceedance	23.2	23	0.86

**Fig. 1: Hydrograph**

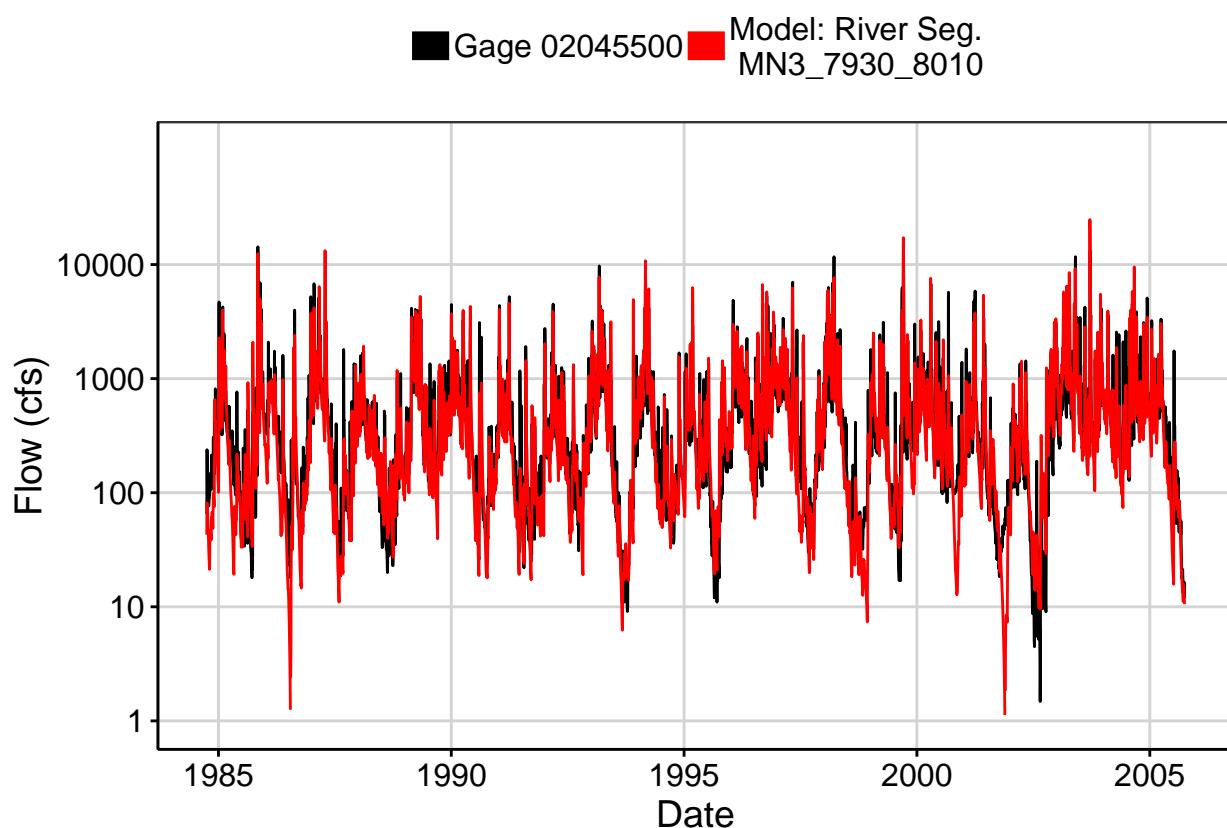


Fig. 2: Zoomed Hydrograph

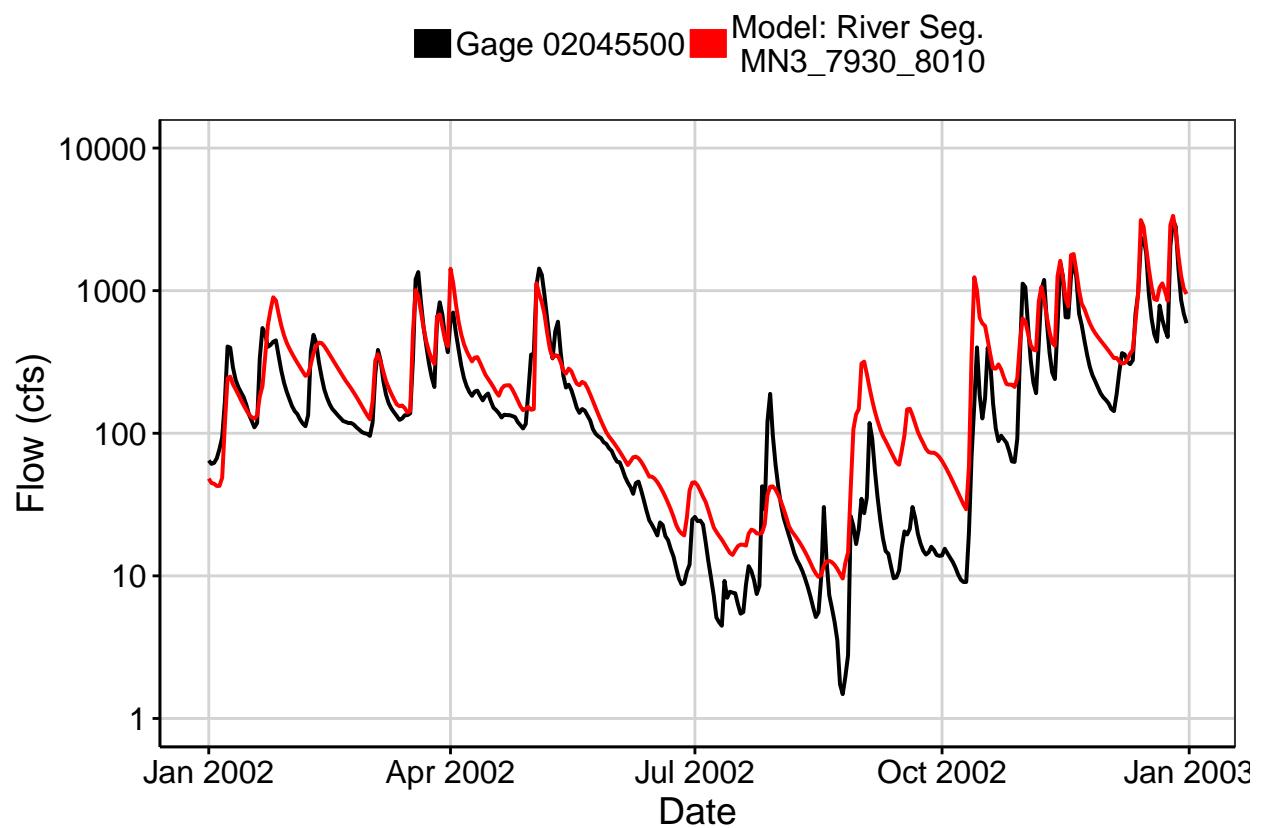


Fig. 3: Flow Exceedance

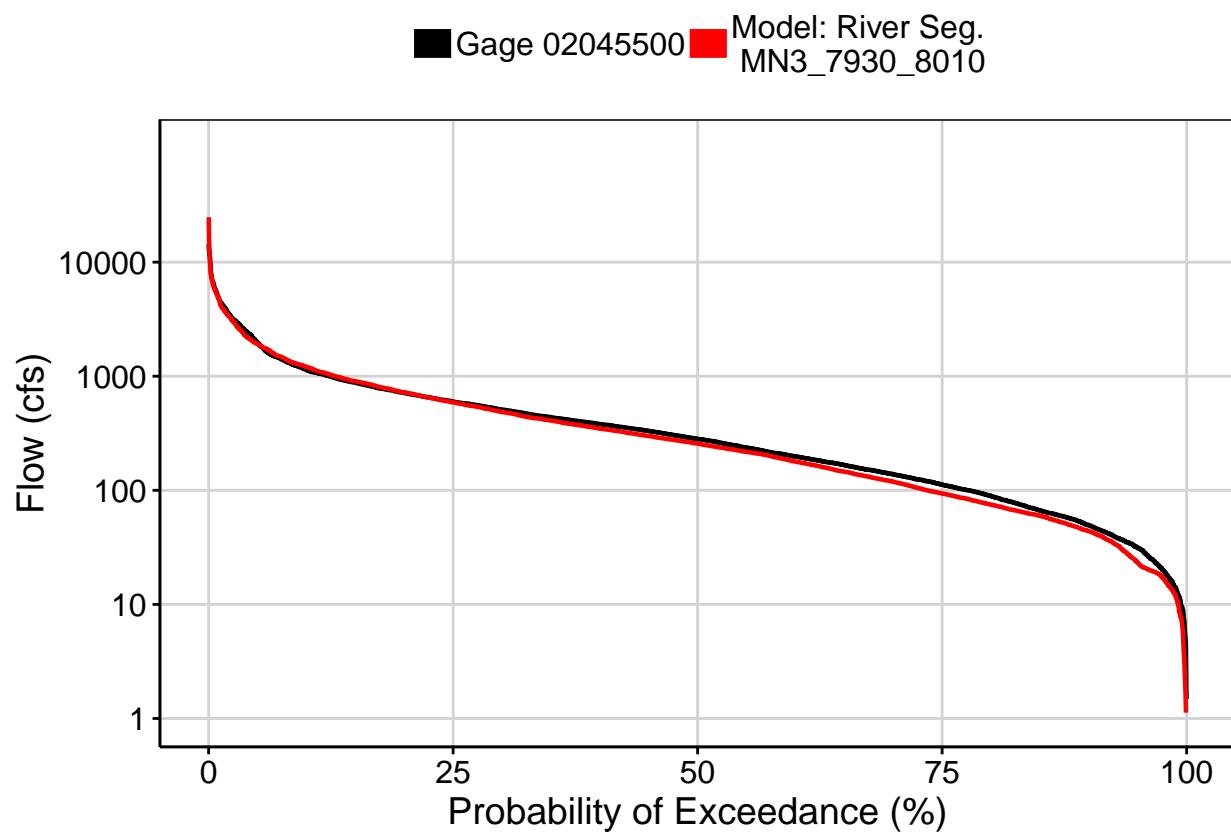


Fig. 4: Baseflow

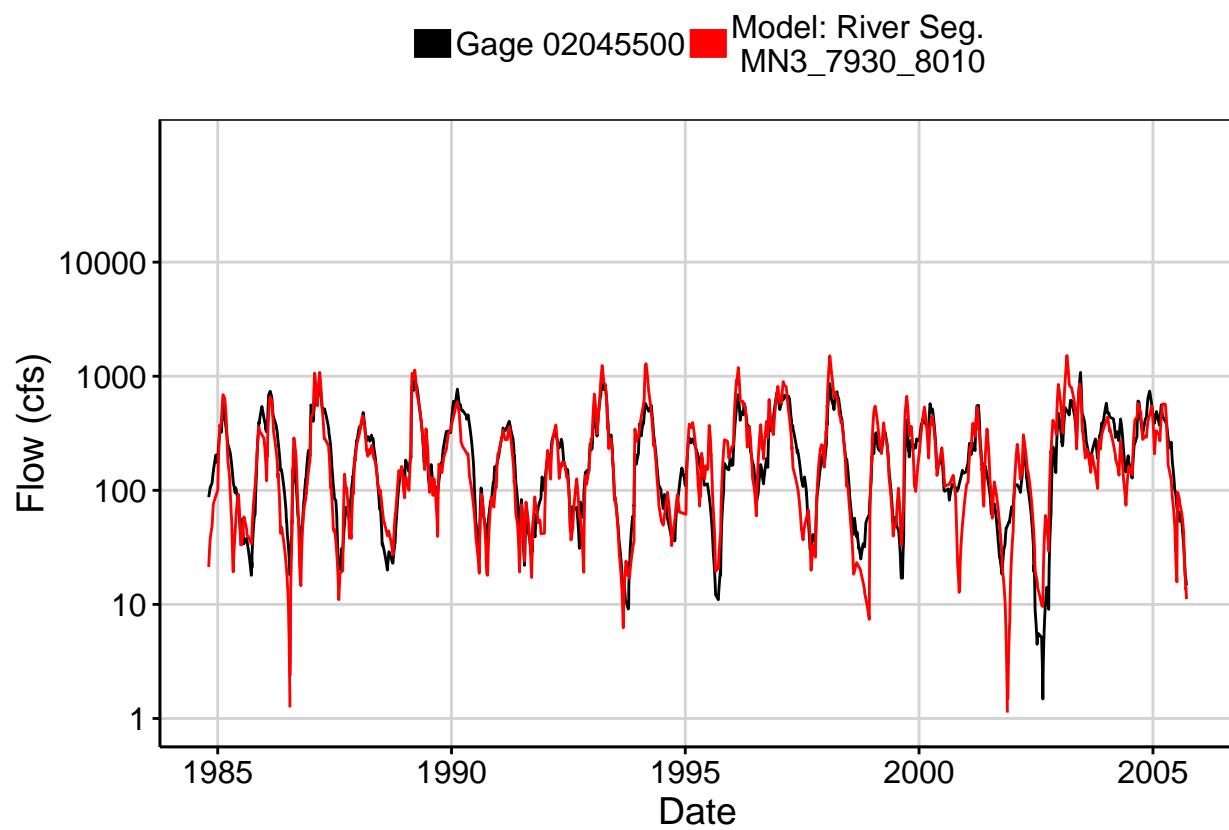


Fig. 5: Combined Baseflow

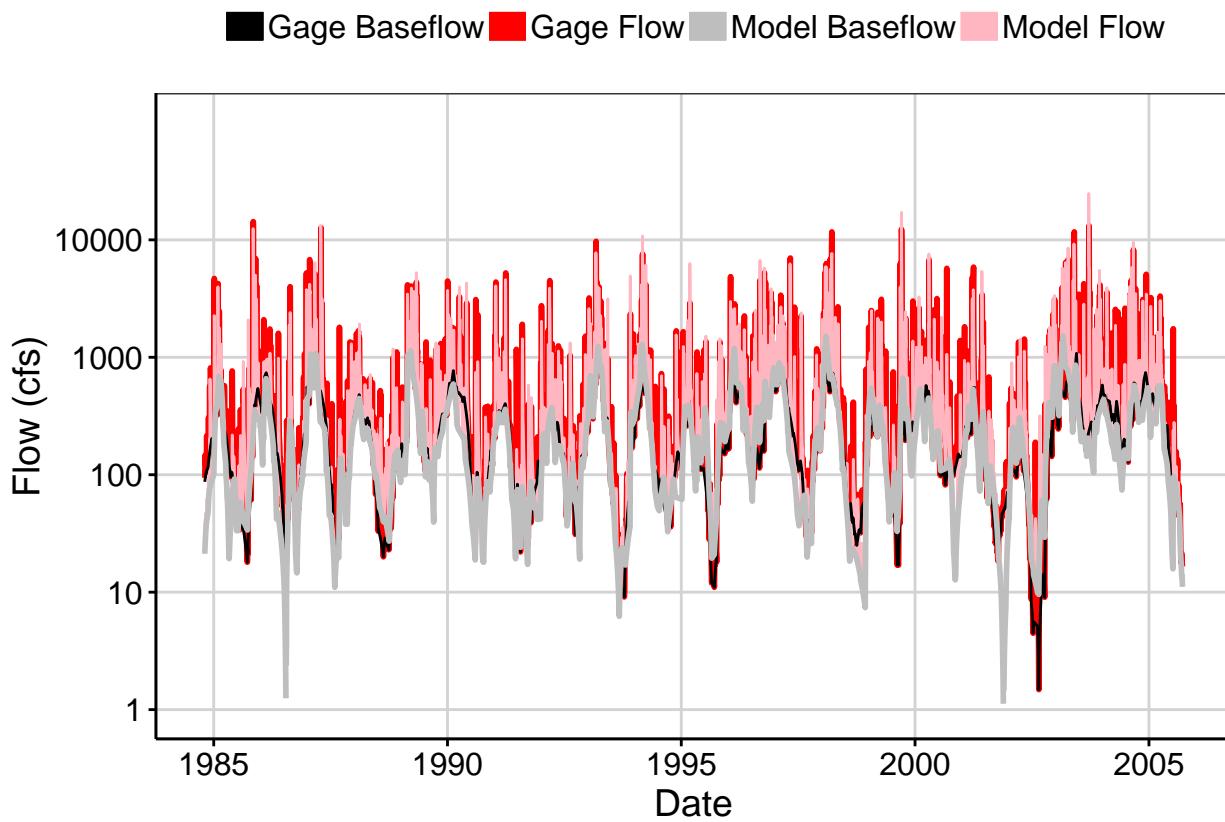


Fig. 6: Largest Error Segment

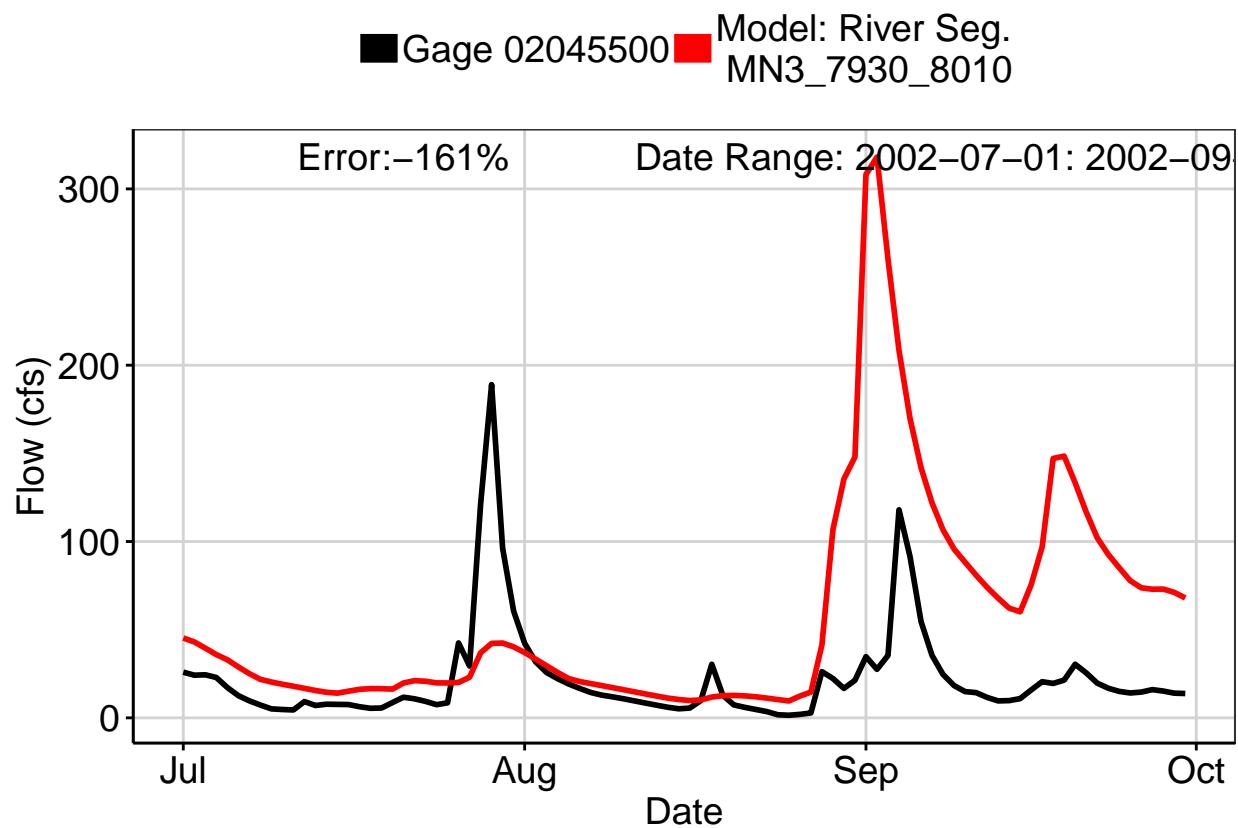


Fig. 7: Second Largest Error Segment

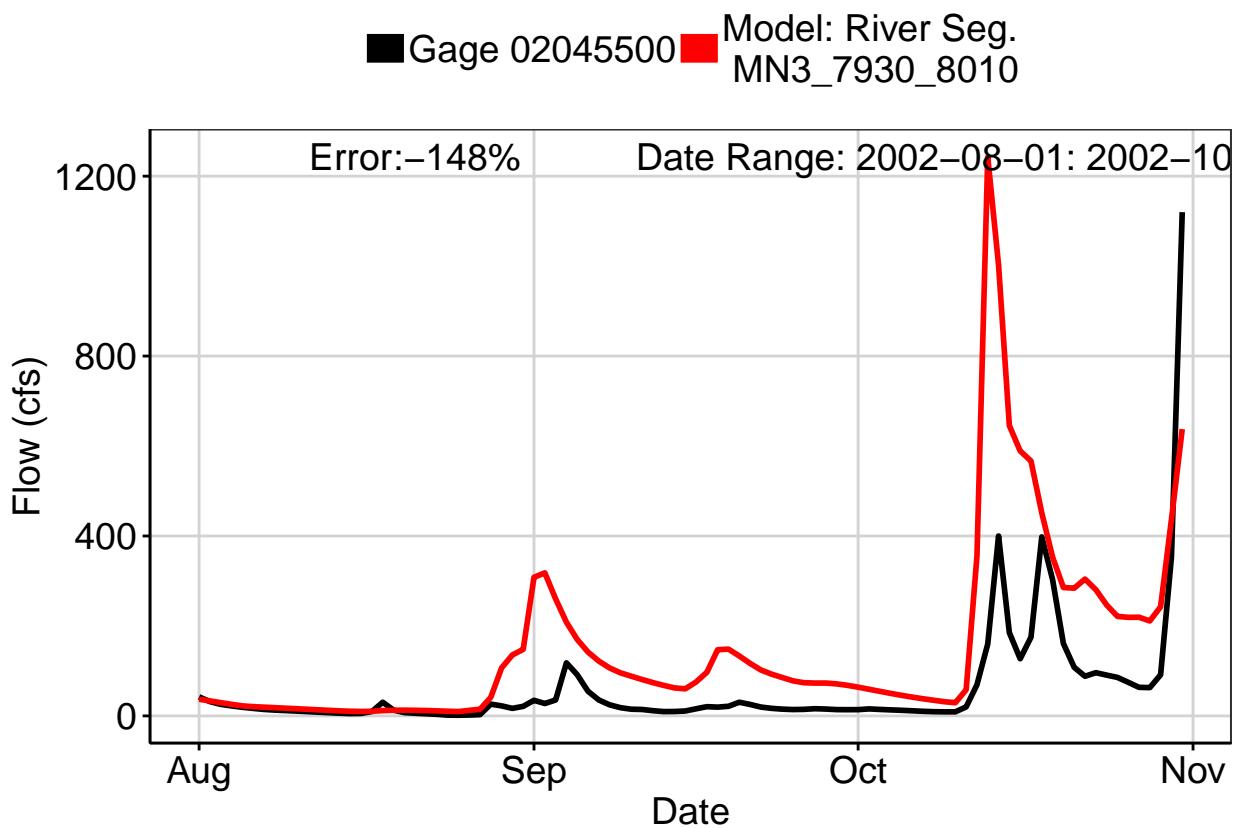


Fig. 8: Third Largest Error Segment

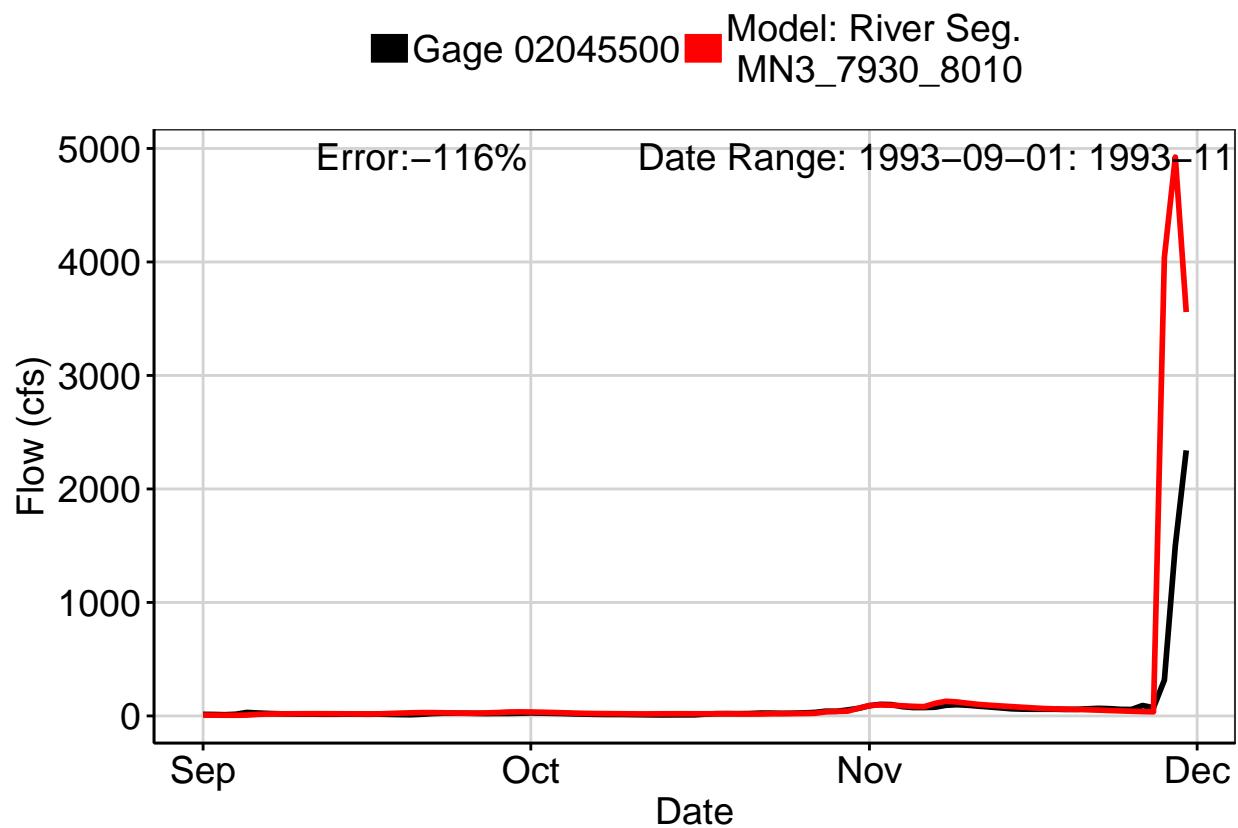
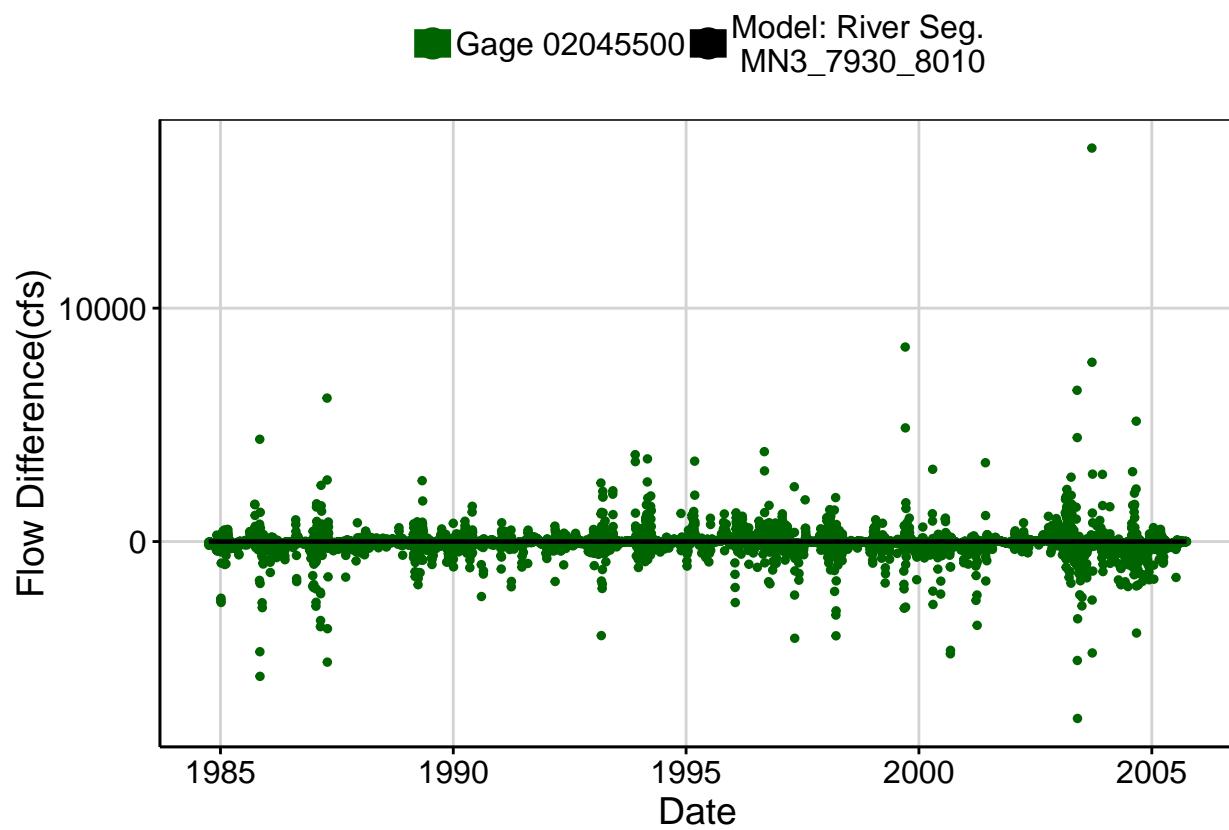
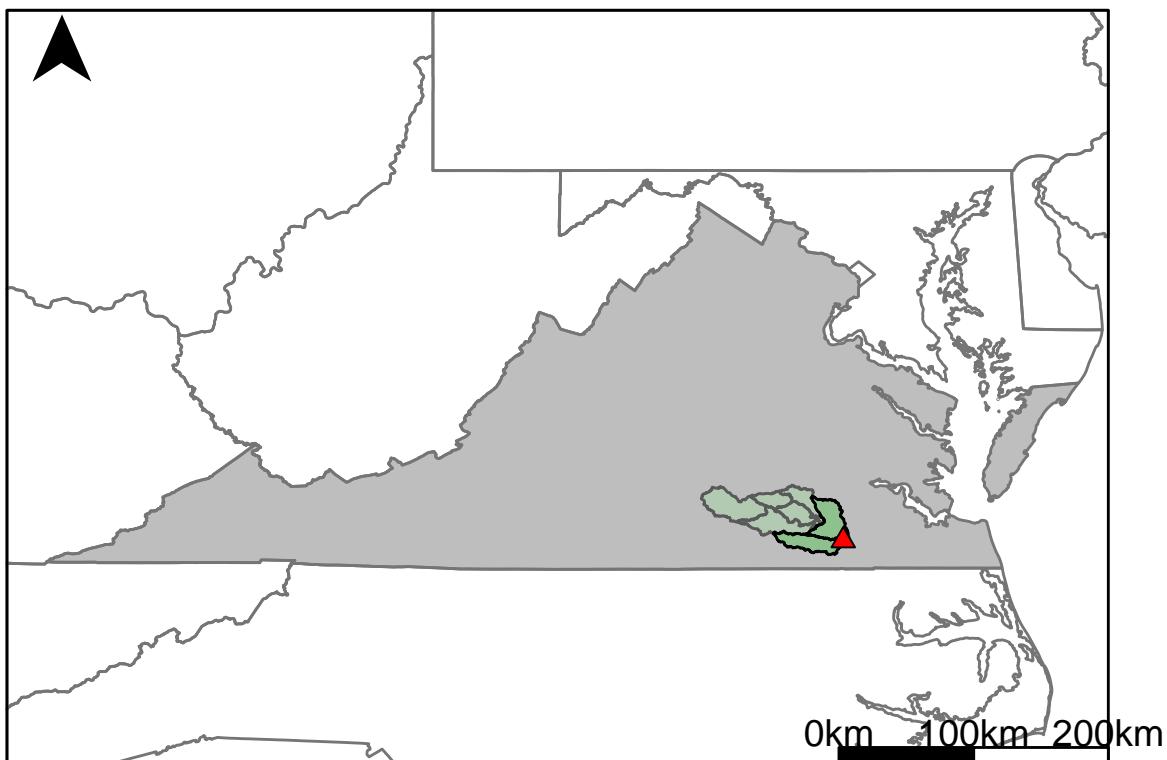


Fig. 9: Residuals Plot



## Appendix G.4: USGS Gage 02047000 vs. MN4\_7710\_8161+MN5\_8230\_8161



This river segment follows part of the flow of the Nottoway River, a tributary of the Meherrin River. The gage is located in Southampton County, VA (Lat 36°46'13", Long 77°09'59") approximately 34 miles southeast of Petersburg, VA. Drainage area is 1441 sq. miles. This gage started taking data in 1950 and is still taking data today. The City of Virginia Beach withdraws water downstream of this gage. It is believed that these withdrawals are far enough downstream that they would not drastically affect the gage, but it is unsure. The average daily discharge error between the model and gage data for the 20 year timespan was 15.8%, with 41.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	67	71.1	-6.12
Feb. Low Flow	156	251	-60.9
Mar. Low Flow	445	373	16.2
Apr. Low Flow	703	534	24
May Low Flow	1090	919	15.7
Jun. Low Flow	1020	690	32.4
Jul. Low Flow	759	454	40.2
Aug. Low Flow	389	218	44
Sep. Low Flow	191	156	18.3
Oct. Low Flow	96	77.1	19.7
Nov. Low Flow	75	89	-18.7
Dec. Low Flow	64	67.3	-5.16

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	1390	1170	15.8
Jan. Mean Flow	1900	1620	14.7
Feb. Mean Flow	2310	1980	14.3
Mar. Mean Flow	2710	2400	11.4
Apr. Mean Flow	2340	1720	26.5
May Mean Flow	1270	985	22.4
Jun. Mean Flow	796	564	29.1
Jul. Mean Flow	505	373	26.1
Aug. Mean Flow	747	660	11.6
Sep. Mean Flow	1330	1260	5.26
Oct. Mean Flow	585	585	0
Nov. Mean Flow	932	828	11.2
Dec. Mean Flow	1340	1110	17.2

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	707	679	3.96
Feb. High Flow	1490	1490	0
Mar. High Flow	1960	1770	9.69
Apr. High Flow	4210	3630	13.8
May High Flow	4790	3970	17.1
Jun. High Flow	4550	6040	-32.7
Jul. High Flow	4900	3730	23.9
Aug. High Flow	3130	2100	32.9
Sep. High Flow	1960	1030	47.4
Oct. High Flow	1090	682	37.4
Nov. High Flow	1500	826	44.9
Dec. High Flow	675	650	3.7

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	13	3.61	72.2
Med. 1 Day Min	42	37.9	9.76
Min. 3 Day Min	14.3	4.08	71.5
Med. 3 Day Min	43.3	39	9.93
Min. 7 Day Min	17.4	4.93	71.7
Med. 7 Day Min	47.4	40.5	14.6
Min. 30 Day Min	30	13.1	56.3
Med. 30 Day Min	82.6	66.1	20
Min. 90 Day Min	41.2	54.9	-33.3
Med. 90 Day Min	235	227	3.4
7Q10	24.6	13.6	44.7
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	316	1170	-270
Mean Baseflow	664	525	20.9

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	34500	37800	-9.57
Med. 1 Day Max	8350	12500	-49.7
Max. 3 Day Max	32700	34800	-6.42
Med. 3 Day Max	8020	11100	-38.4
Max. 7 Day Max	26100	23800	8.81
Med. 7 Day Max	7300	7380	-1.1
Max. 30 Day Max	9190	7750	15.7
Med. 30 Day Max	4040	3340	17.3
Max. 90 Day Max	5420	4810	11.3
Med. 90 Day Max	3020	2270	24.8

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	29.3	24.4	16.7
5% Non-Exceedance	56	47.8	14.6
50% Non-Exceedance	751	582	22.5
95% Non-Exceedance	5000	3970	20.6
99% Non-Exceedance	9160	9860	-7.64
Sept. 10% Non-Exceedance	54.6	45.3	17

**Fig. 1: Hydrograph**

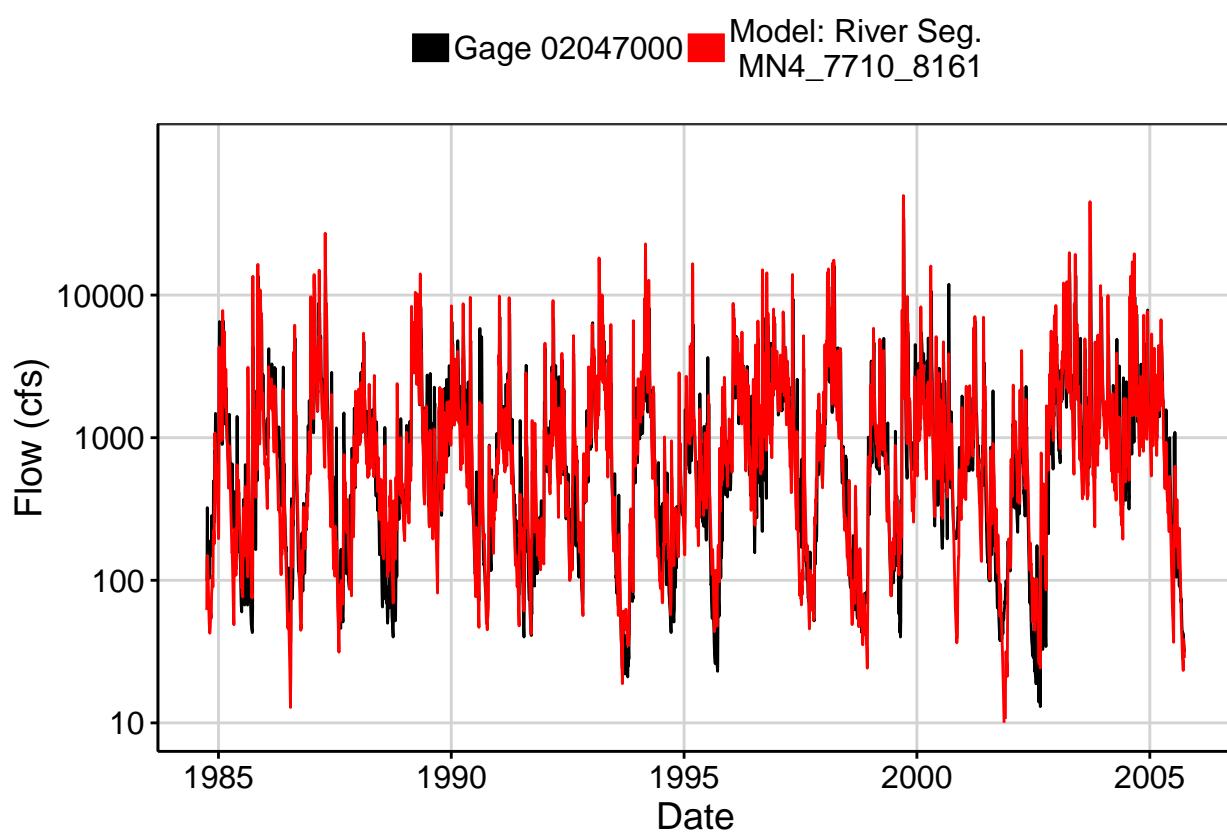


Fig. 2: Zoomed Hydrograph

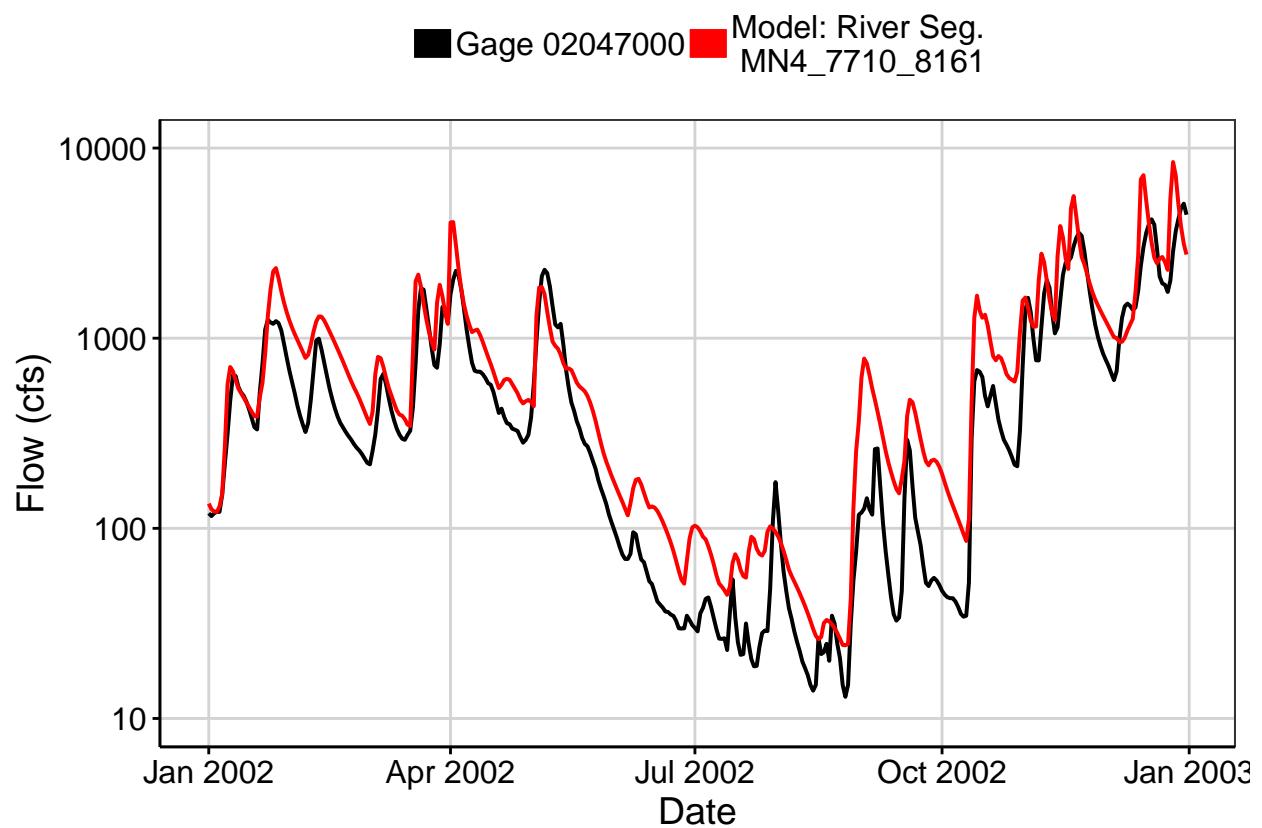


Fig. 3: Flow Exceedance

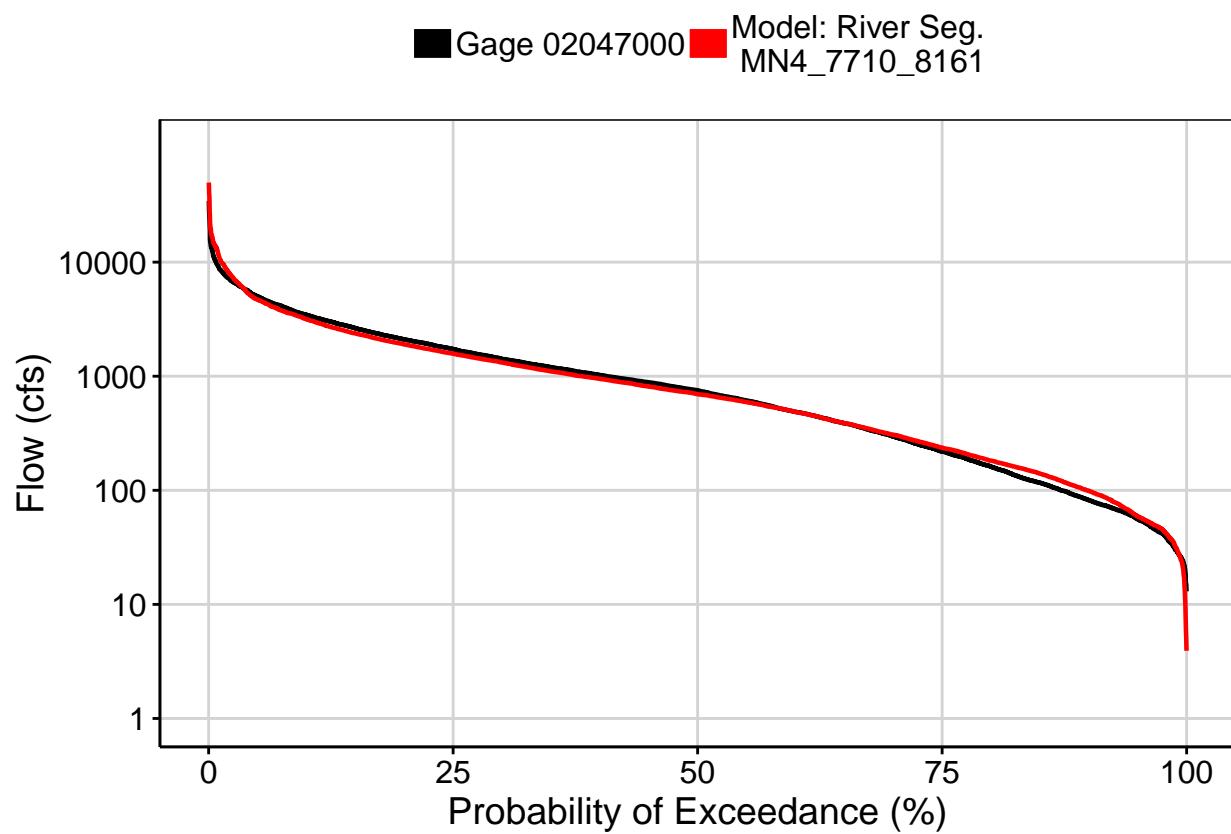


Fig. 4: Baseflow

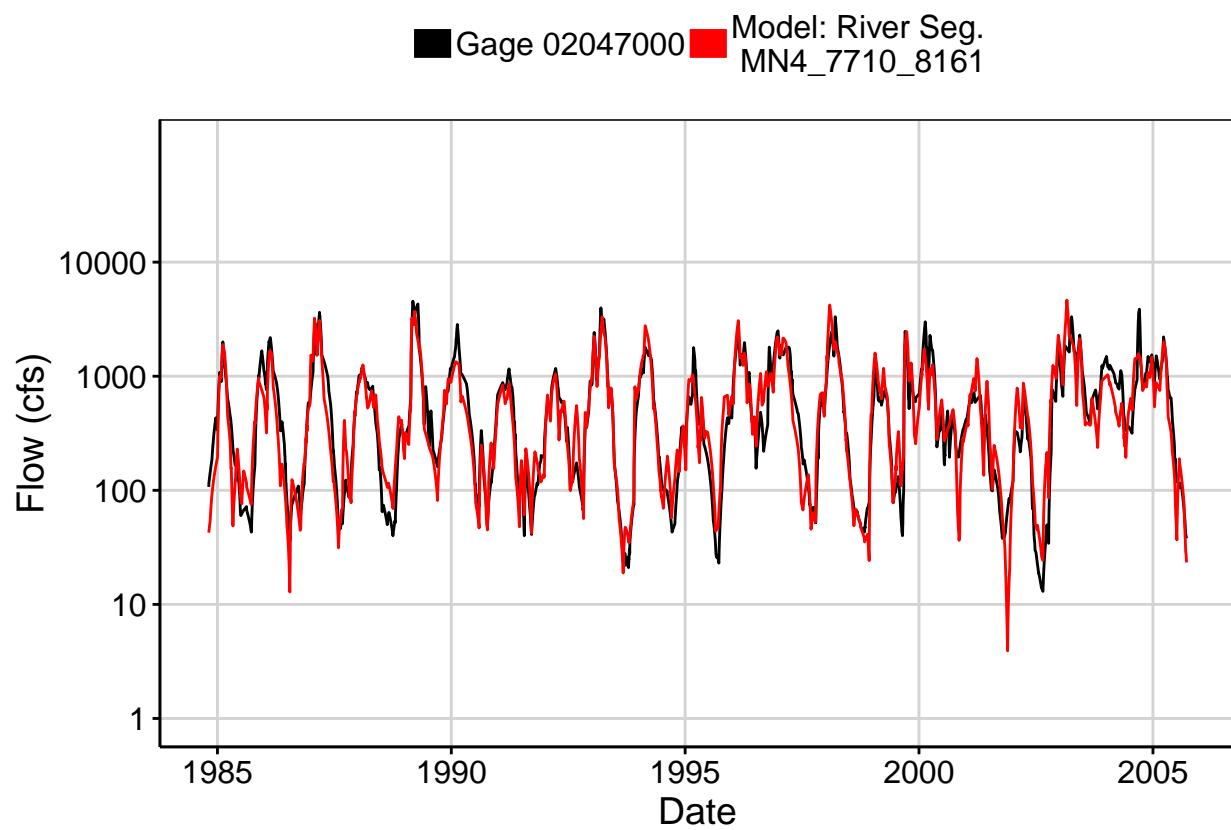


Fig. 5: Combined Baseflow

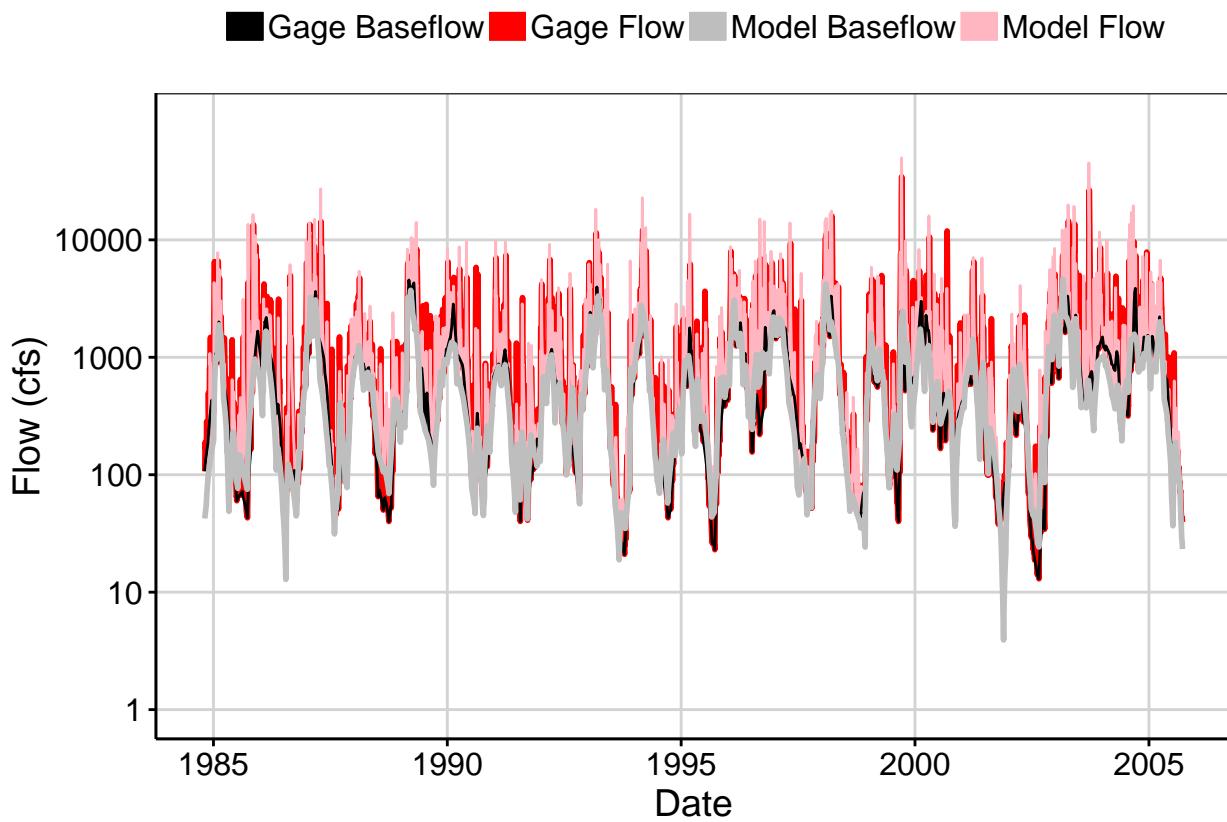


Fig. 6: Largest Error Segment

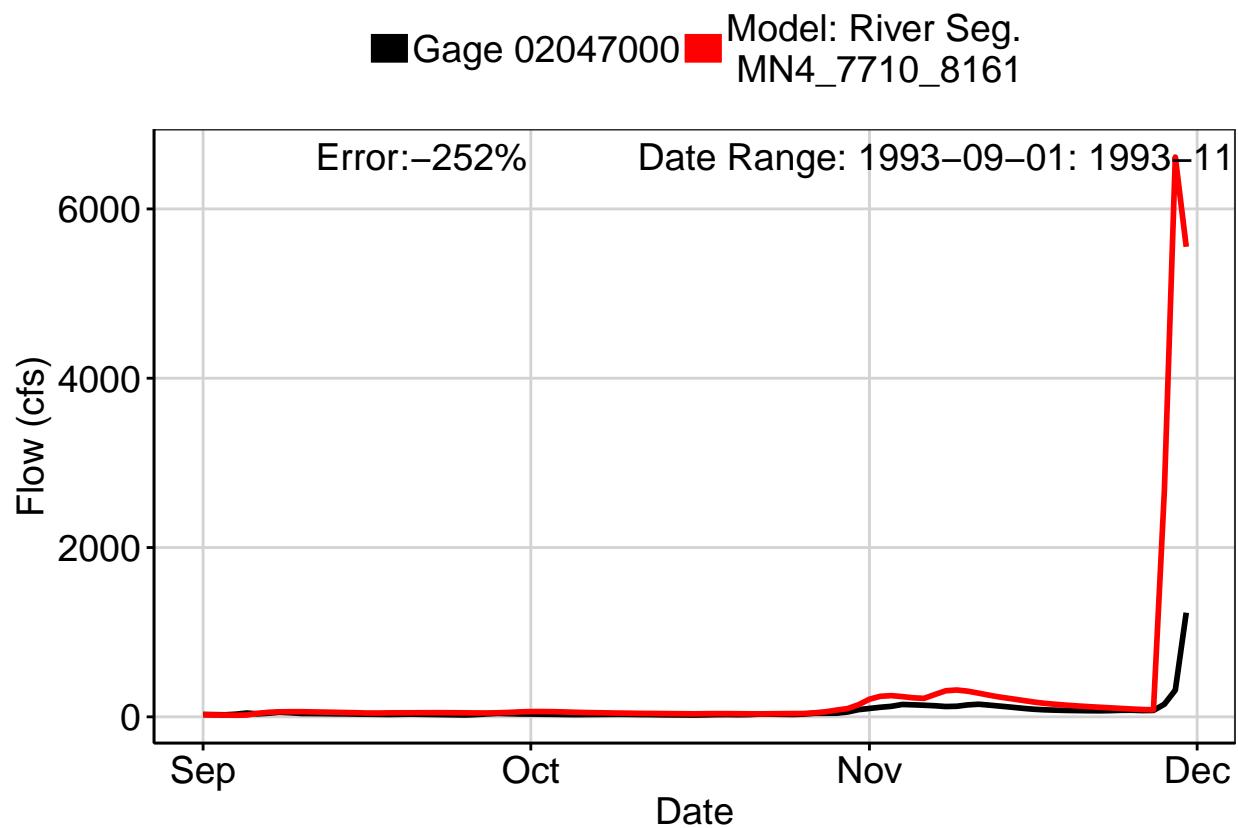


Fig. 7: Second Largest Error Segment

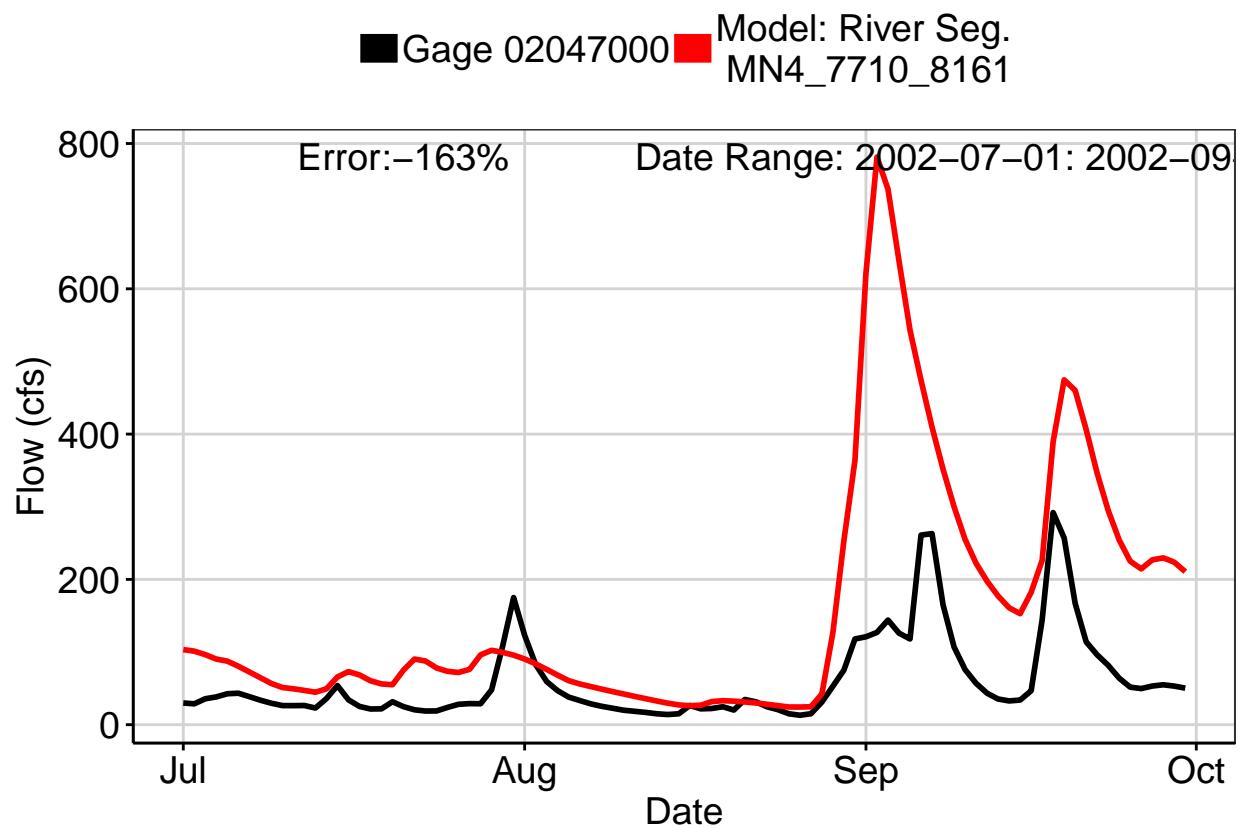


Fig. 8: Third Largest Error Segment

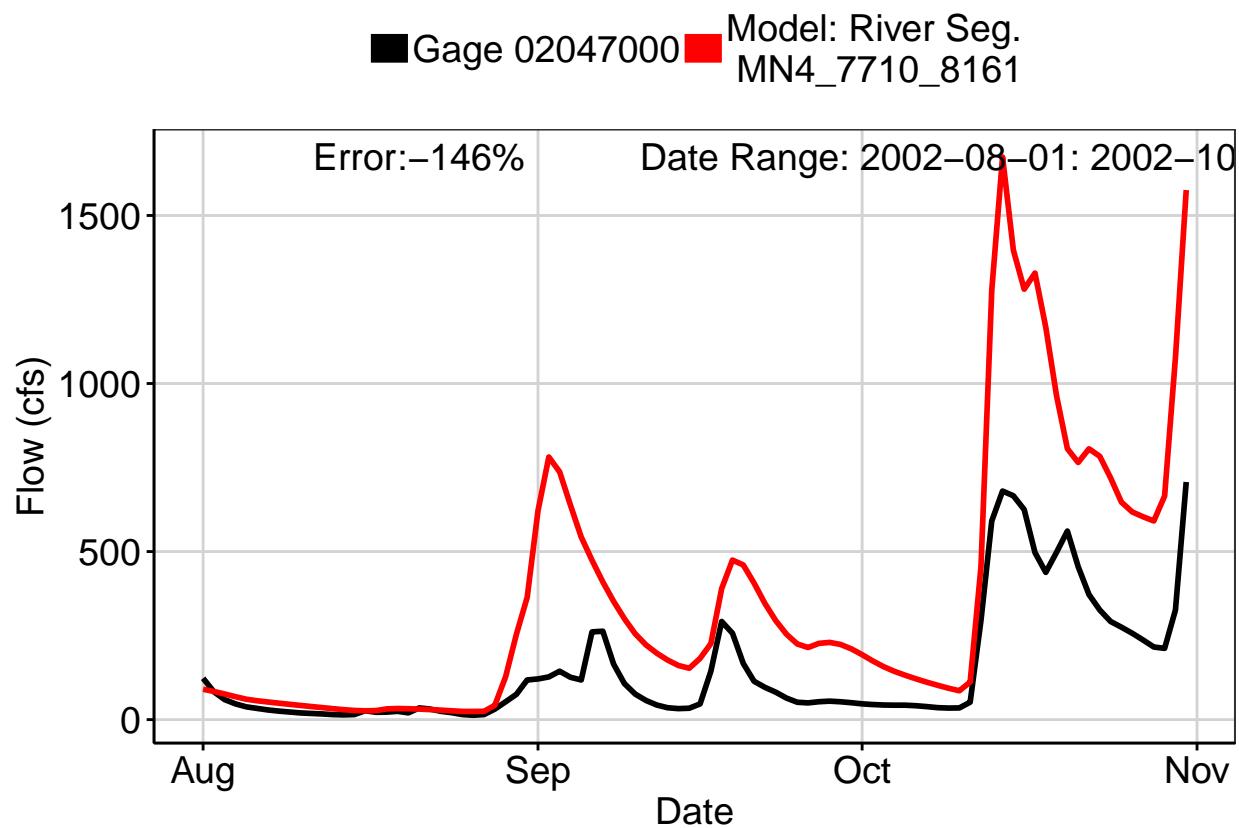
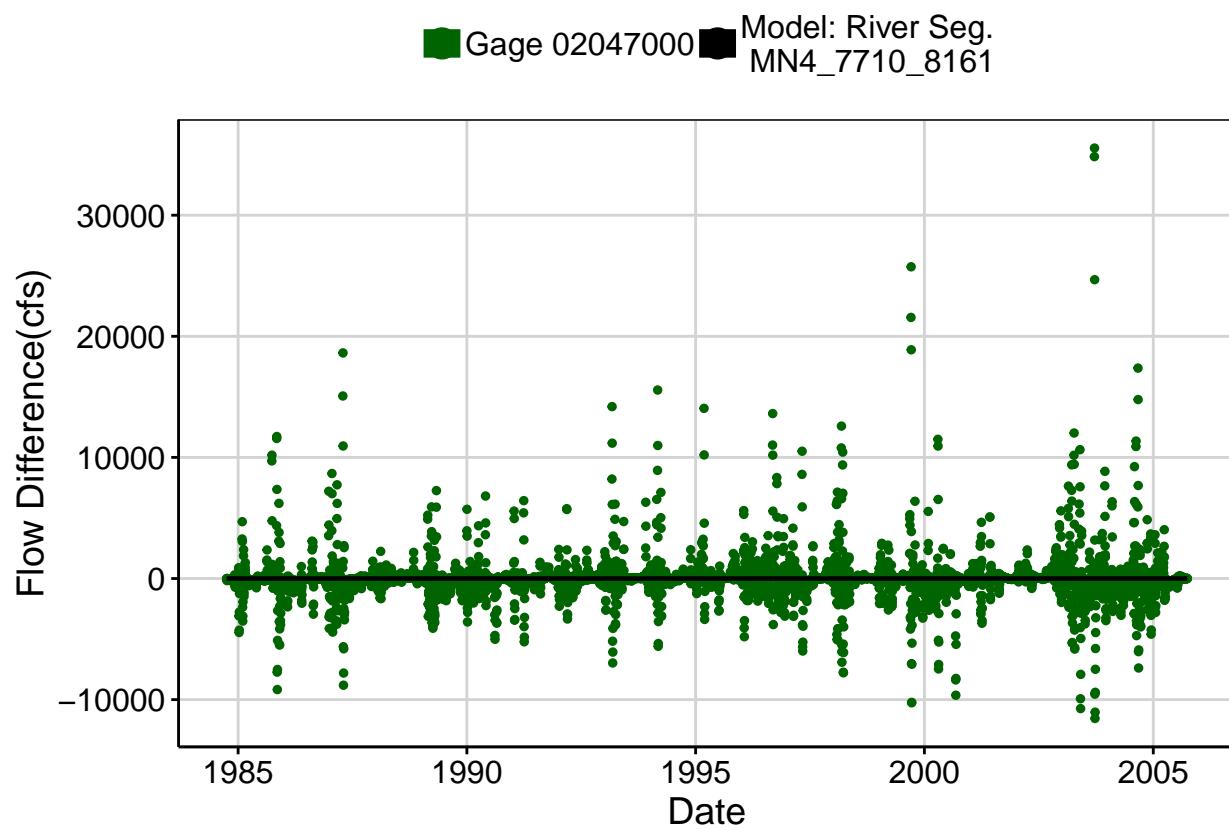
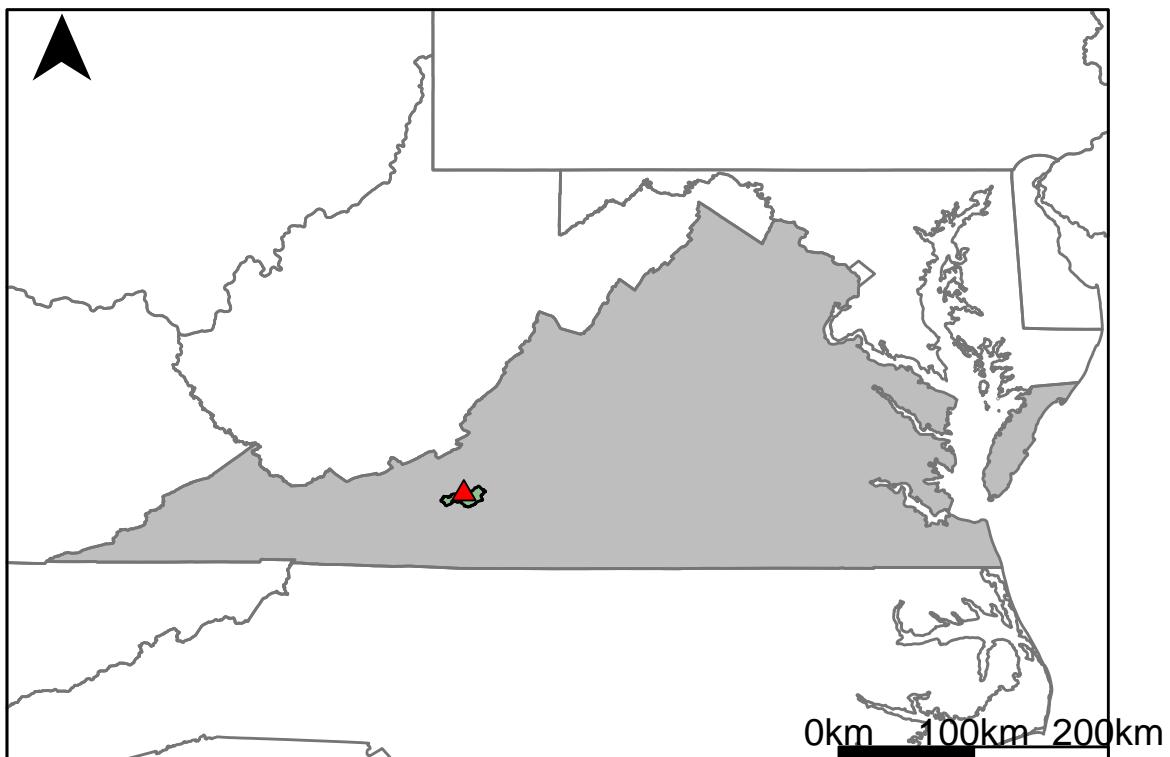


Fig. 9: Residuals Plot



## Appendix H: Roanoke River Gages

### Appendix H.1: USGS Gage 02053800 vs. OR1\_8280\_8020



This river segment follows part of the flow of the South Fork of the Roanoke River. The gage is located in Montgomery County, VA (Lat 37°08'24", Long 80°16'00") approximately 17 miles east of Radford, VA. Drainage area is 109 sq. miles. This gage started taking data in 1960 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 5.88%, with 37.5% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	29	22.1	23.8
Feb. Low Flow	38	22.7	40.3
Mar. Low Flow	44	49.9	-13.4
Apr. Low Flow	45	52.8	-17.3
May Low Flow	66	94.7	-43.5
Jun. Low Flow	91	107	-17.6
Jul. Low Flow	76	81.5	-7.24
Aug. Low Flow	68	67.5	0.74
Sep. Low Flow	51	52.6	-3.14
Oct. Low Flow	39	32.4	16.9
Nov. Low Flow	31	24.8	20
Dec. Low Flow	28	21.9	21.8

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	119	112	5.88
Jan. Mean Flow	141	138	2.13
Feb. Mean Flow	174	173	0.57
Mar. Mean Flow	205	202	1.46
Apr. Mean Flow	183	176	3.83
May Mean Flow	136	128	5.88
Jun. Mean Flow	107	109	-1.87
Jul. Mean Flow	71.1	67.8	4.64
Aug. Mean Flow	58.8	54.7	6.97
Sep. Mean Flow	93.4	73.2	21.6
Oct. Mean Flow	62.9	56.1	10.8
Nov. Mean Flow	97.7	83.5	14.5
Dec. Mean Flow	98.5	88.7	9.95

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	101	59.5	41.1
Feb. High Flow	222	203	8.56
Mar. High Flow	239	117	51
Apr. High Flow	378	463	-22.5
May High Flow	338	317	6.21
Jun. High Flow	631	697	-10.5
Jul. High Flow	341	356	-4.4
Aug. High Flow	301	276	8.31
Sep. High Flow	172	187	-8.72
Oct. High Flow	117	97.6	16.6
Nov. High Flow	80	70.3	12.1
Dec. High Flow	72	68	5.56

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	6.95	3.87	44.3
Med. 1 Day Min	22	13.8	37.3
Min. 3 Day Min	7.19	3.9	45.8
Med. 3 Day Min	22	14.1	35.9
Min. 7 Day Min	7.52	4.01	46.7
Med. 7 Day Min	23.3	14.8	36.5
Min. 30 Day Min	12.2	5.35	56.1
Med. 30 Day Min	29.9	19.8	33.8
Min. 90 Day Min	15.6	14.3	8.33
Med. 90 Day Min	42.4	31.3	26.2
7Q10	13.3	7.63	42.6
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	38.8	112	-189
Mean Baseflow	64.9	69.7	-7.4

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	4270	4330	-1.41
Med. 1 Day Max	1920	1400	27.1
Max. 3 Day Max	2460	1860	24.4
Med. 3 Day Max	1300	954	26.6
Max. 7 Day Max	1340	1050	21.6
Med. 7 Day Max	757	591	21.9
Max. 30 Day Max	768	598	22.1
Med. 30 Day Max	327	300	8.26
Max. 90 Day Max	477	389	18.4
Med. 90 Day Max	205	203	0.98

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	14.1	9.79	30.6
5% Non-Exceedance	22	16.3	25.9
50% Non-Exceedance	71	69.3	2.39
95% Non-Exceedance	313	314	-0.32
99% Non-Exceedance	847	791	6.61
Sept. 10% Non-Exceedance	15.3	14.9	2.61

**Fig. 1: Hydrograph**

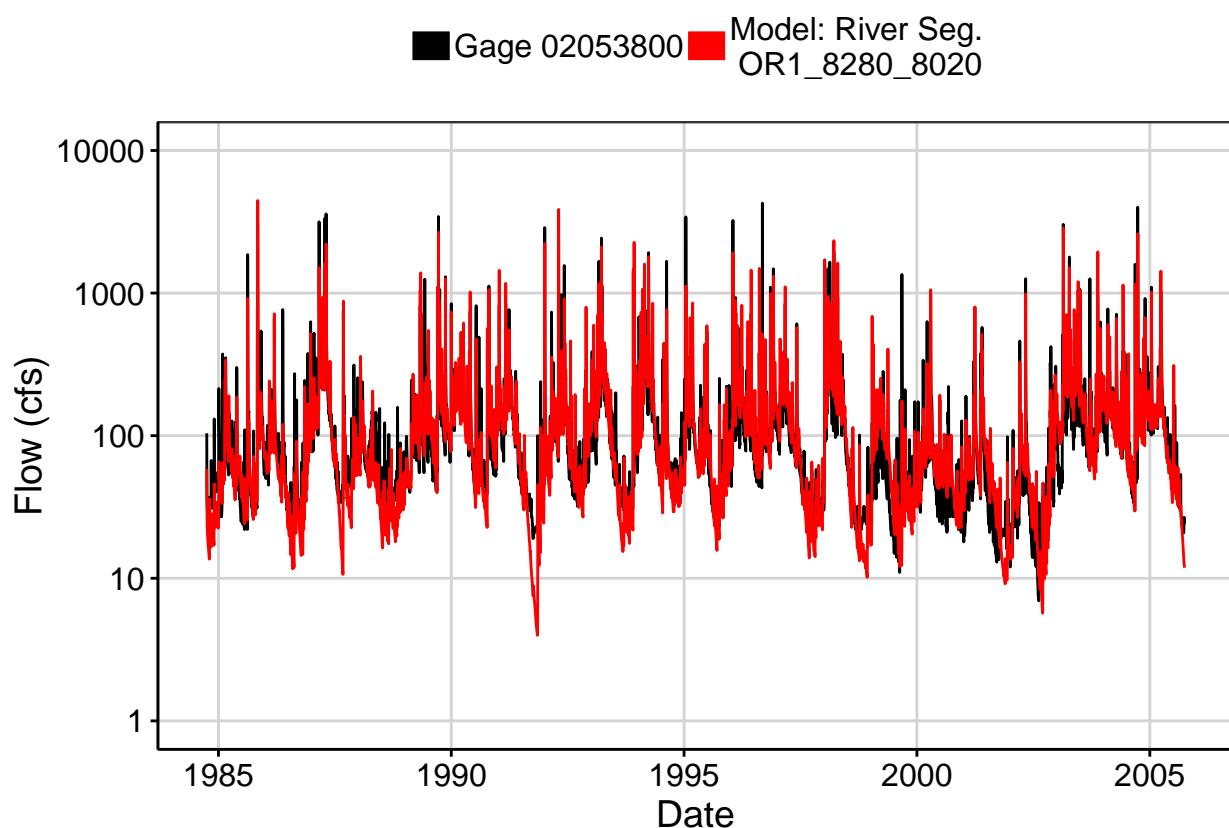


Fig. 2: Zoomed Hydrograph

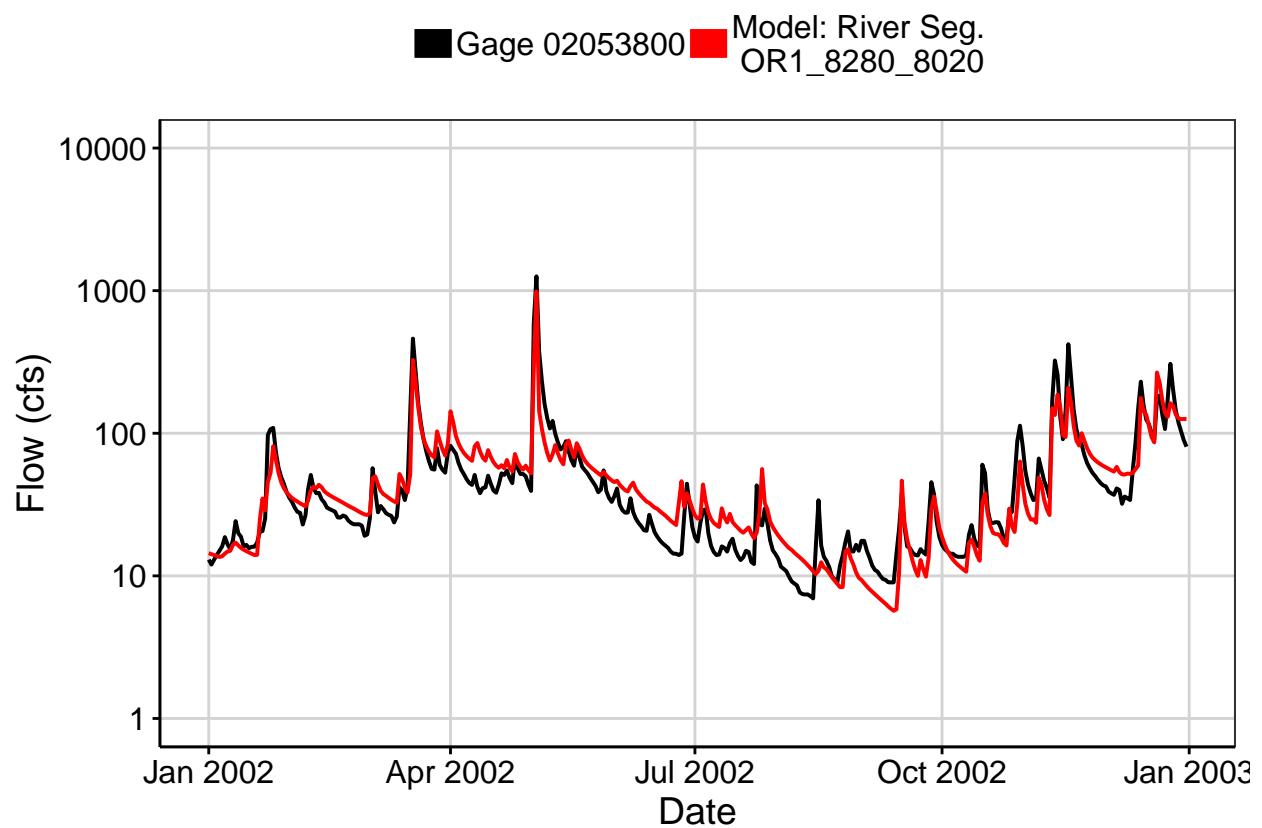


Fig. 3: Flow Exceedance

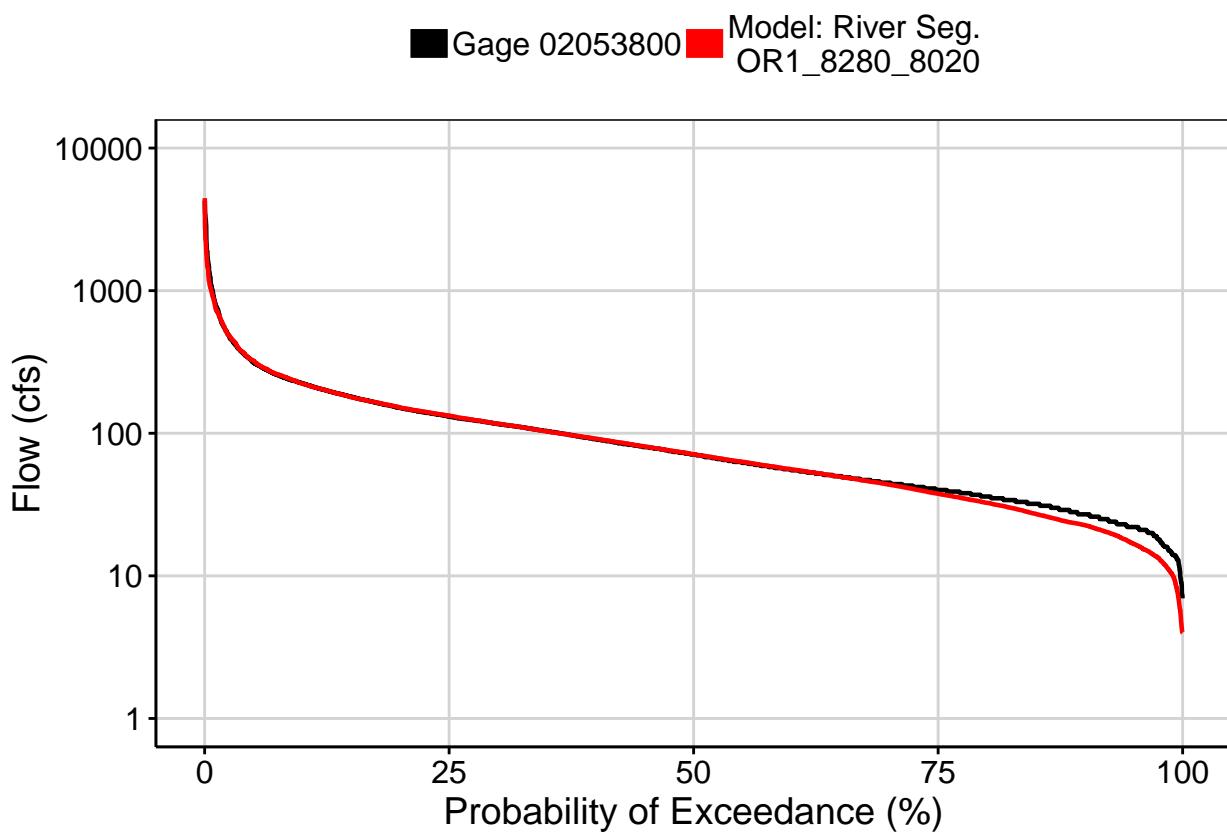


Fig. 4: Baseflow

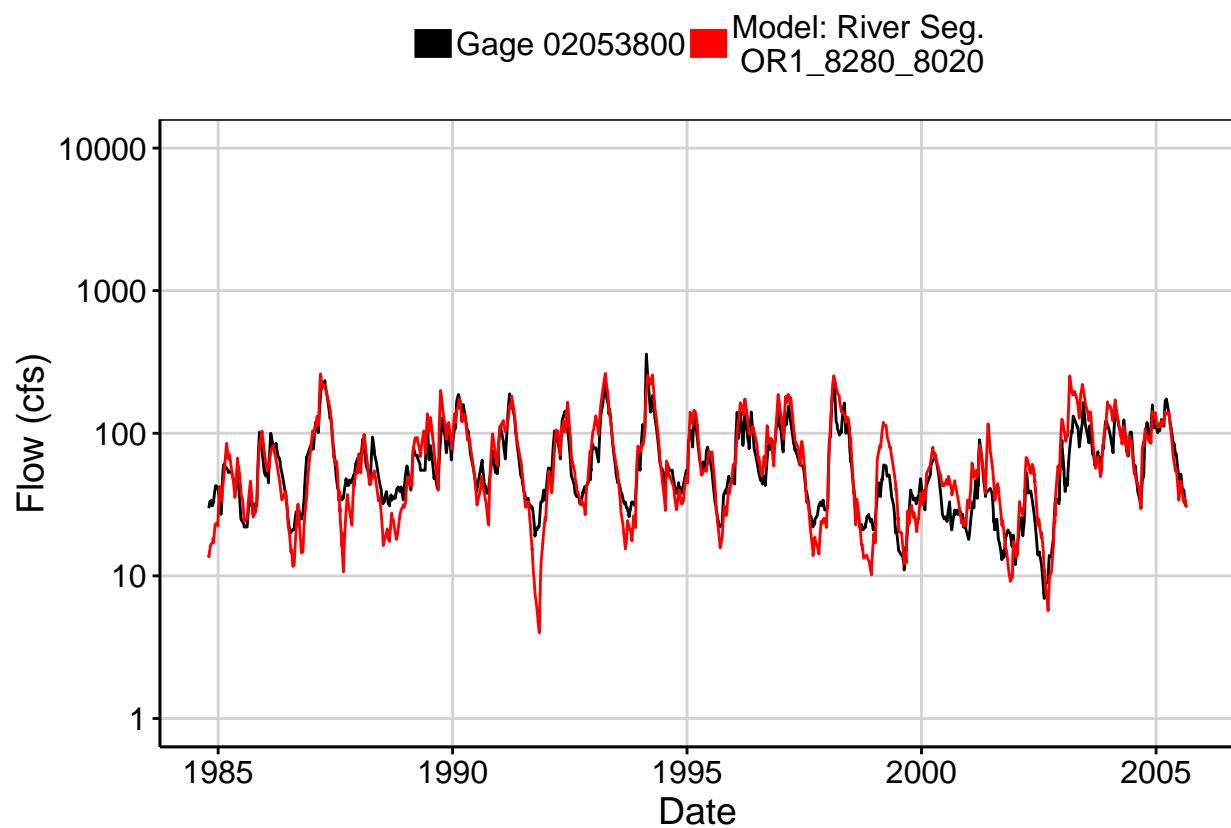


Fig. 5: Combined Baseflow

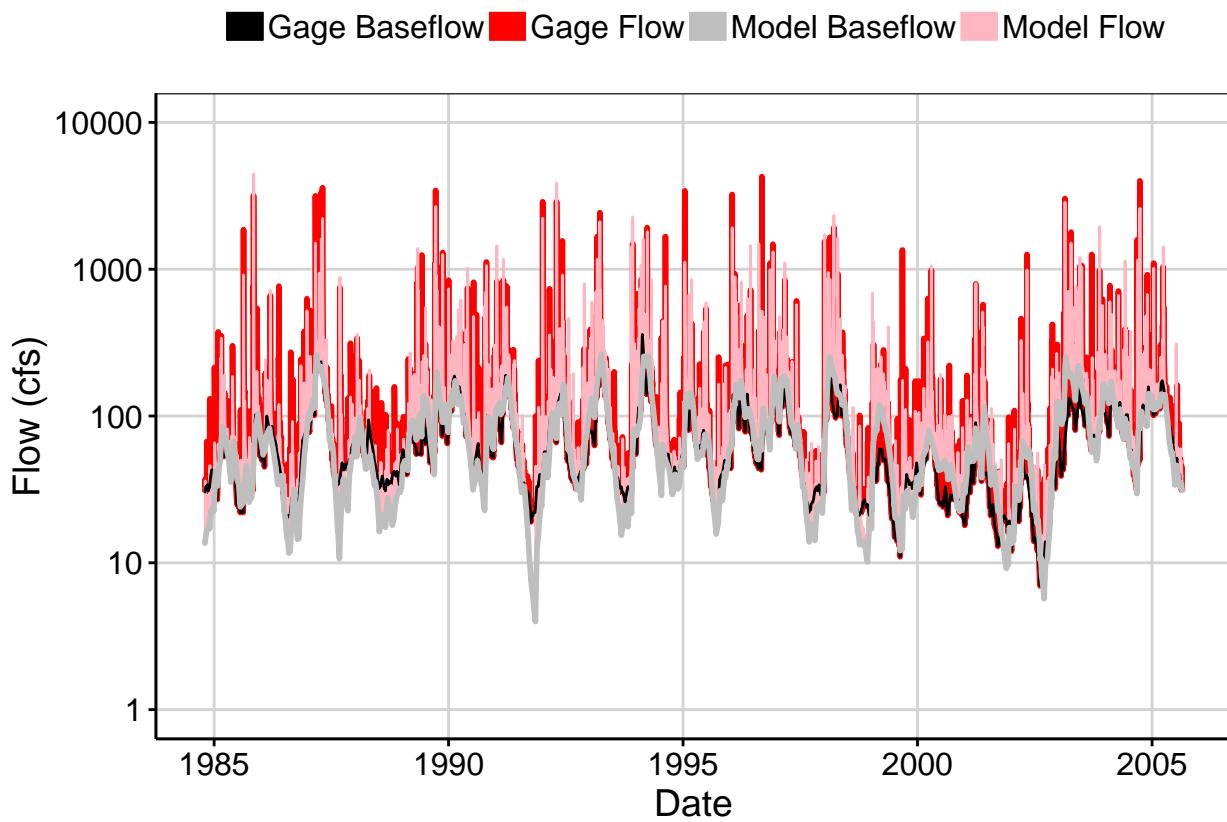


Fig. 6: Largest Error Segment

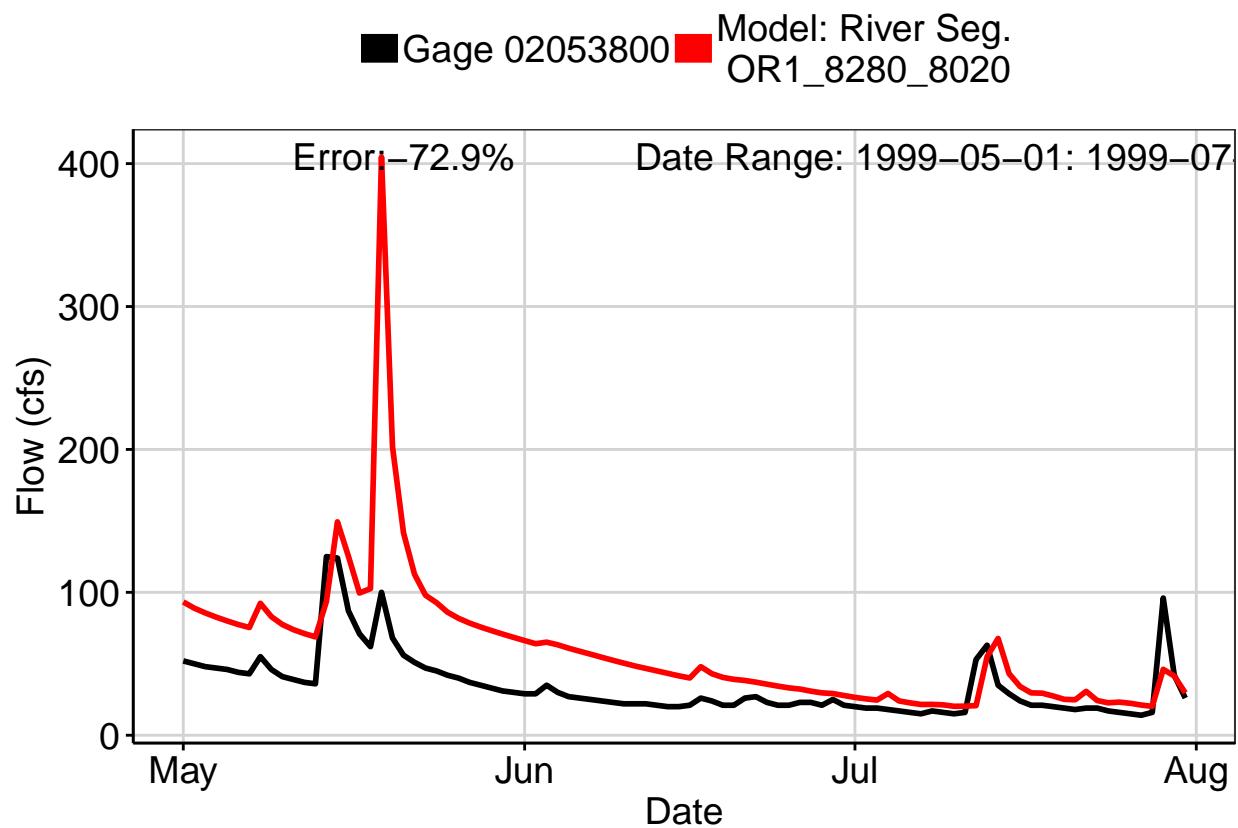


Fig. 7: Second Largest Error Segment

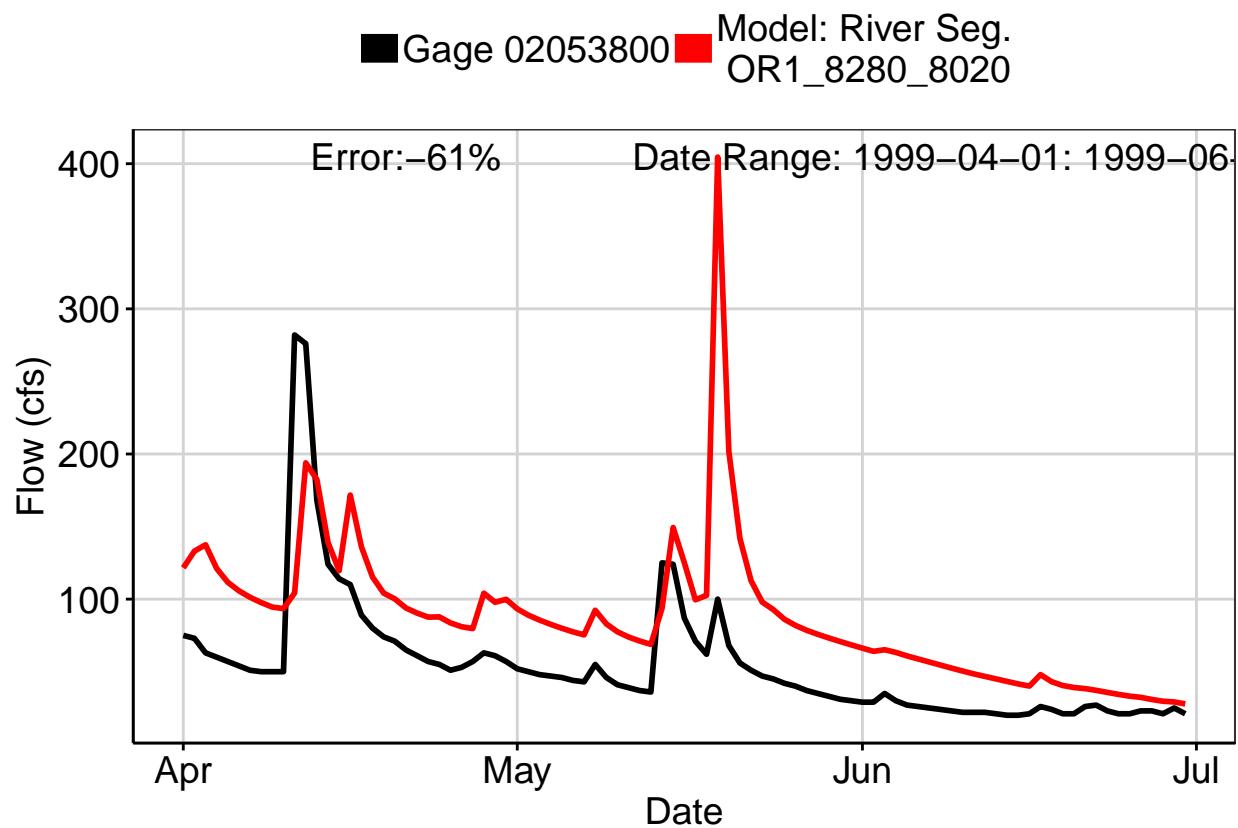


Fig. 8: Third Largest Error Segment

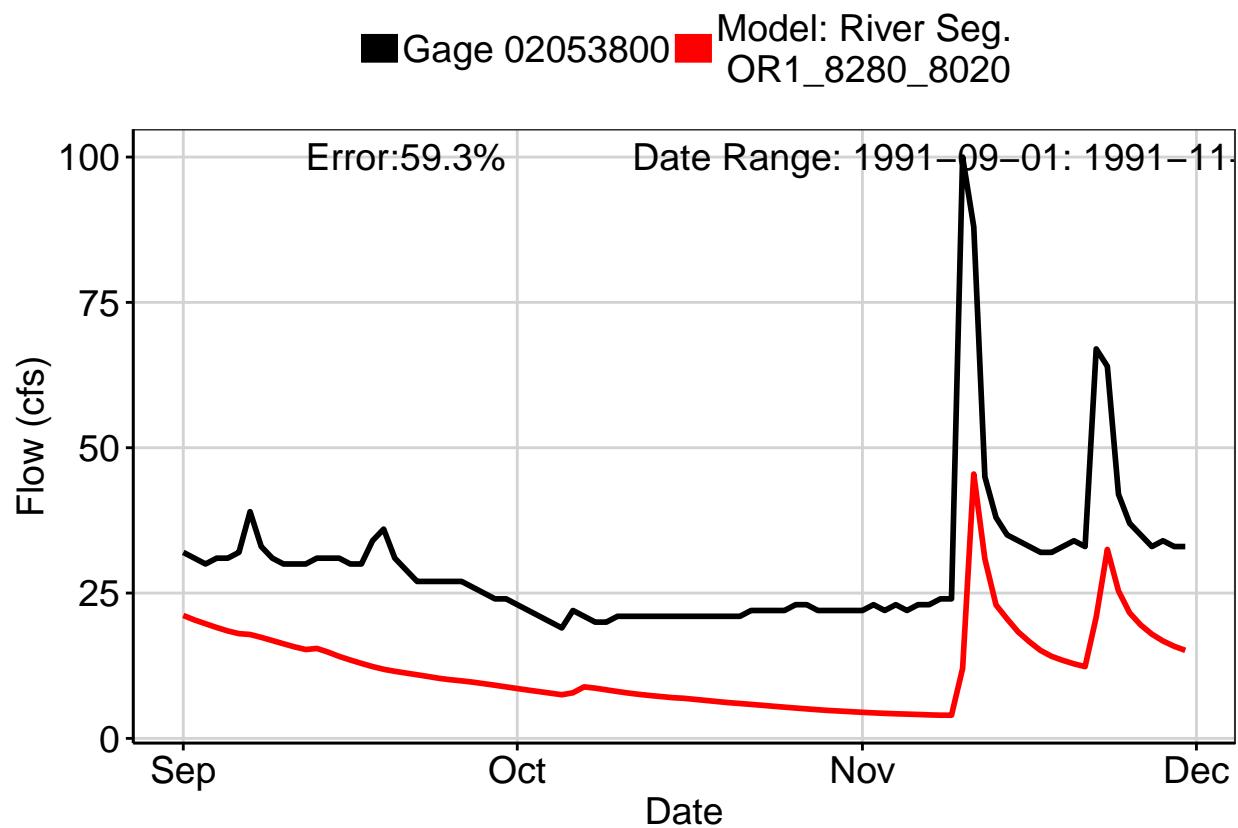
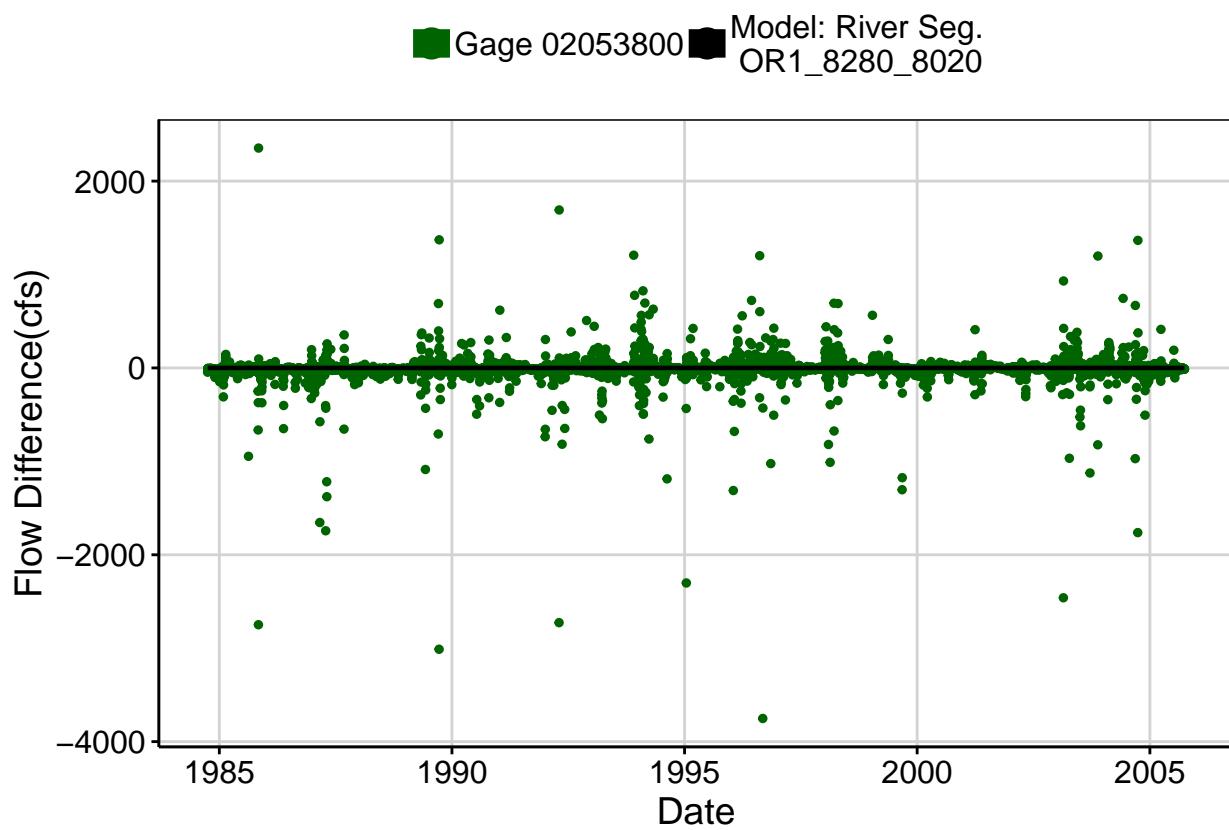
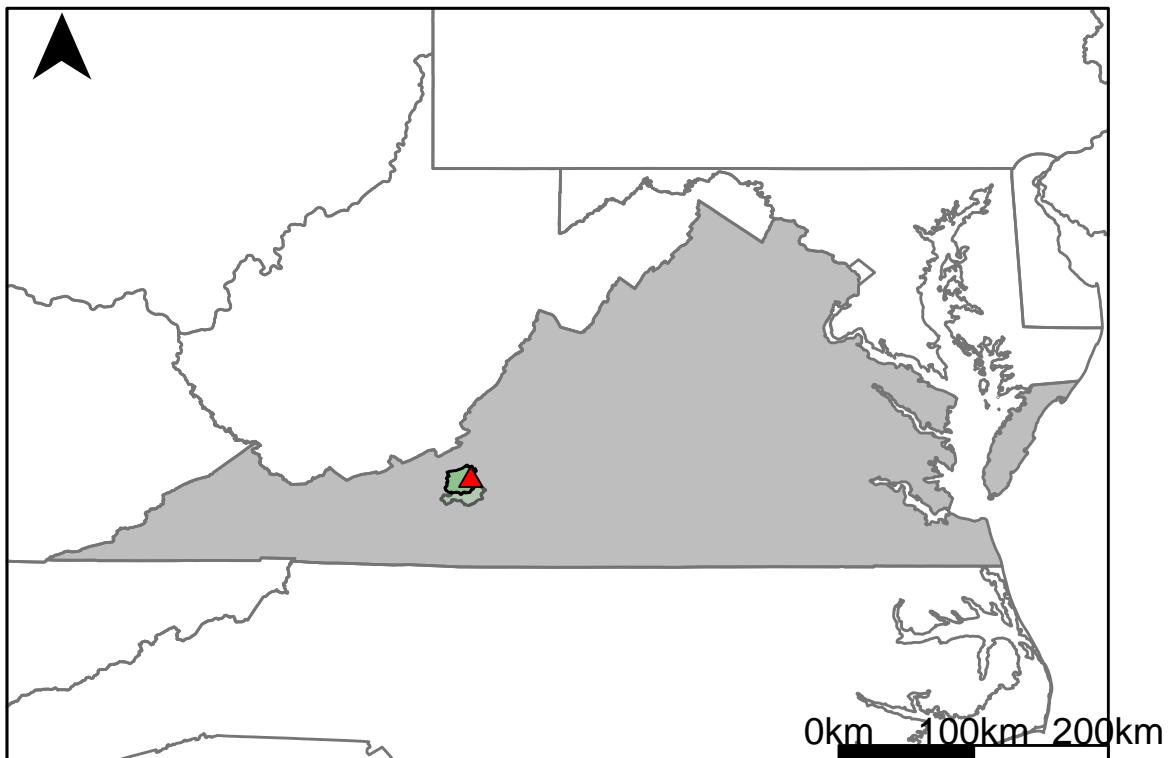


Fig. 9: Residuals Plot



## Appendix H.2: USGS Gage 02054500 vs. OR2\_8020\_8130



This river segment follows part of the flow of the Roanoke River. The gage is located in Montgomery County, VA (Lat 3714'11", Long 8012'34") approximately 21 miles northeast of Radford, VA. Drainage area is 254 sq. miles. This gage started taking data in 1943 and is still taking data. There is a possibility for slight diurnal fluctuations caused by a meat-processing plant upstream. The average daily discharge error between the model and gage data for the 20 year timespan was -5.31%, with 35.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	48	47.7	0.62
Feb. Low Flow	60	46.2	23
Mar. Low Flow	79.7	92	-15.4
Apr. Low Flow	79	123	-55.7
May Low Flow	118	218	-84.7
Jun. Low Flow	197	227	-15.2
Jul. Low Flow	143	199	-39.2
Aug. Low Flow	129	161	-24.8
Sep. Low Flow	93	123	-32.3
Oct. Low Flow	65	74.7	-14.9
Nov. Low Flow	45	55.8	-24
Dec. Low Flow	46	43.2	6.09

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	245	258	-5.31
Jan. Mean Flow	303	320	-5.61
Feb. Mean Flow	392	397	-1.28
Mar. Mean Flow	444	462	-4.05
Apr. Mean Flow	406	404	0.49
May Mean Flow	290	307	-5.86
Jun. Mean Flow	218	257	-17.9
Jul. Mean Flow	131	158	-20.6
Aug. Mean Flow	112	124	-10.7
Sep. Mean Flow	160	164	-2.5
Oct. Mean Flow	108	122	-13
Nov. Mean Flow	181	189	-4.42
Dec. Mean Flow	213	200	6.1

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	159	176	-10.7
Feb. High Flow	344	491	-42.7
Mar. High Flow	509	286	43.8
Apr. High Flow	1040	1290	-24
May High Flow	913	703	23
Jun. High Flow	1160	1900	-63.8
Jul. High Flow	837	850	-1.55
Aug. High Flow	677	755	-11.5
Sep. High Flow	362	477	-31.8
Oct. High Flow	279	244	12.5
Nov. High Flow	165	158	4.24
Dec. High Flow	147	176	-19.7

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	14	9.61	31.4
Med. 1 Day Min	36.9	28.8	22
Min. 3 Day Min	14.3	9.66	32.4
Med. 3 Day Min	38	29.6	22.1
Min. 7 Day Min	15.2	9.87	35.1
Med. 7 Day Min	39.4	31.4	20.3
Min. 30 Day Min	22.1	12.3	44.3
Med. 30 Day Min	49.5	42.7	13.7
Min. 90 Day Min	31.9	34.8	-9.09
Med. 90 Day Min	75.6	73.3	3.04
7Q10	26.4	16.6	37.1
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	73.8	258	-250
Mean Baseflow	126	155	-23

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	7480	9990	-33.6
Med. 1 Day Max	4510	3620	19.7
Max. 3 Day Max	5090	4590	9.82
Med. 3 Day Max	2630	2350	10.6
Max. 7 Day Max	2870	2410	16
Med. 7 Day Max	1570	1430	8.92
Max. 30 Day Max	1510	1340	11.3
Med. 30 Day Max	684	690	-0.88
Max. 90 Day Max	920	891	3.15
Med. 90 Day Max	465	463	0.43

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	29.9	22.3	25.4
5% Non-Exceedance	40	34.8	13
50% Non-Exceedance	130	156	-20
95% Non-Exceedance	731	723	1.09
99% Non-Exceedance	1920	1920	0
Sept. 10% Non-Exceedance	32.2	32.2	0

**Fig. 1: Hydrograph**

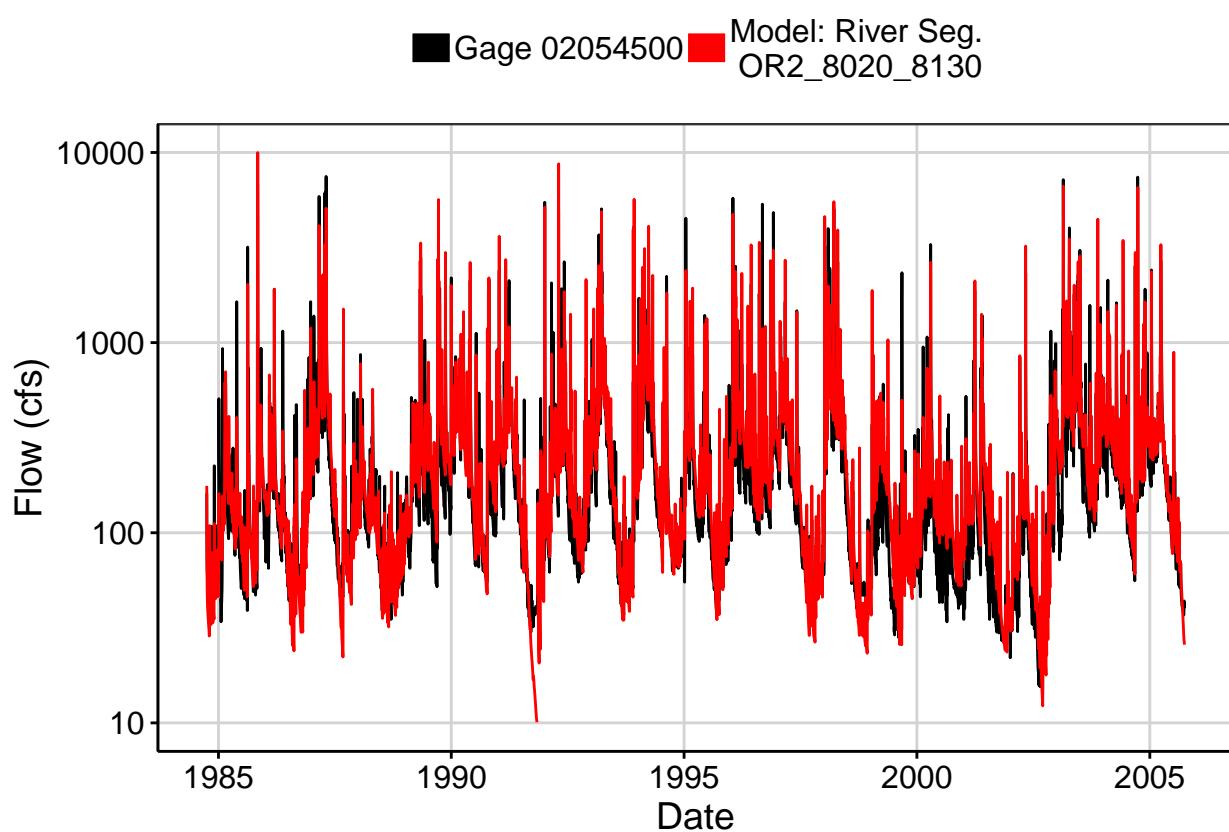


Fig. 2: Zoomed Hydrograph

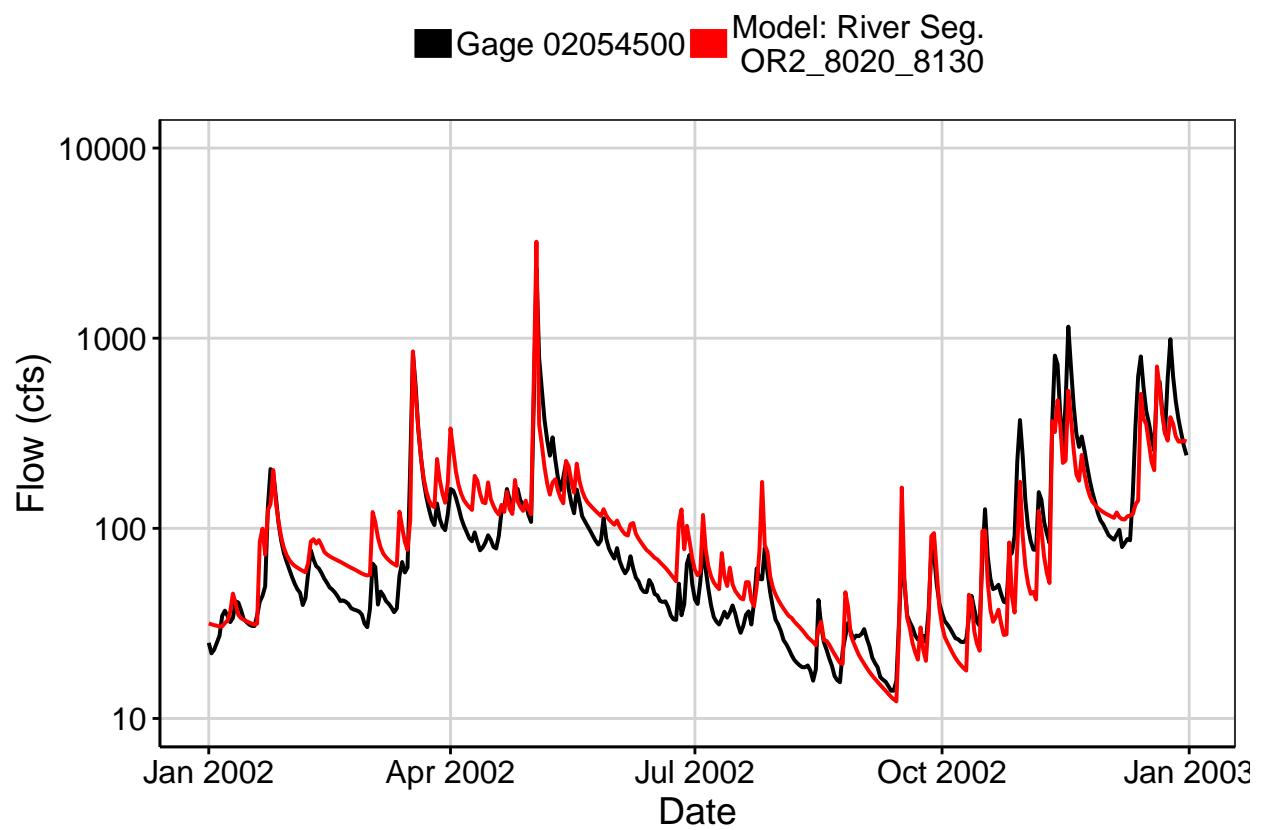


Fig. 3: Flow Exceedance

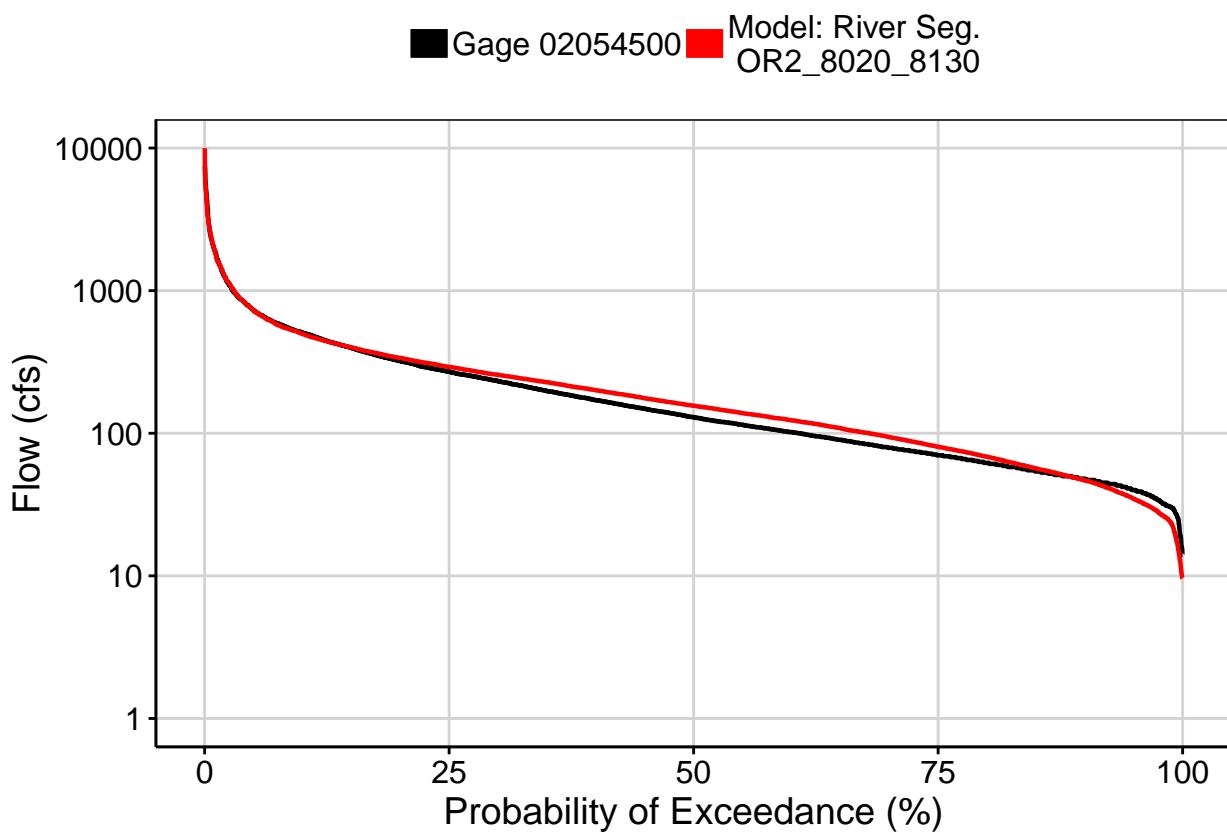


Fig. 4: Baseflow

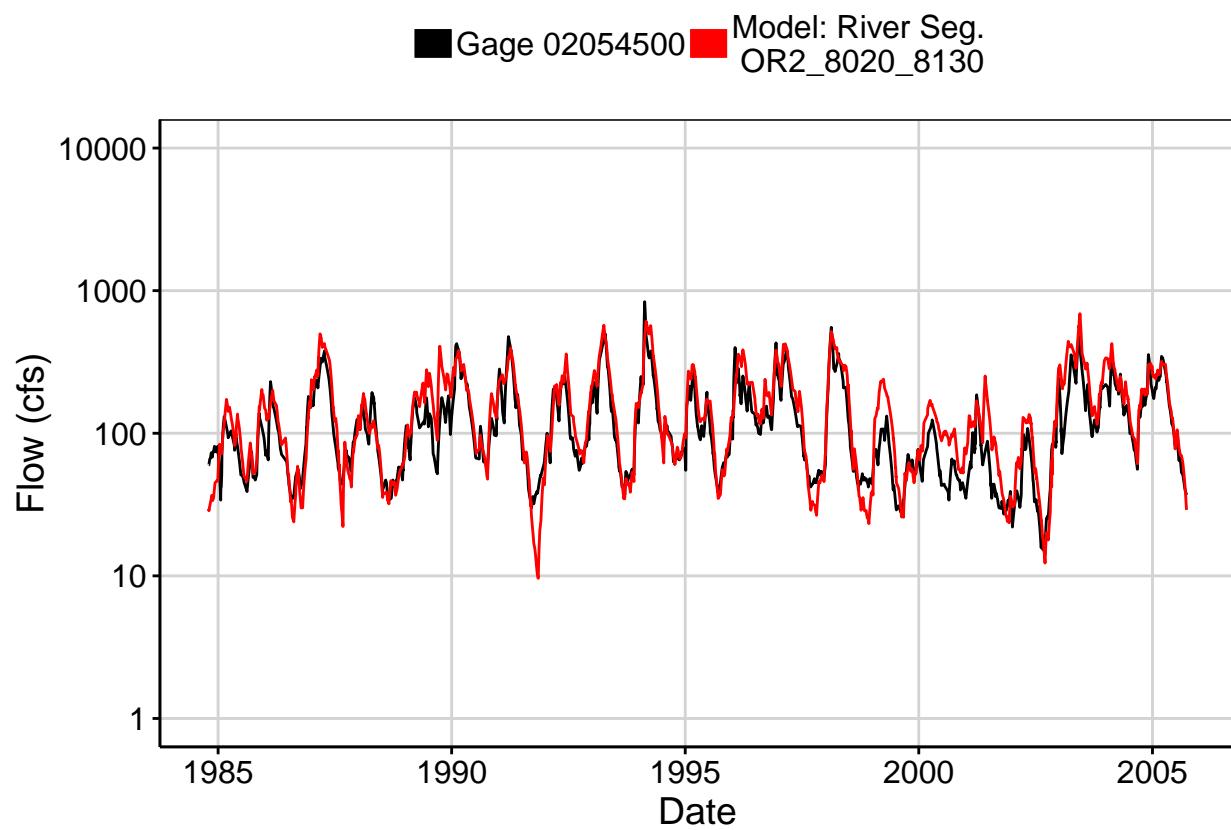


Fig. 5: Combined Baseflow

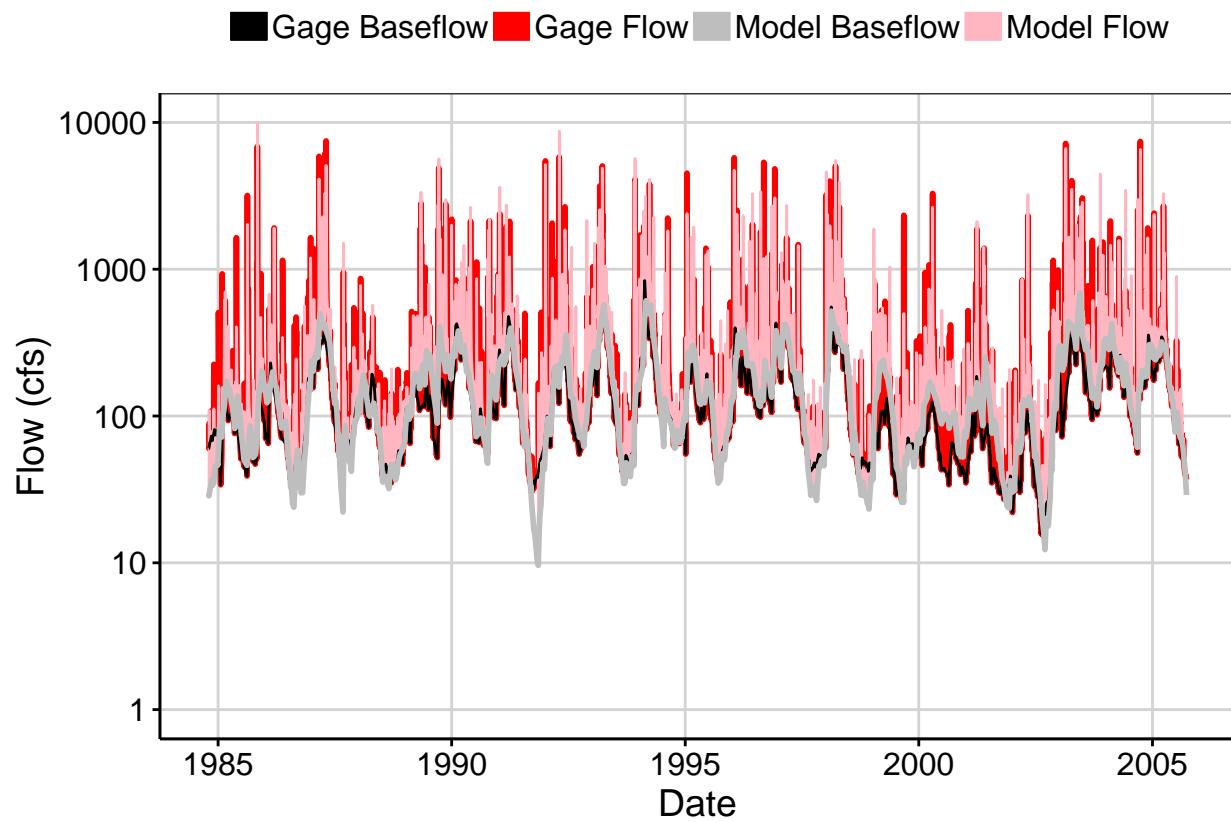


Fig. 6: Largest Error Segment

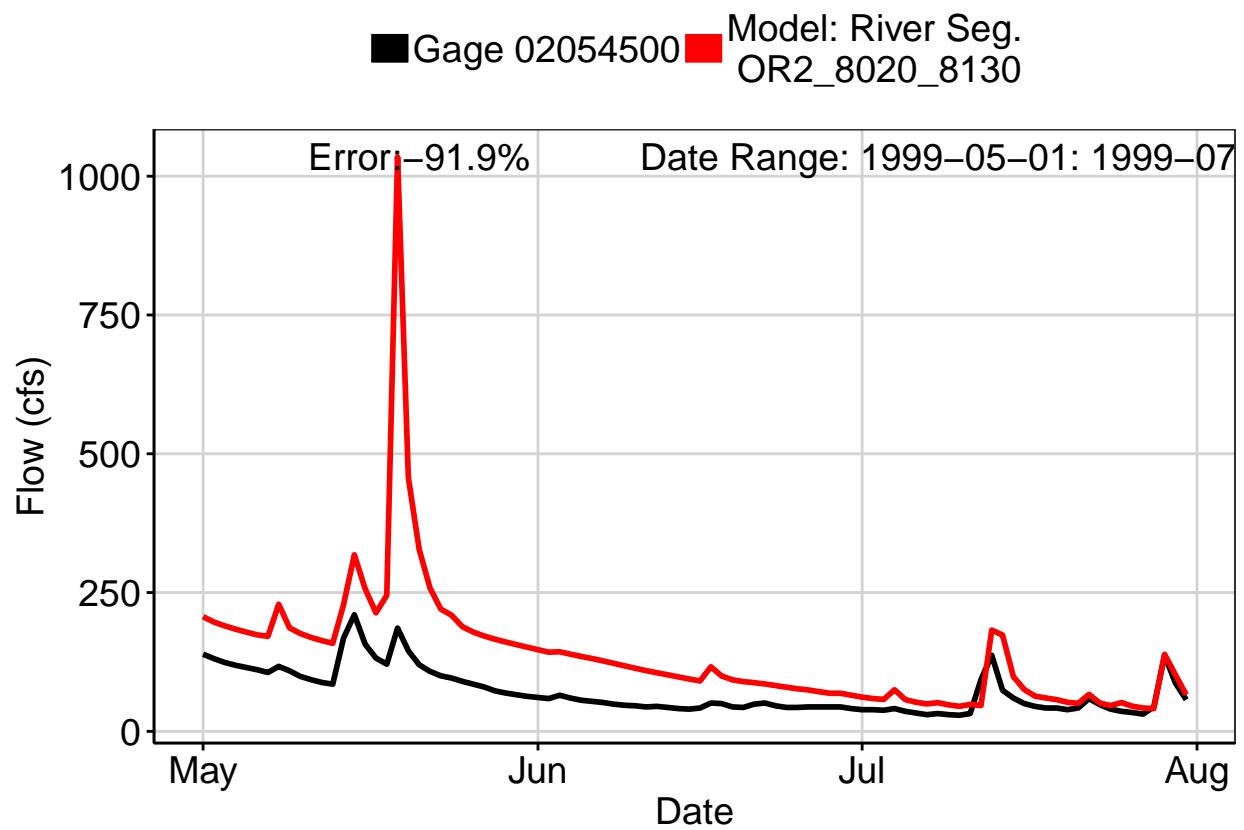


Fig. 7: Second Largest Error Segment

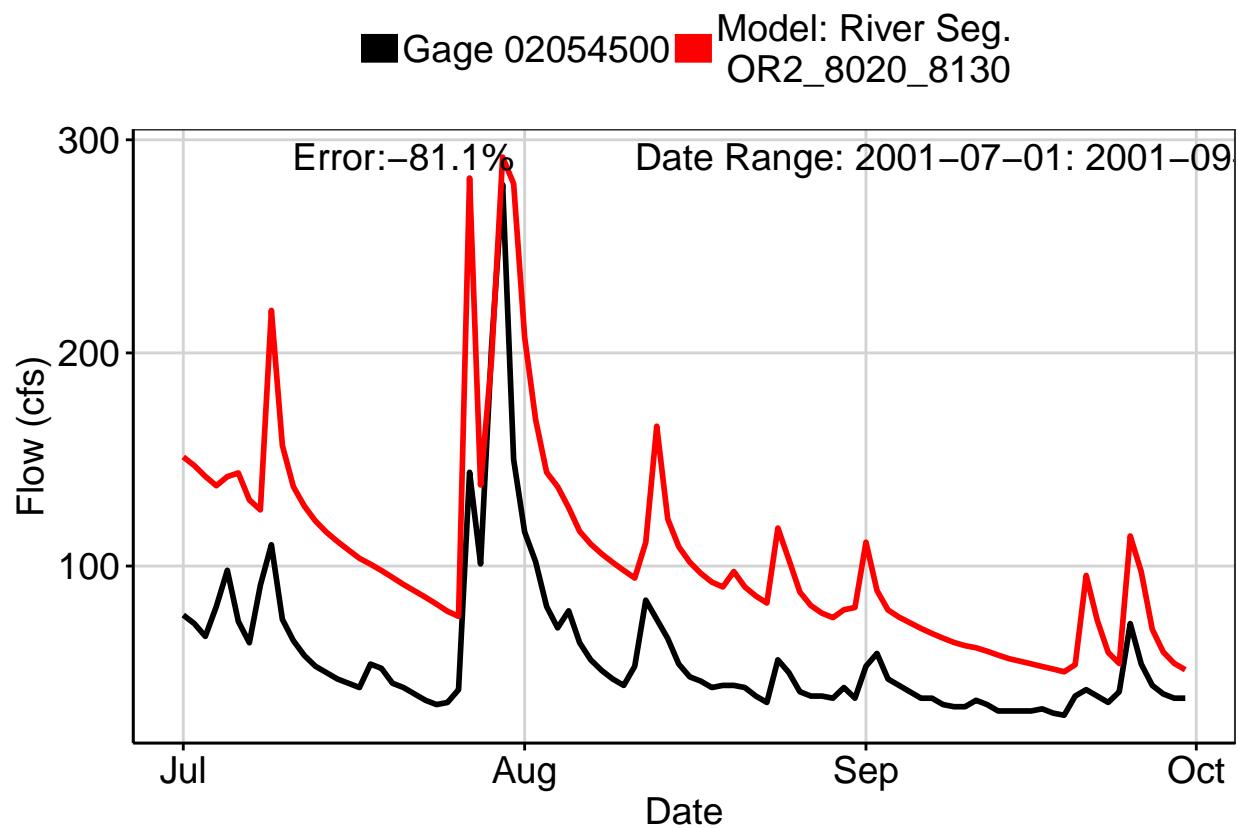


Fig. 8: Third Largest Error Segment

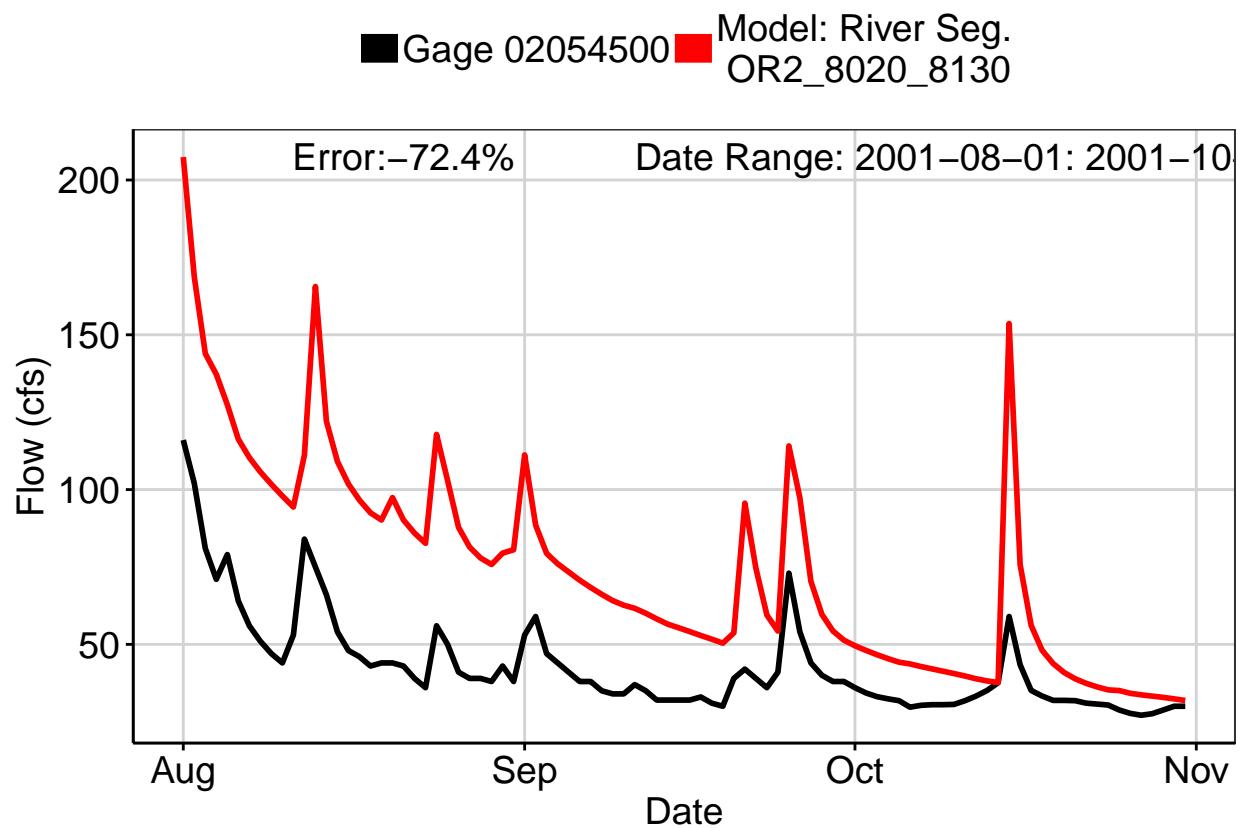
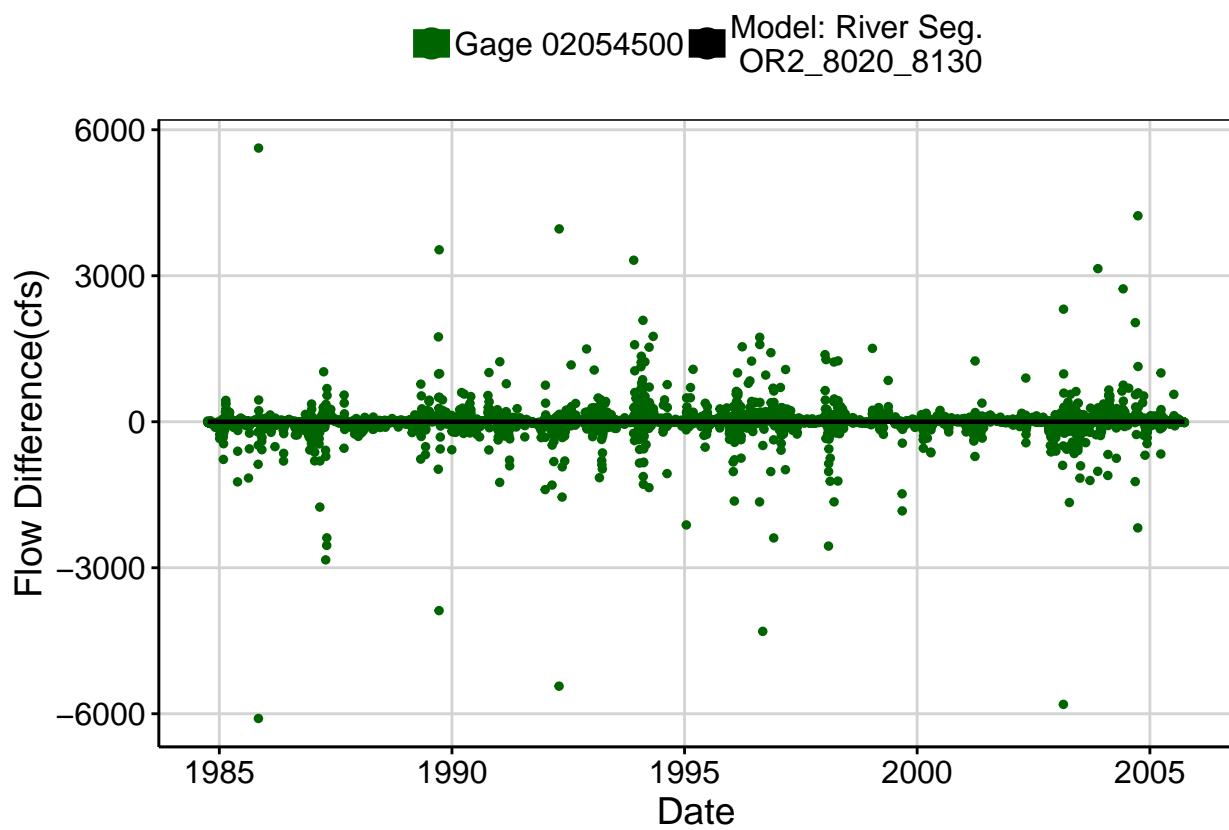
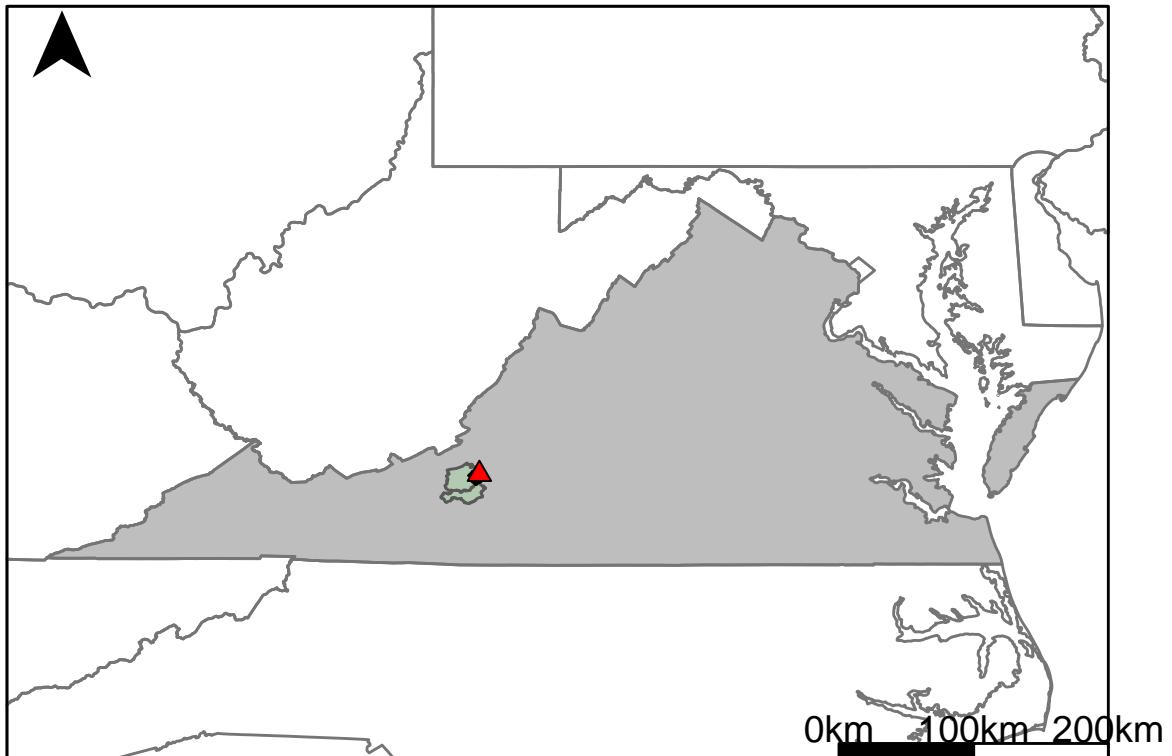


Fig. 9: Residuals Plot



## Appendix H.3: USGS Gage 02054530 vs. OR2\_8130\_7900



This river segment follows part of the flow of the Roanoke River. The gage is located in Roanoke County, VA (Lat 3716'04", Long 8008'23") approximately 5 miles southwest of Salem, VA. Drainage area is 281 sq. miles. This gage started taking data in 1991-12-12 and is still taking data. There is frequent pumping from the river into the Spring Hollow Reservoir approximately two miles below Lafayette and seven miles upstream of Glenvar; this diversion of water is significant enough that the Glenvar gage reads lower than the Lafayette gage. The average daily discharge error between the model and gage data for the 20 year timespan was 1.45%, with 38.9% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	61	42.1	31
Feb. Low Flow	72	51.9	27.9
Mar. Low Flow	83	108	-30.1
Apr. Low Flow	85	139	-63.5
May Low Flow	158	235	-48.7
Jun. Low Flow	184	219	-19
Jul. Low Flow	181	175	3.31
Aug. Low Flow	114	159	-39.5
Sep. Low Flow	99	124	-25.3
Oct. Low Flow	73	68.8	5.75
Nov. Low Flow	55	57.8	-5.09
Dec. Low Flow	51	47	7.84

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	276	272	1.45
Jan. Mean Flow	352	347	1.42
Feb. Mean Flow	509	428	15.9
Mar. Mean Flow	543	485	10.7
Apr. Mean Flow	402	415	-3.23
May Mean Flow	283	316	-11.7
Jun. Mean Flow	255	261	-2.35
Jul. Mean Flow	154	162	-5.19
Aug. Mean Flow	121	126	-4.13
Sep. Mean Flow	195	178	8.72
Oct. Mean Flow	94.6	132	-39.5
Nov. Mean Flow	170	209	-22.9
Dec. Mean Flow	245	219	10.6

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	186	173	6.99
Feb. High Flow	260	515	-98.1
Mar. High Flow	604	293	51.5
Apr. High Flow	1180	1350	-14.4
May High Flow	1100	776	29.5
Jun. High Flow	1720	1930	-12.2
Jul. High Flow	1080	819	24.2
Aug. High Flow	483	794	-64.4
Sep. High Flow	419	552	-31.7
Oct. High Flow	296	262	11.5
Nov. High Flow	173	174	-0.58
Dec. High Flow	134	186	-38.8

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	15.2	0	100
Med. 1 Day Min	47	29.6	37
Min. 3 Day Min	15.9	0	100
Med. 3 Day Min	47.7	29.9	37.3
Min. 7 Day Min	17.7	0	100
Med. 7 Day Min	50.9	31.5	38.1
Min. 30 Day Min	25.9	0.15	99.4
Med. 30 Day Min	57.9	45.3	21.8
Min. 90 Day Min	34.8	10.6	69.5
Med. 90 Day Min	86	75.4	12.3
7Q10	26.2	0.35	98.7
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	77.6	272	-251
Mean Baseflow	136	156	-14.7

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	10500	11600	-10.5
Med. 1 Day Max	5850	3930	32.8
Max. 3 Day Max	6140	5110	16.8
Med. 3 Day Max	3490	2560	26.6
Max. 7 Day Max	3590	2700	24.8
Med. 7 Day Max	1880	1570	16.5
Max. 30 Day Max	1750	1510	13.7
Med. 30 Day Max	769	767	0.26
Max. 90 Day Max	1020	985	3.43
Med. 90 Day Max	498	491	1.41

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	31.5	0	100
5% Non-Exceedance	45.7	24.1	47.3
50% Non-Exceedance	128	158	-23.4
95% Non-Exceedance	841	797	5.23
99% Non-Exceedance	2470	2060	16.6
Sept. 10% Non-Exceedance	14.7	24.7	-68

**Fig. 1: Hydrograph**

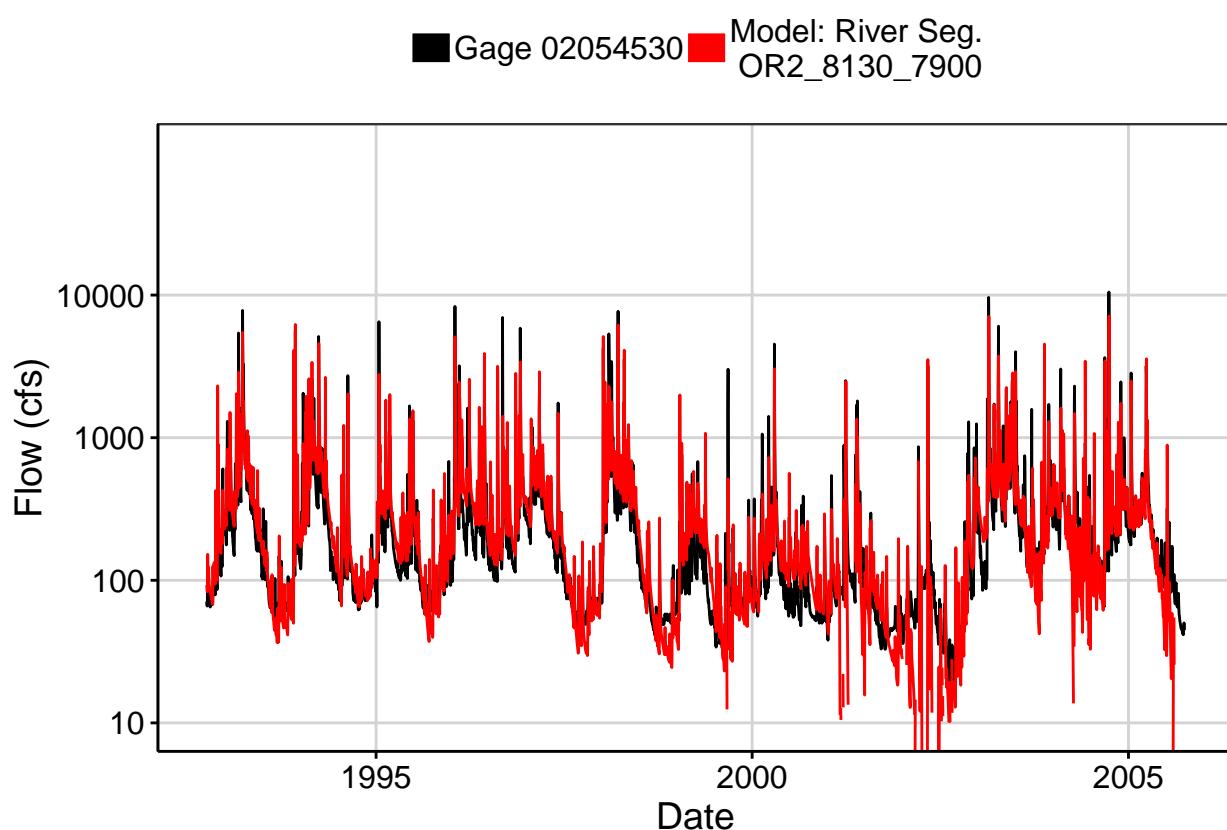


Fig. 2: Zoomed Hydrograph

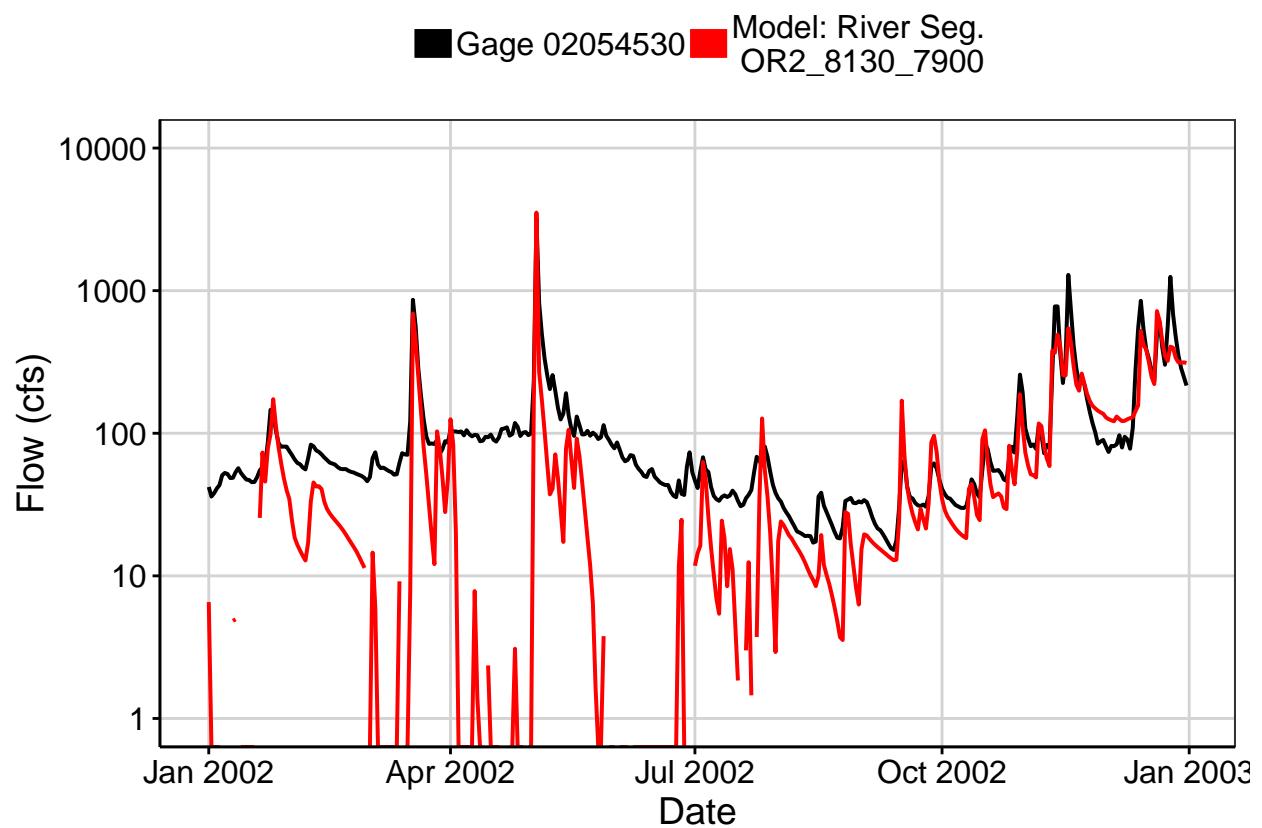


Fig. 3: Flow Exceedance

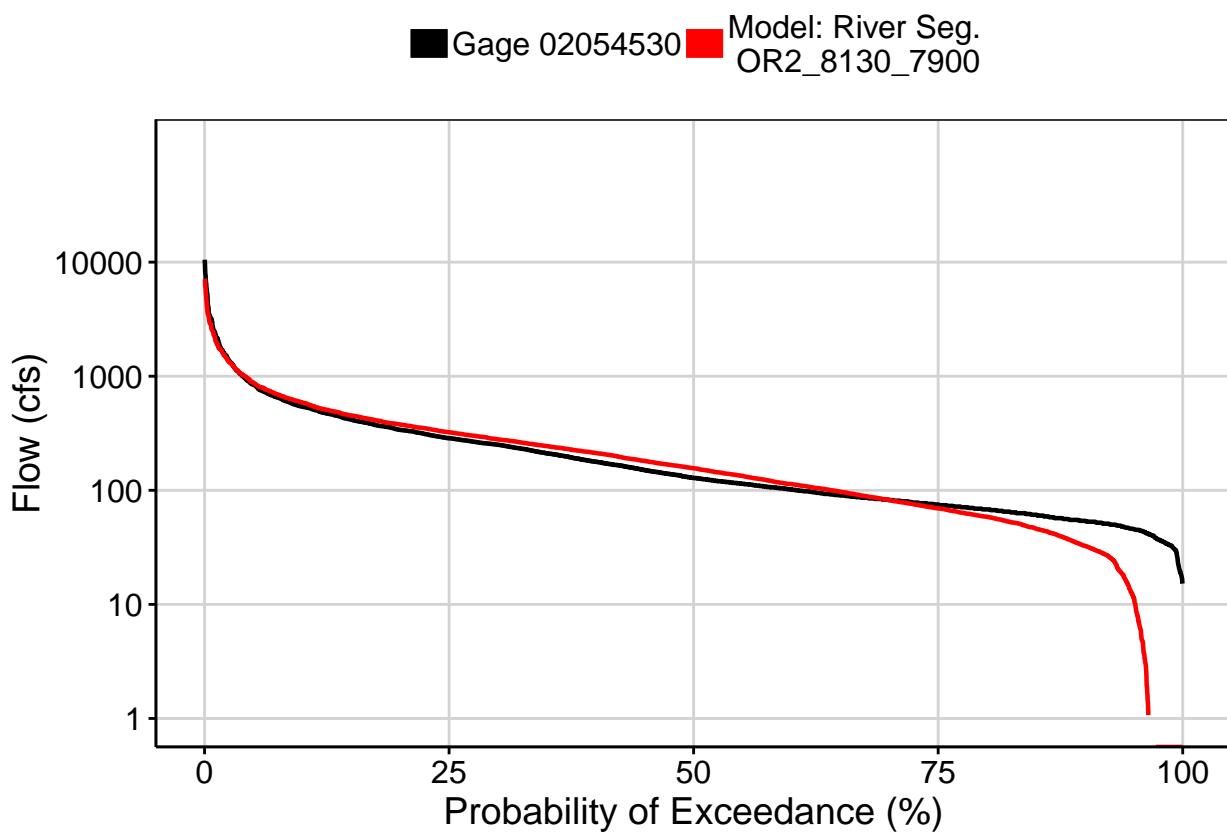


Fig. 4: Baseflow

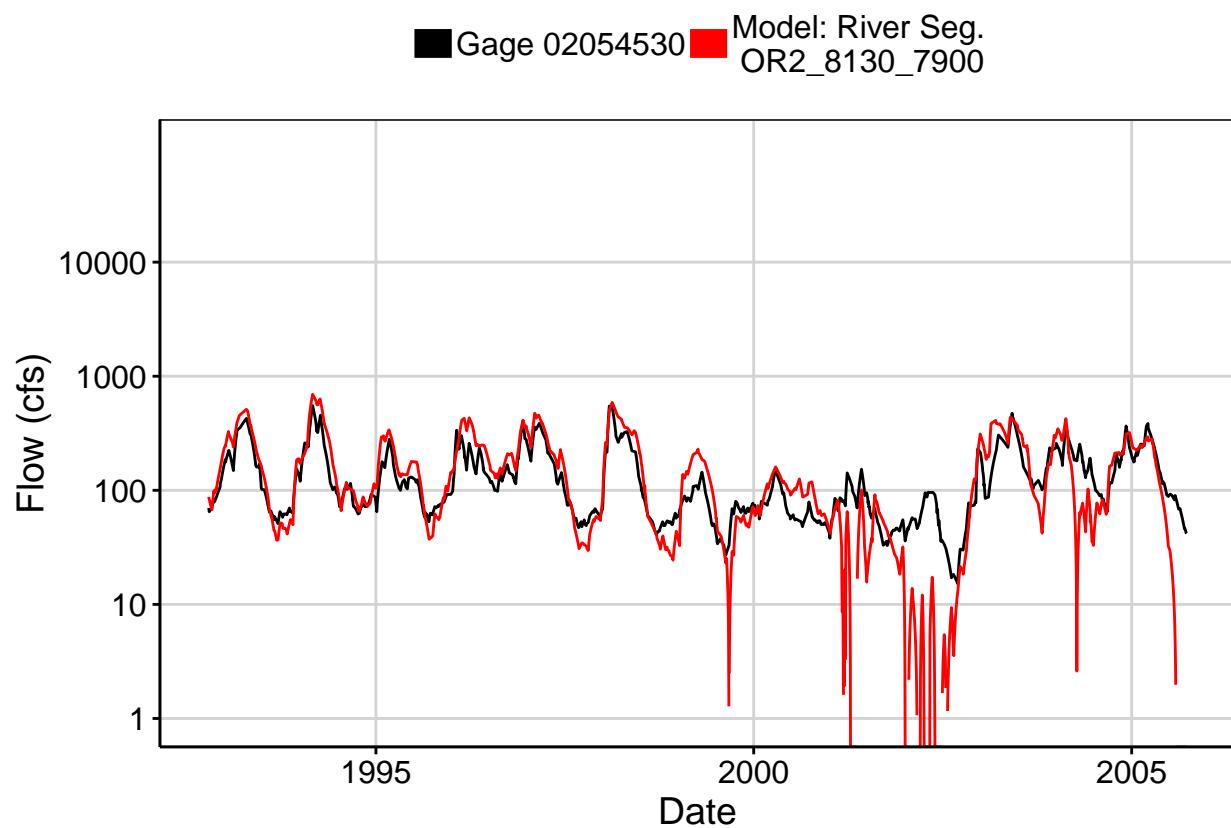


Fig. 5: Combined Baseflow

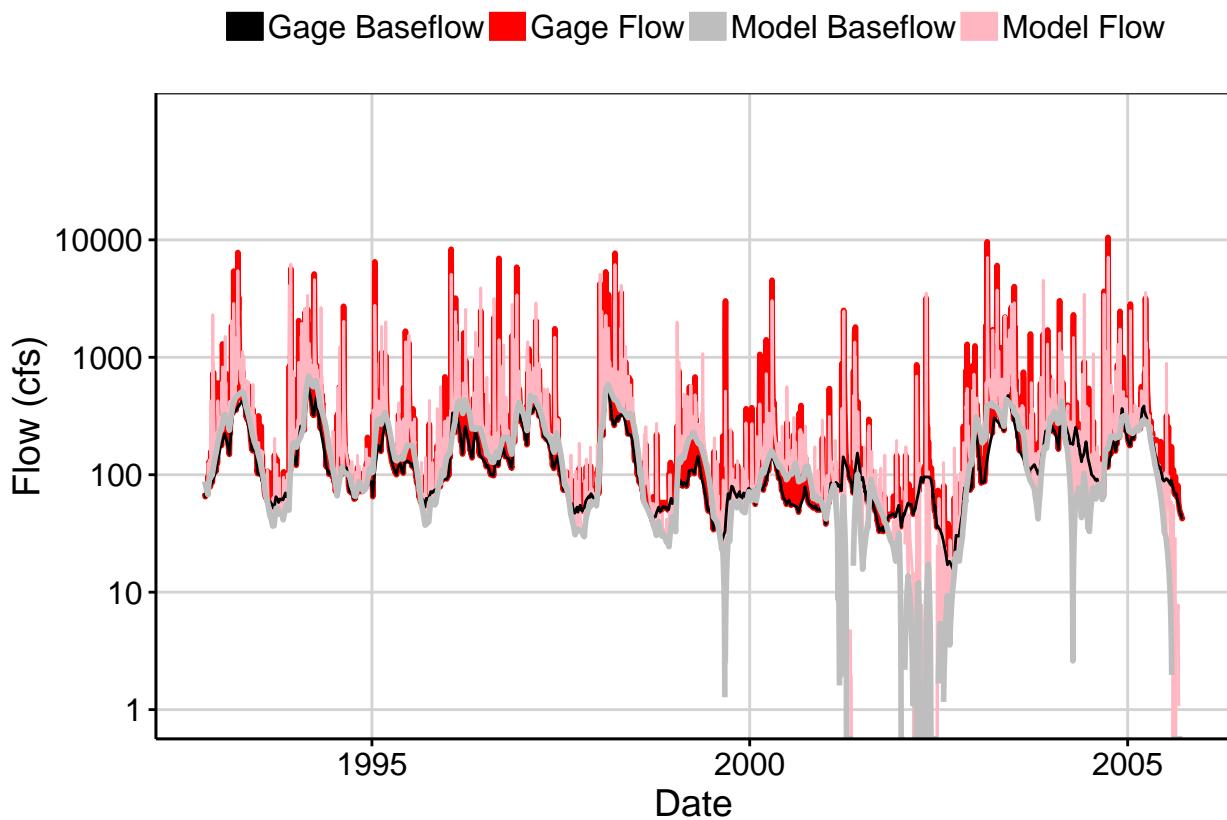


Fig. 6: Largest Error Segment

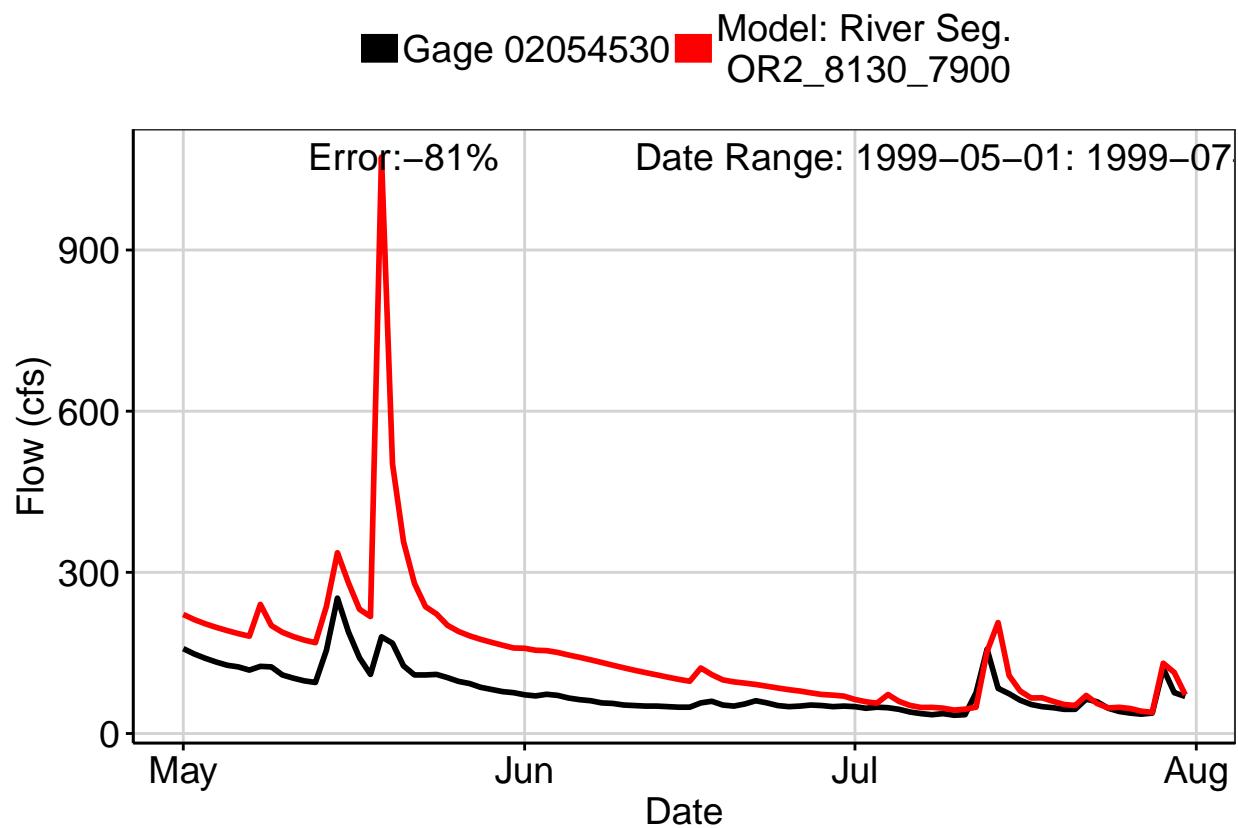


Fig. 7: Second Largest Error Segment

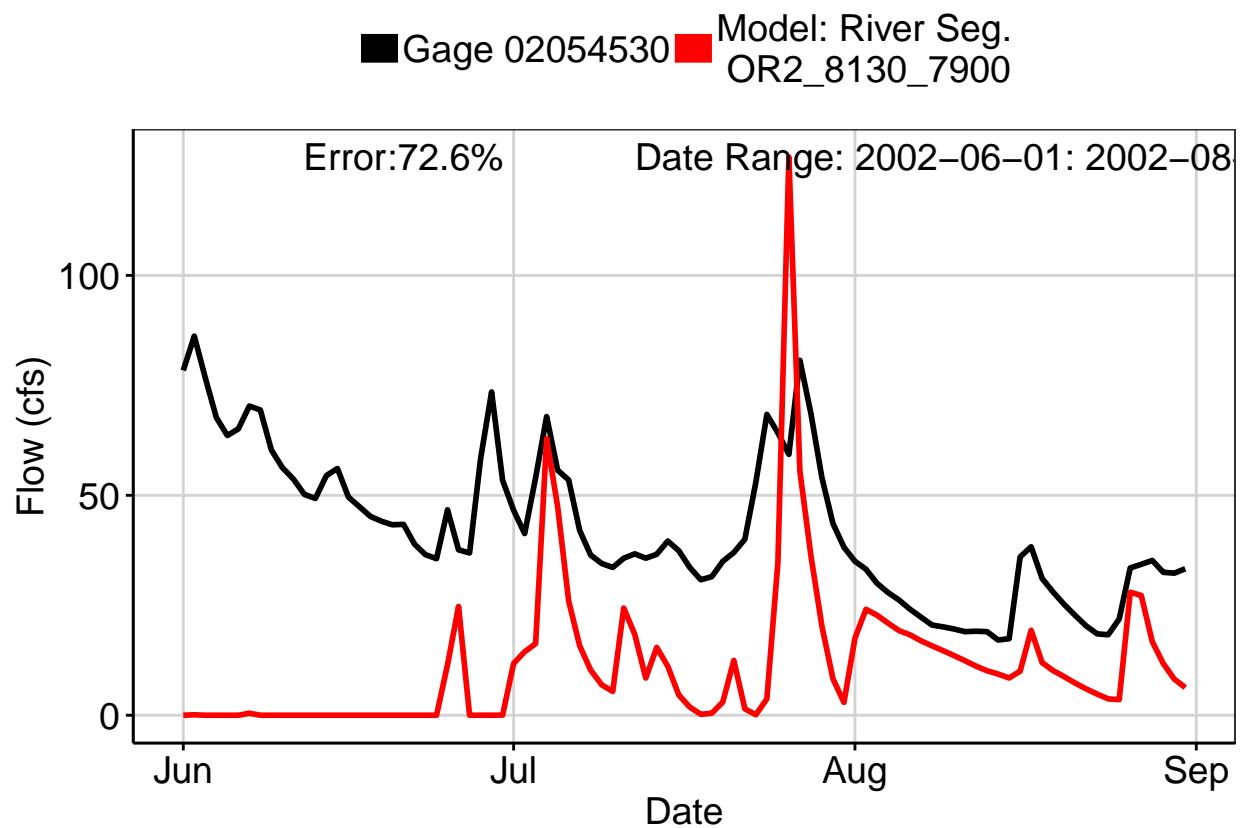


Fig. 8: Third Largest Error Segment

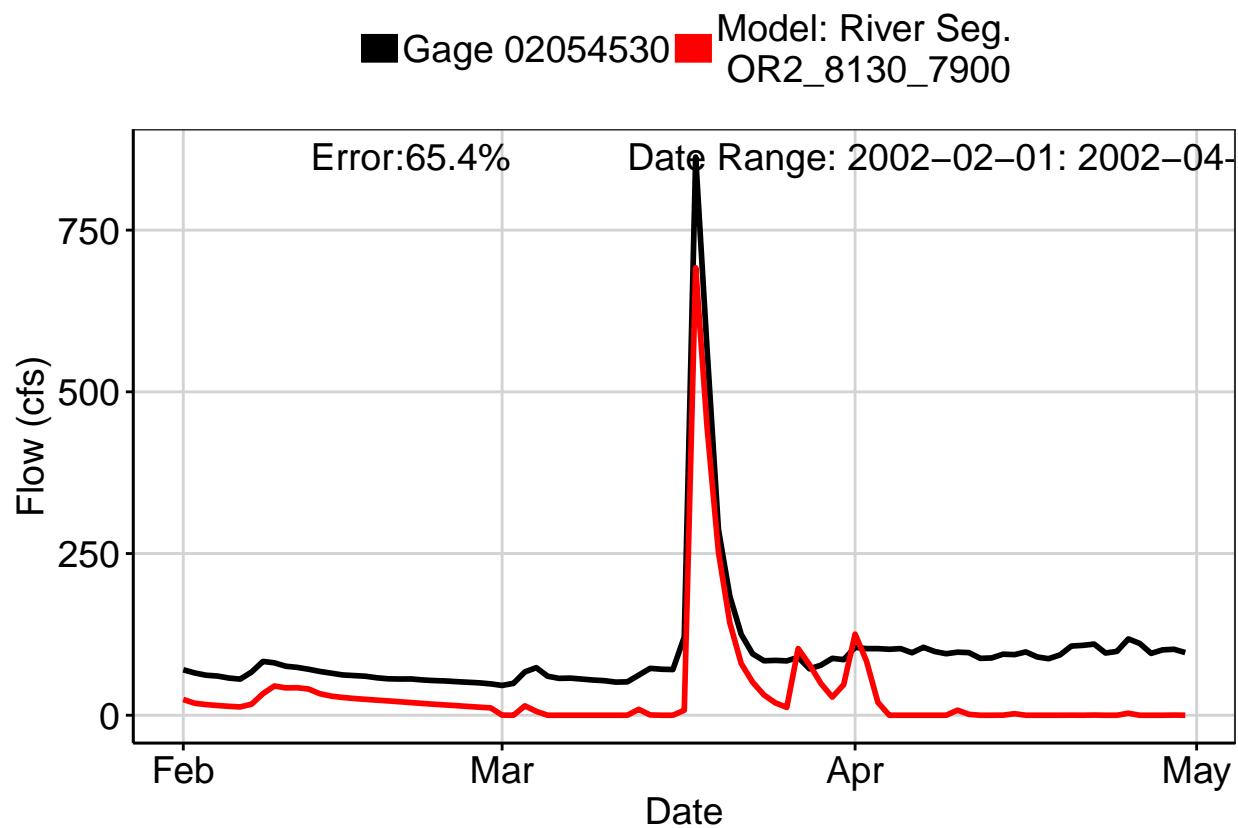
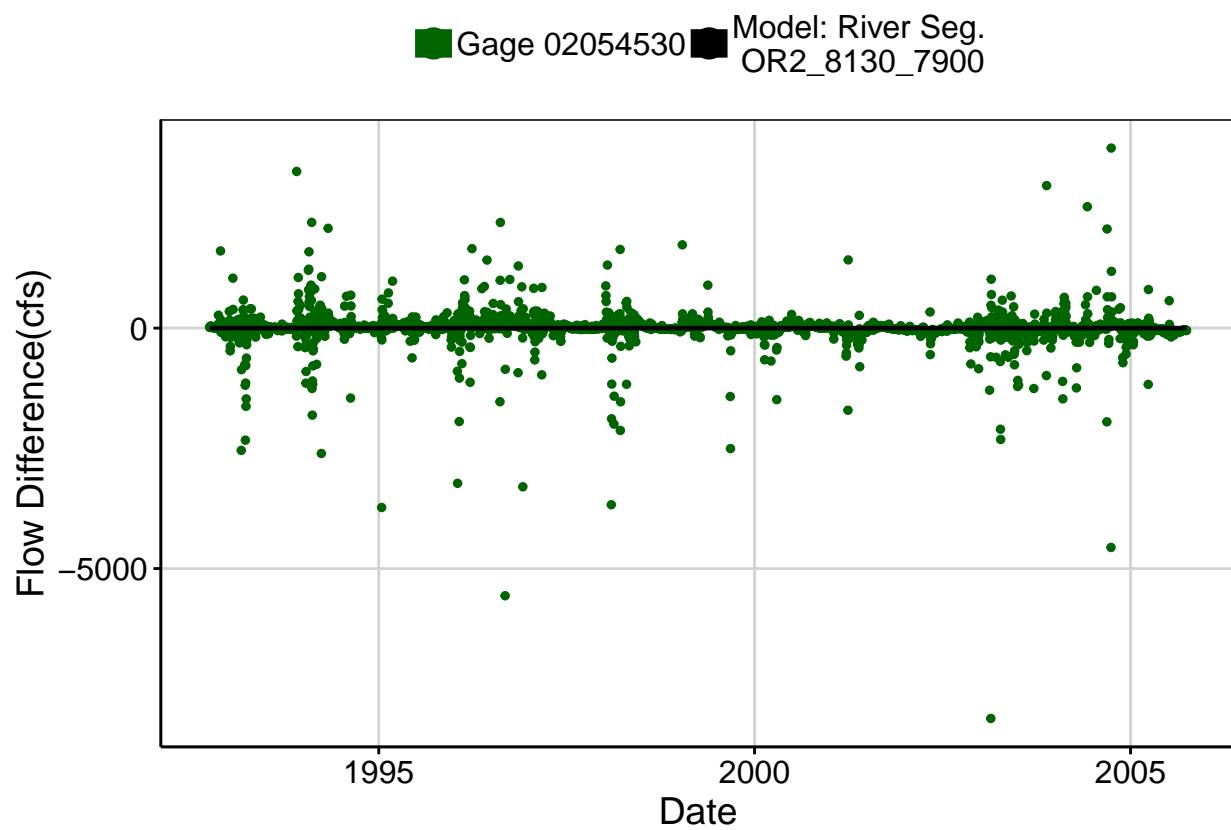
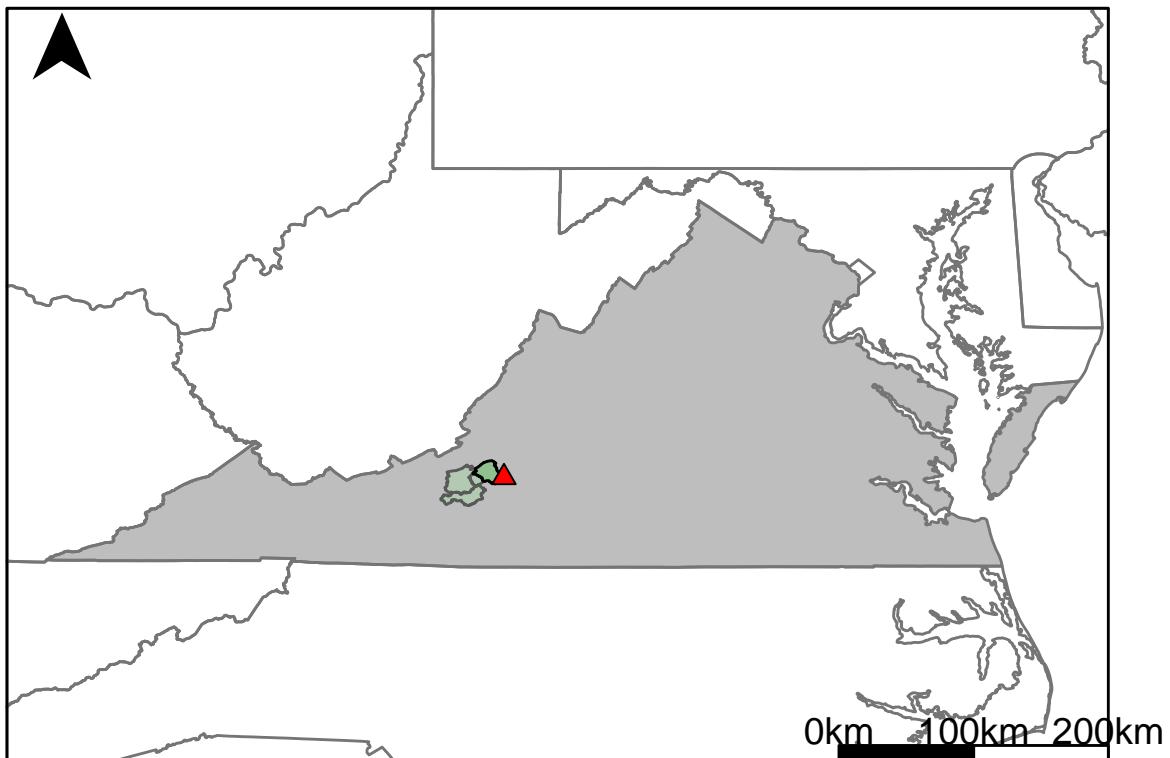


Fig. 9: Residuals Plot



## Appendix H.4: USGS Gage 02055000 vs. OR2\_7900\_7740



This river segment follows part of the flow of the Roanoke River. The gage is located in Roanoke County, VA (Lat 3715'30", Long 7956'20") approximately 1 mile southeast of Roanoke, VA. Drainage area is 384 sq. miles. This gage started taking data in 1899 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was -1.61%, with 35.4% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	69	62.3	9.71
Feb. Low Flow	84	71.7	14.6
Mar. Low Flow	120	151	-25.8
Apr. Low Flow	125	178	-42.4
May Low Flow	214	311	-45.3
Jun. Low Flow	249	281	-12.9
Jul. Low Flow	212	237	-11.8
Aug. Low Flow	163	198	-21.5
Sep. Low Flow	126	155	-23
Oct. Low Flow	83	89.3	-7.59
Nov. Low Flow	67	70.9	-5.82
Dec. Low Flow	59	55.9	5.25

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	372	378	-1.61
Jan. Mean Flow	460	479	-4.13
Feb. Mean Flow	580	582	-0.34
Mar. Mean Flow	650	658	-1.23
Apr. Mean Flow	604	572	5.3
May Mean Flow	434	440	-1.38
Jun. Mean Flow	337	361	-7.12
Jul. Mean Flow	204	233	-14.2
Aug. Mean Flow	173	181	-4.62
Sep. Mean Flow	263	266	-1.14
Oct. Mean Flow	170	187	-10
Nov. Mean Flow	291	297	-2.06
Dec. Mean Flow	313	304	2.88

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	213	349	-63.8
Feb. High Flow	455	748	-64.4
Mar. High Flow	829	569	31.4
Apr. High Flow	1400	1490	-6.43
May High Flow	1290	1070	17.1
Jun. High Flow	2180	2000	8.26
Jul. High Flow	1390	1130	18.7
Aug. High Flow	1020	1170	-14.7
Sep. High Flow	498	710	-42.6
Oct. High Flow	413	444	-7.51
Nov. High Flow	262	383	-46.2
Dec. High Flow	208	334	-60.6

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	16.3	0	100
Med. 1 Day Min	50	38.2	23.6
Min. 3 Day Min	16.8	0.86	94.9
Med. 3 Day Min	51.7	40.7	21.3
Min. 7 Day Min	18.5	4.58	75.2
Med. 7 Day Min	55.6	42.7	23.2
Min. 30 Day Min	33.8	13.3	60.7
Med. 30 Day Min	66.8	62.6	6.29
Min. 90 Day Min	50.2	24.7	50.8
Med. 90 Day Min	111	113	-1.8
7Q10	33.9	10.8	68.1
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	110	378	-244
Mean Baseflow	184	207	-12.5

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	15000	17400	-16
Med. 1 Day Max	5700	5730	-0.53
Max. 3 Day Max	9480	7810	17.6
Med. 3 Day Max	3680	3350	8.97
Max. 7 Day Max	5250	3900	25.7
Med. 7 Day Max	2310	2090	9.52
Max. 30 Day Max	2590	2120	18.1
Med. 30 Day Max	992	1070	-7.86
Max. 90 Day Max	1500	1320	12
Med. 90 Day Max	655	669	-2.14

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	42.8	11.9	72.2
5% Non-Exceedance	59.5	36.3	39
50% Non-Exceedance	191	222	-16.2
95% Non-Exceedance	1120	1100	1.79
99% Non-Exceedance	2900	3030	-4.48
Sept. 10% Non-Exceedance	30.9	30.4	1.62

**Fig. 1: Hydrograph**

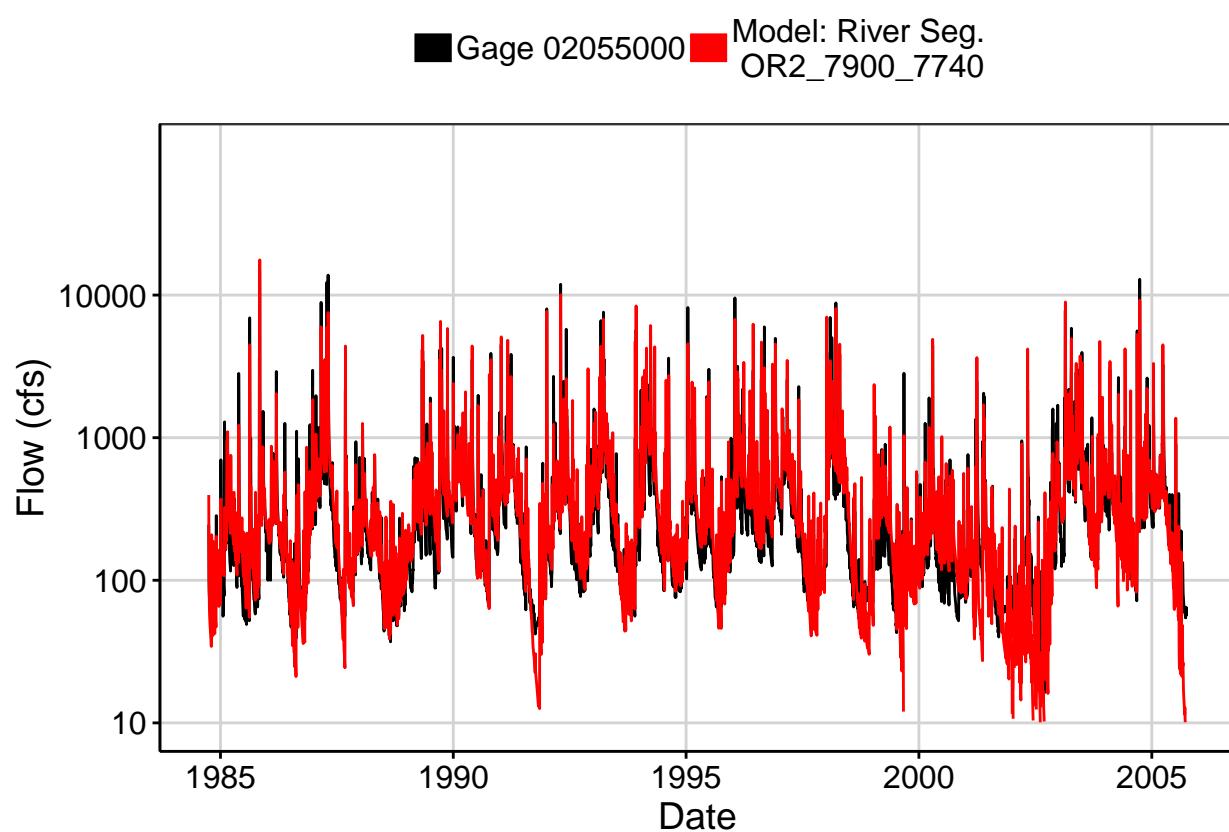


Fig. 2: Zoomed Hydrograph

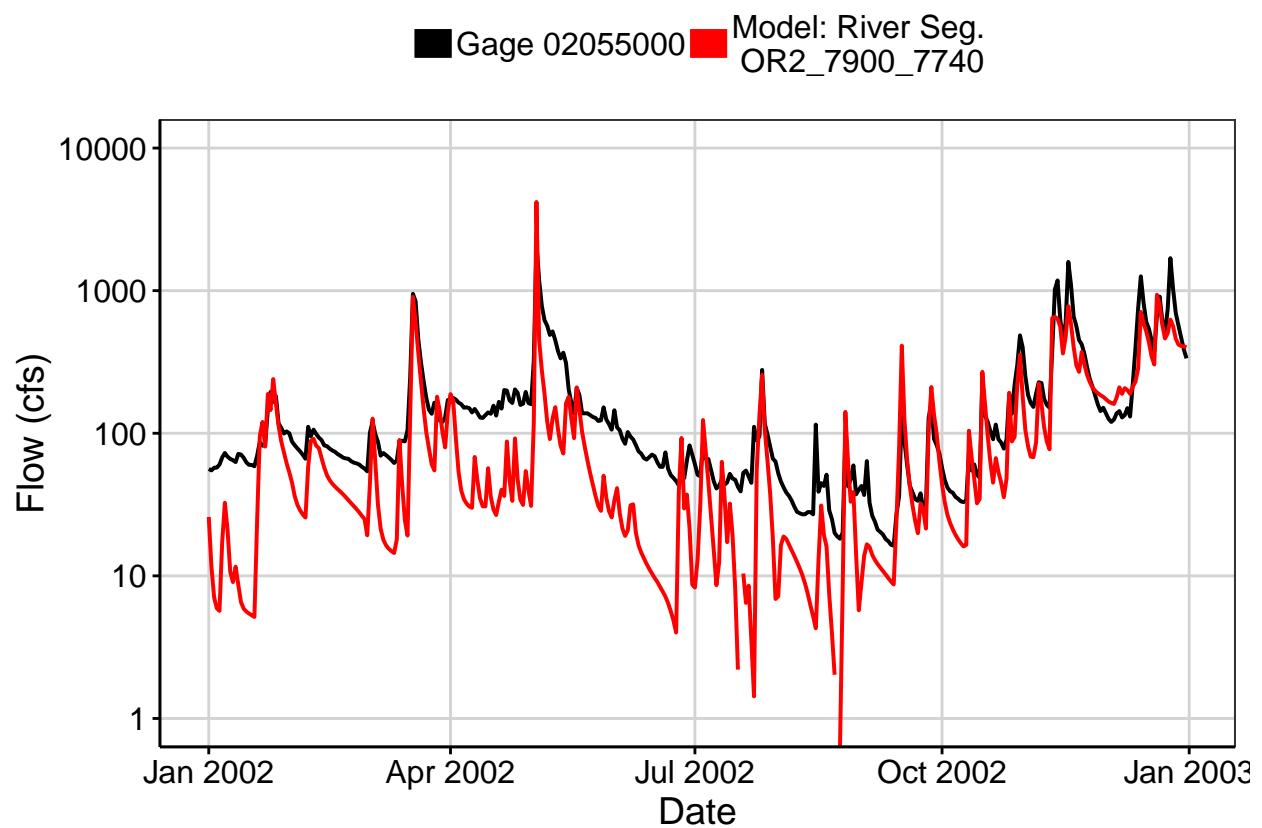


Fig. 3: Flow Exceedance

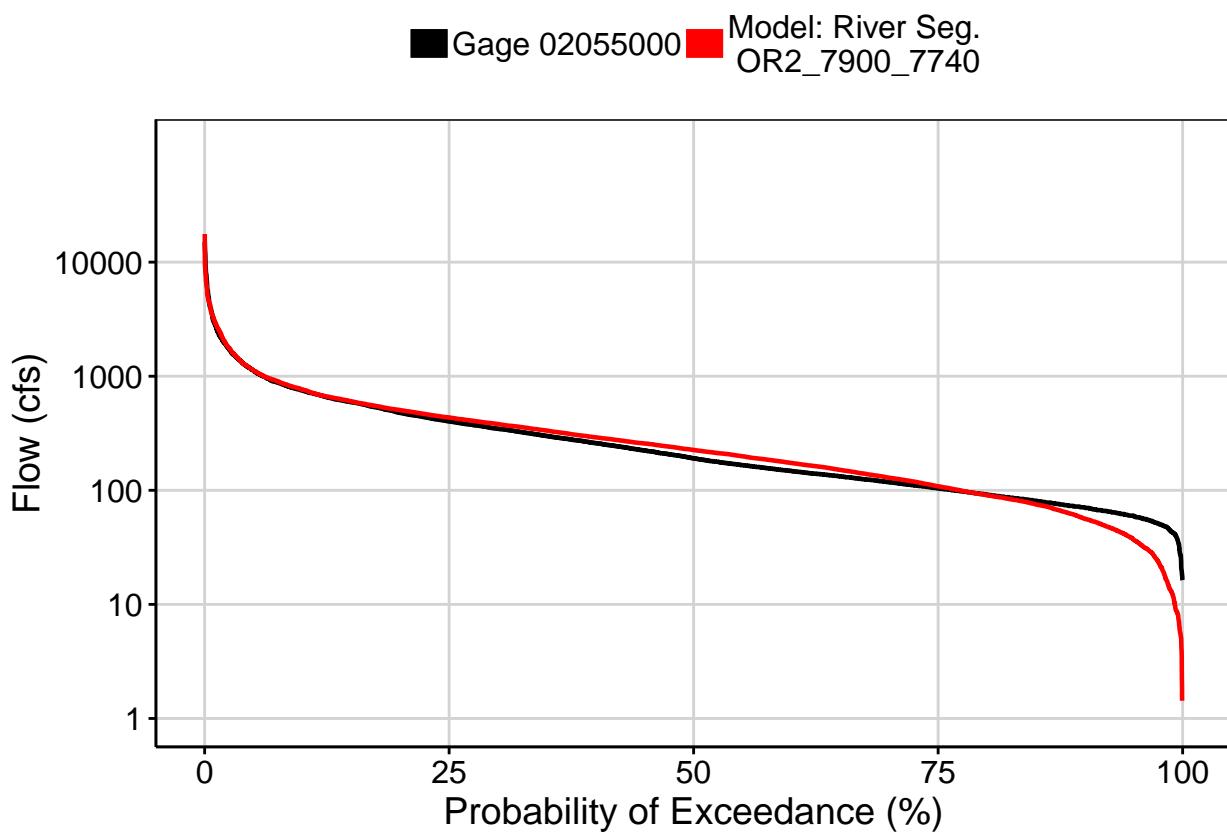


Fig. 4: Baseflow

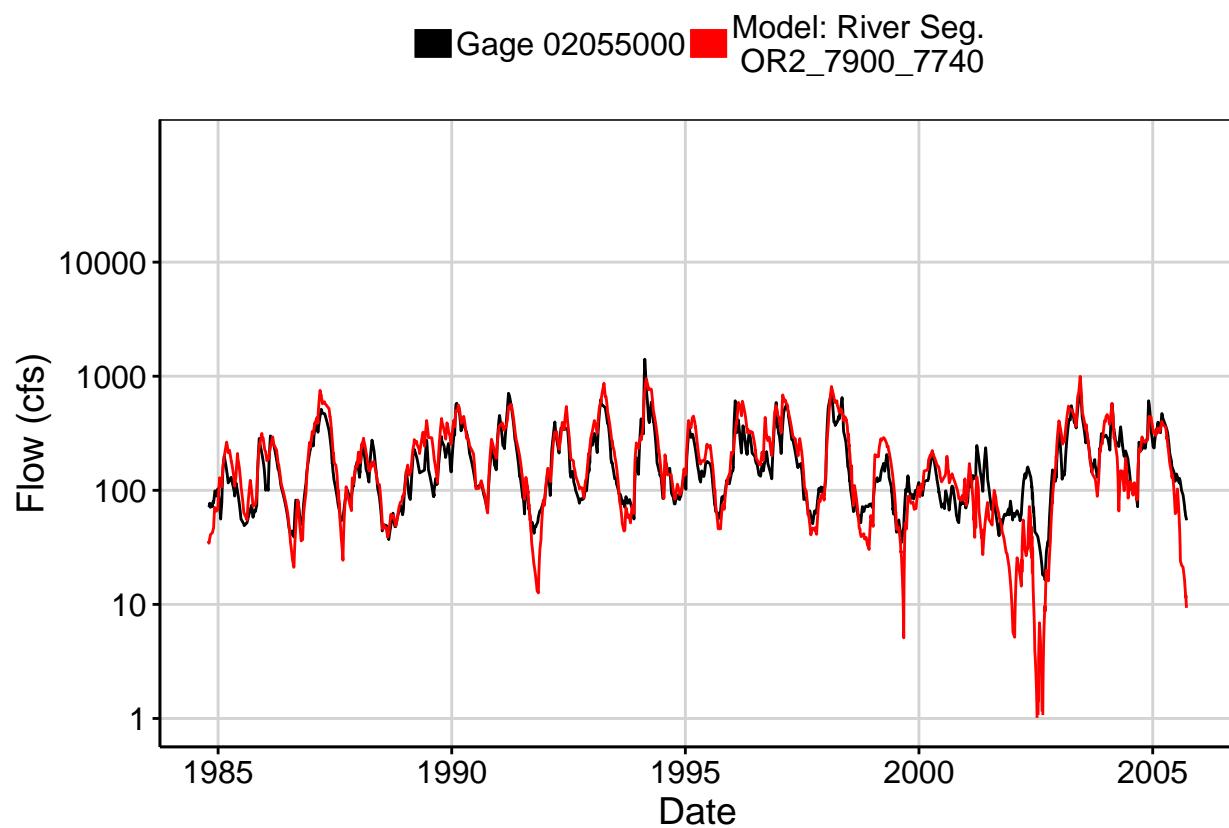


Fig. 5: Combined Baseflow

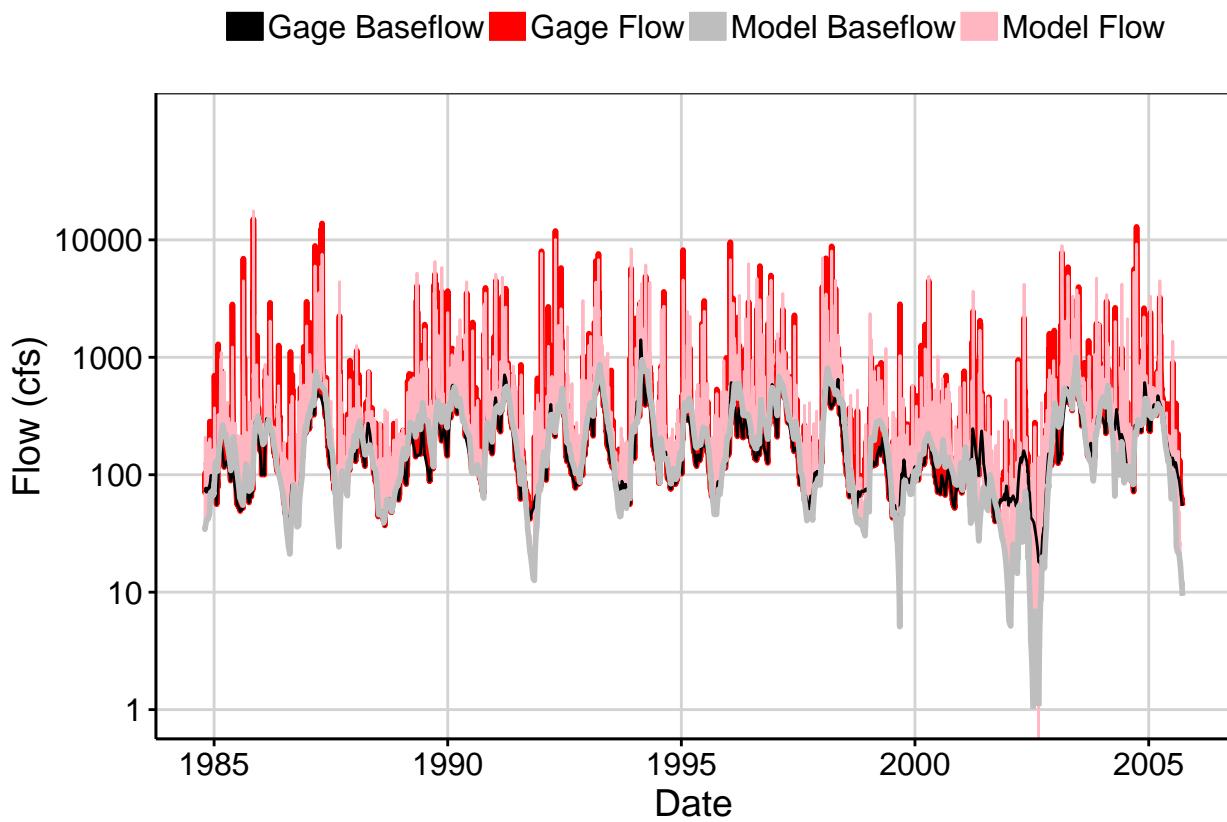


Fig. 6: Largest Error Segment

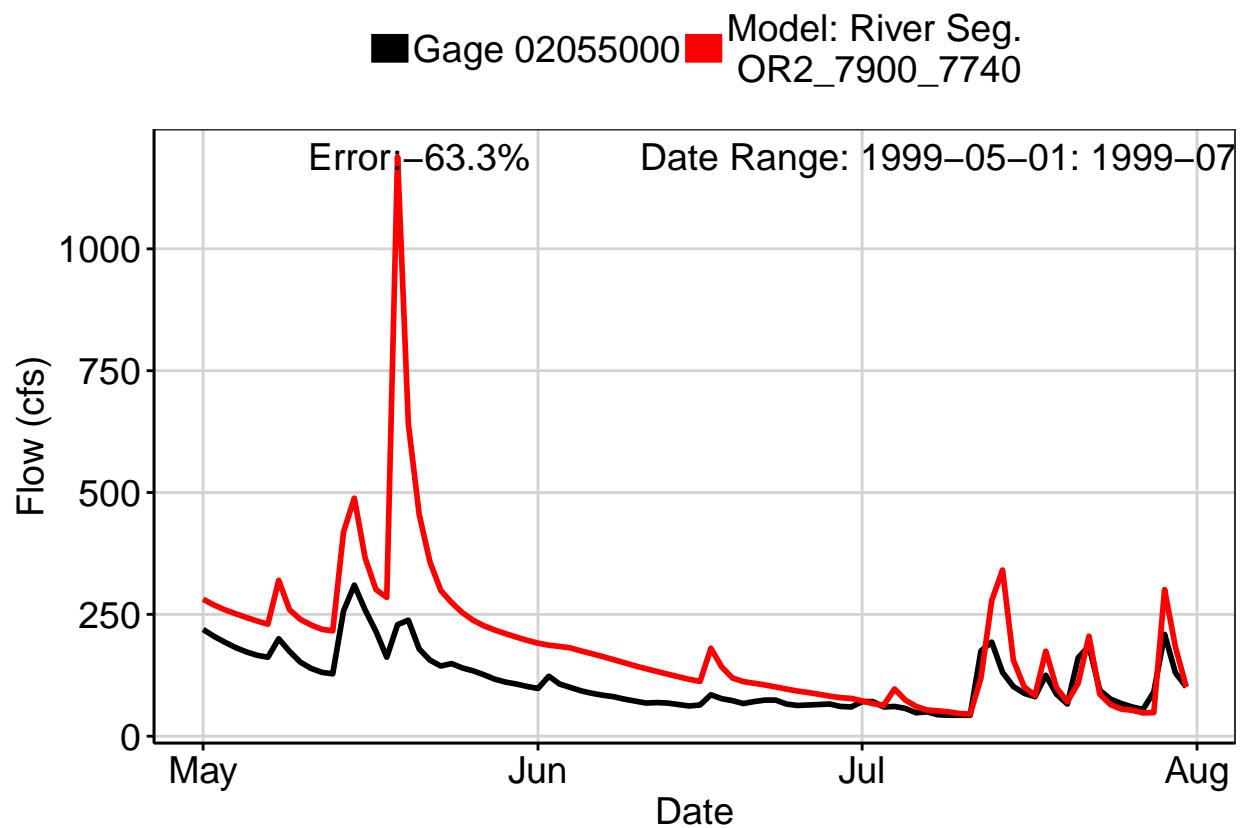


Fig. 7: Second Largest Error Segment

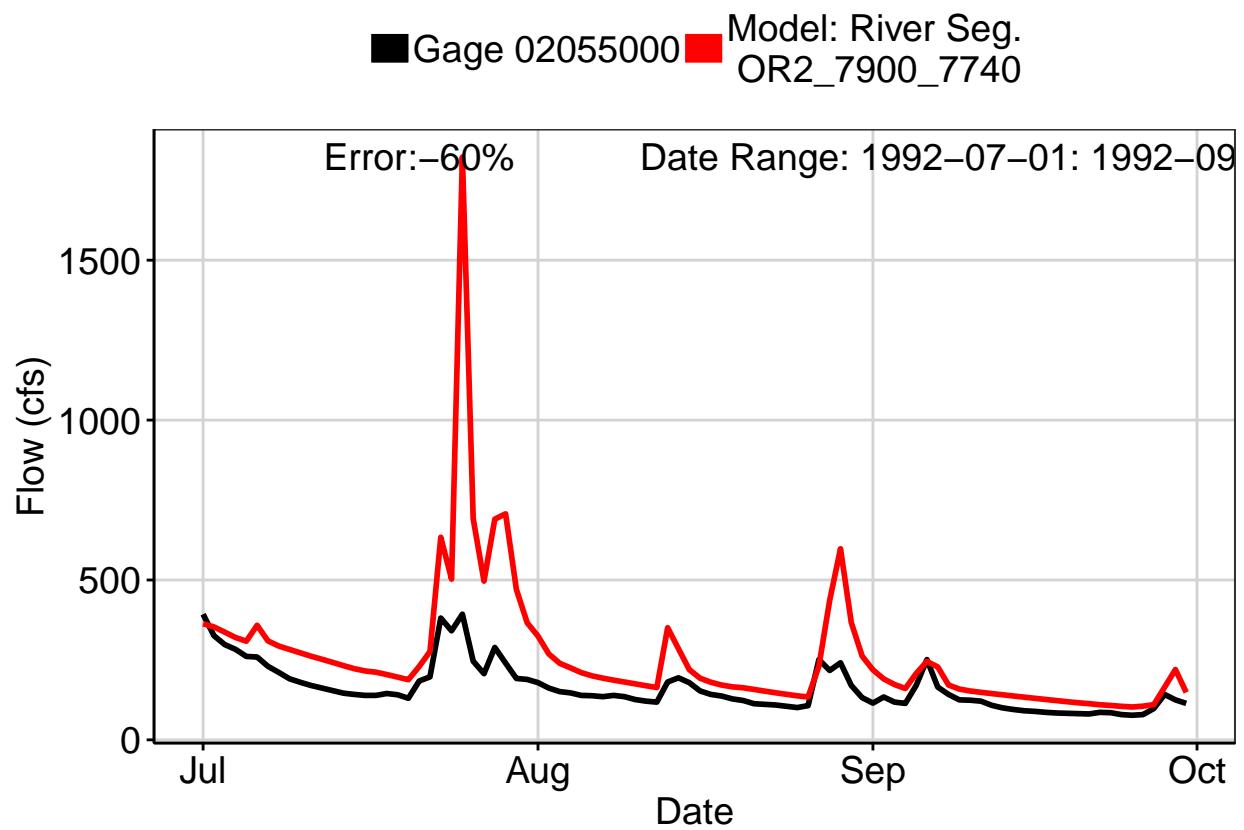


Fig. 8: Third Largest Error Segment

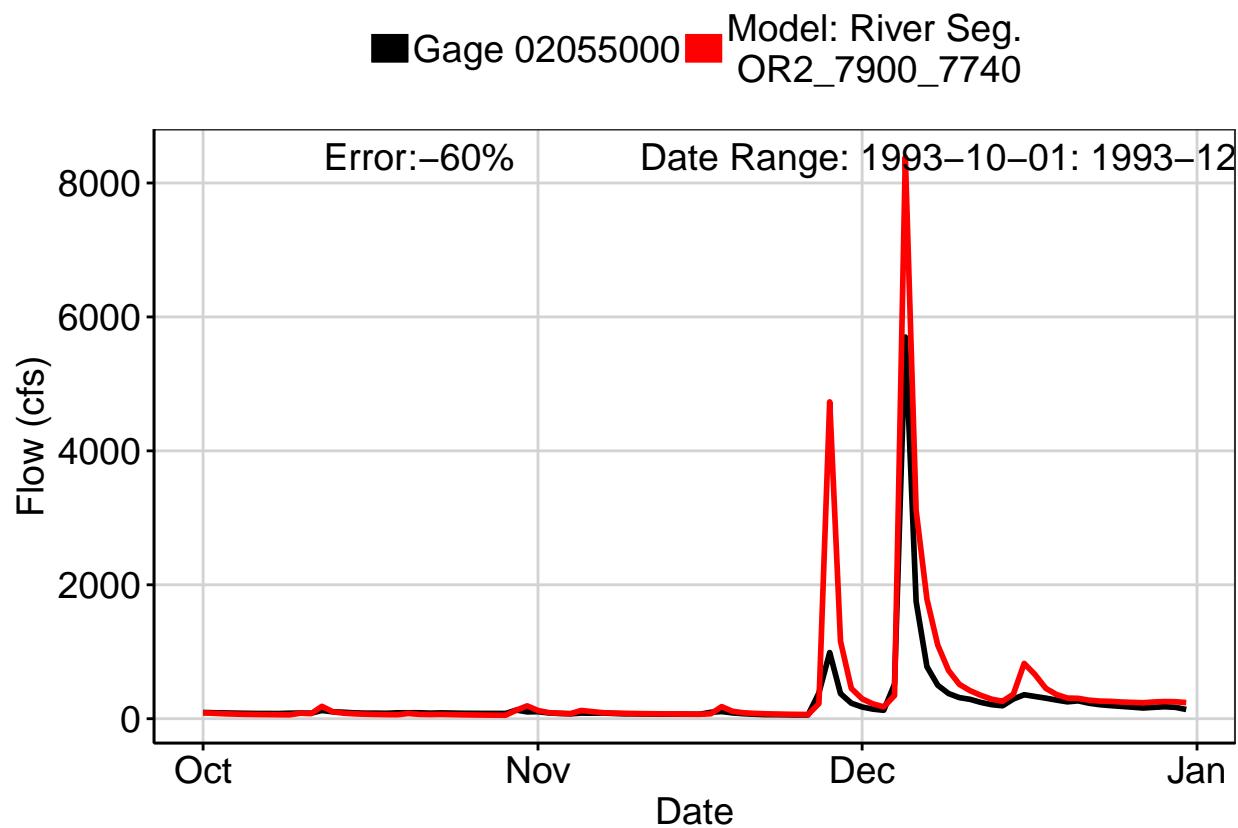
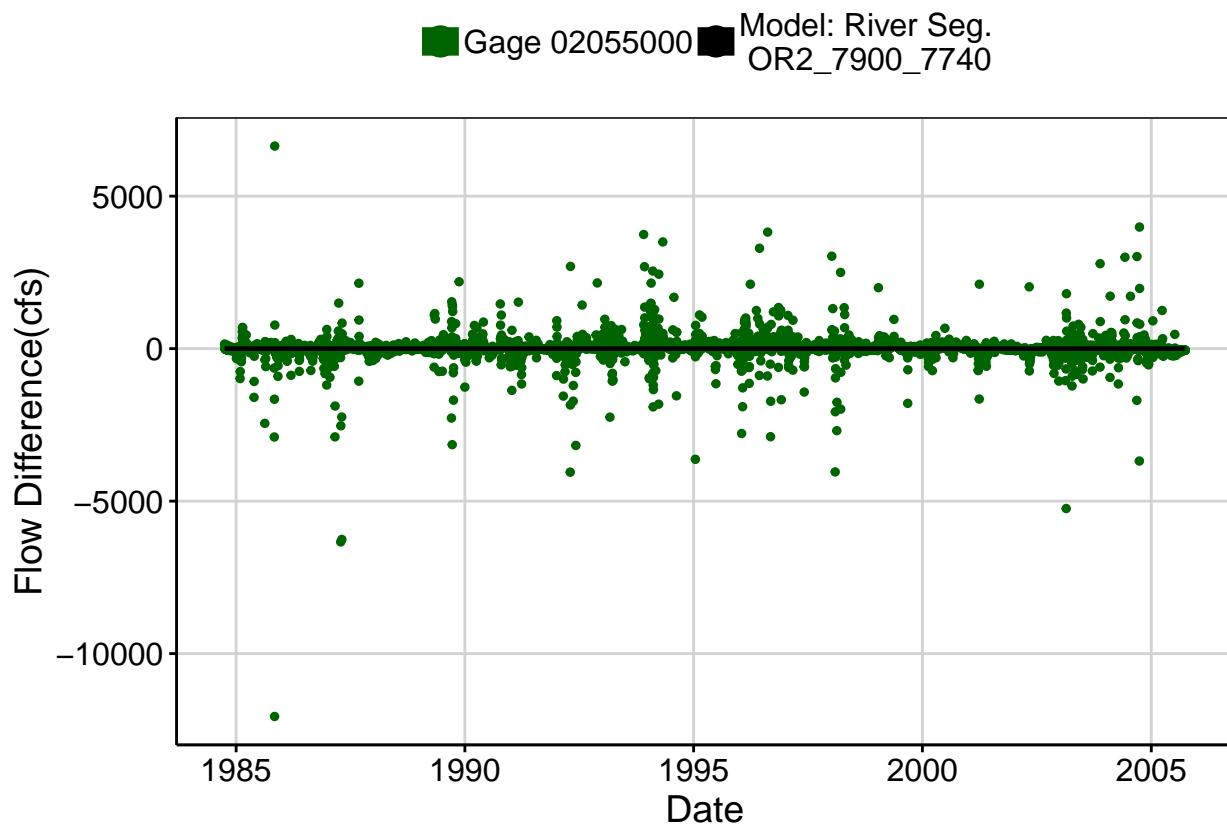
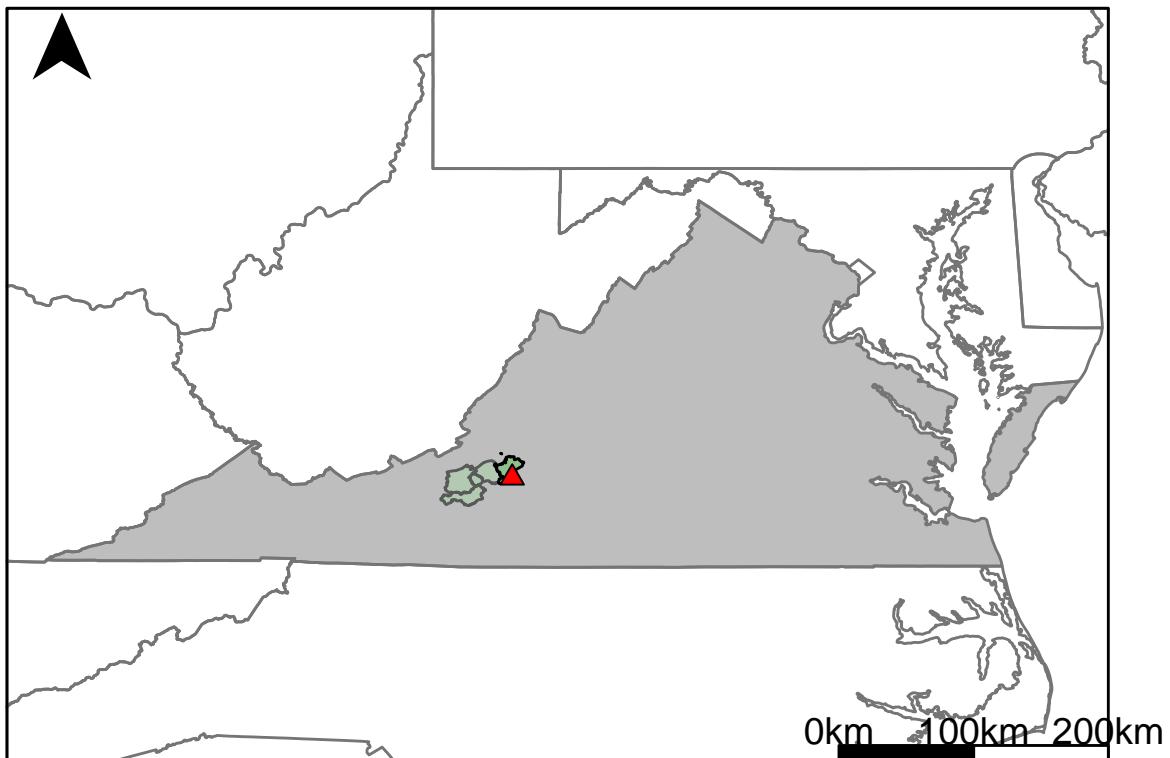


Fig. 9: Residuals Plot



## Appendix H.5: USGS Gage 02056000 vs. OR3\_7740\_8271



This river segment follows part of the flow of the Roanoke River. The gage is located in Roanoke County, VA (Lat 3715'18", Long 7952'18") approximately 4 miles southeast of Roanoke, VA. Drainage area is 509 sq. miles. This gage started taking data in 1926 and is still taking data. There is complete regulation of low flow conditions in this area due to a power plant located only 200 ft upstream. There is very little storage at the facility, so excess water frequently overtops the dam. The average daily discharge error between the model and gage data for the 20 year timespan was 3.86%, with 29.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	137	65.9	51.9
Feb. Low Flow	156	105	32.7
Mar. Low Flow	192	214	-11.5
Apr. Low Flow	210	222	-5.71
May Low Flow	323	383	-18.6
Jun. Low Flow	363	351	3.31
Jul. Low Flow	315	281	10.8
Aug. Low Flow	245	238	2.86
Sep. Low Flow	224	192	14.3
Oct. Low Flow	178	110	38.2
Nov. Low Flow	135	89.2	33.9
Dec. Low Flow	128	63.6	50.3

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	544	523	3.86
Jan. Mean Flow	639	655	-2.5
Feb. Mean Flow	807	791	1.98
Mar. Mean Flow	909	890	2.09
Apr. Mean Flow	854	777	9.02
May Mean Flow	612	600	1.96
Jun. Mean Flow	515	492	4.47
Jul. Mean Flow	340	323	5
Aug. Mean Flow	304	247	18.8
Sep. Mean Flow	413	396	4.12
Oct. Mean Flow	279	269	3.58
Nov. Mean Flow	422	429	-1.66
Dec. Mean Flow	458	428	6.55

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	364	672	-84.6
Feb. High Flow	727	1120	-54.1
Mar. High Flow	1050	904	13.9
Apr. High Flow	1710	1820	-6.43
May High Flow	1610	1470	8.7
Jun. High Flow	2980	2830	5.03
Jul. High Flow	1700	1540	9.41
Aug. High Flow	1440	1470	-2.08
Sep. High Flow	727	886	-21.9
Oct. High Flow	621	688	-10.8
Nov. High Flow	563	639	-13.5
Dec. High Flow	341	536	-57.2

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	79.5	0.83	99
Med. 1 Day Min	114	45.3	60.3
Min. 3 Day Min	81	5.06	93.8
Med. 3 Day Min	122	49.5	59.4
Min. 7 Day Min	82.4	7.15	91.3
Med. 7 Day Min	131	54.9	58.1
Min. 30 Day Min	103	10.6	89.7
Med. 30 Day Min	153	90.7	40.7
Min. 90 Day Min	123	46.8	62
Med. 90 Day Min	205	158	22.9
7Q10	102	17.7	82.6
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	176	523	-197
Mean Baseflow	283	270	4.59

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	19700	26500	-34.5
Med. 1 Day Max	8200	7590	7.44
Max. 3 Day Max	12500	12600	-0.8
Med. 3 Day Max	4590	4580	0.22
Max. 7 Day Max	6810	6240	8.37
Med. 7 Day Max	3060	2920	4.58
Max. 30 Day Max	3710	2950	20.5
Med. 30 Day Max	1400	1460	-4.29
Max. 90 Day Max	2130	1850	13.1
Med. 90 Day Max	918	951	-3.59

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	104	18.6	82.1
5% Non-Exceedance	130	49.5	61.9
50% Non-Exceedance	302	303	-0.33
95% Non-Exceedance	1490	1540	-3.36
99% Non-Exceedance	4280	4400	-2.8
Sept. 10% Non-Exceedance	43.4	43.5	-0.23

**Fig. 1: Hydrograph**

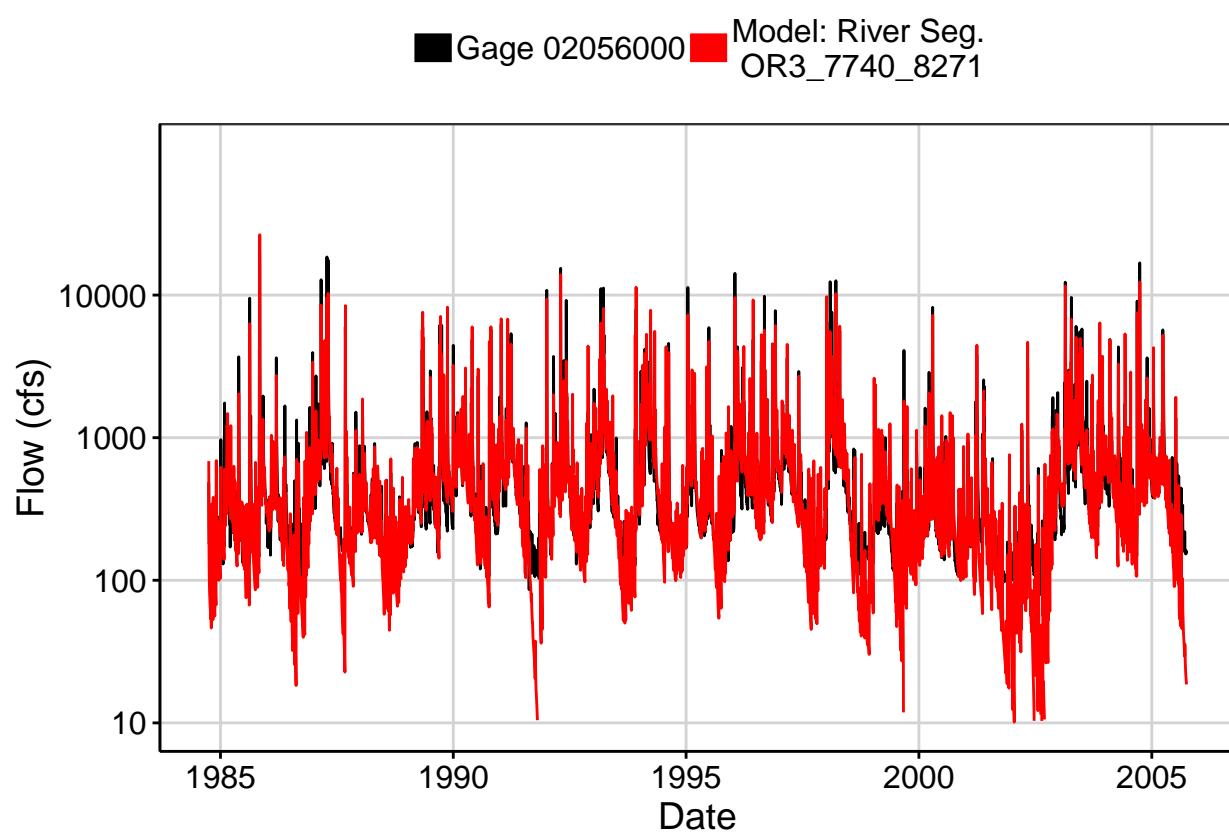


Fig. 2: Zoomed Hydrograph

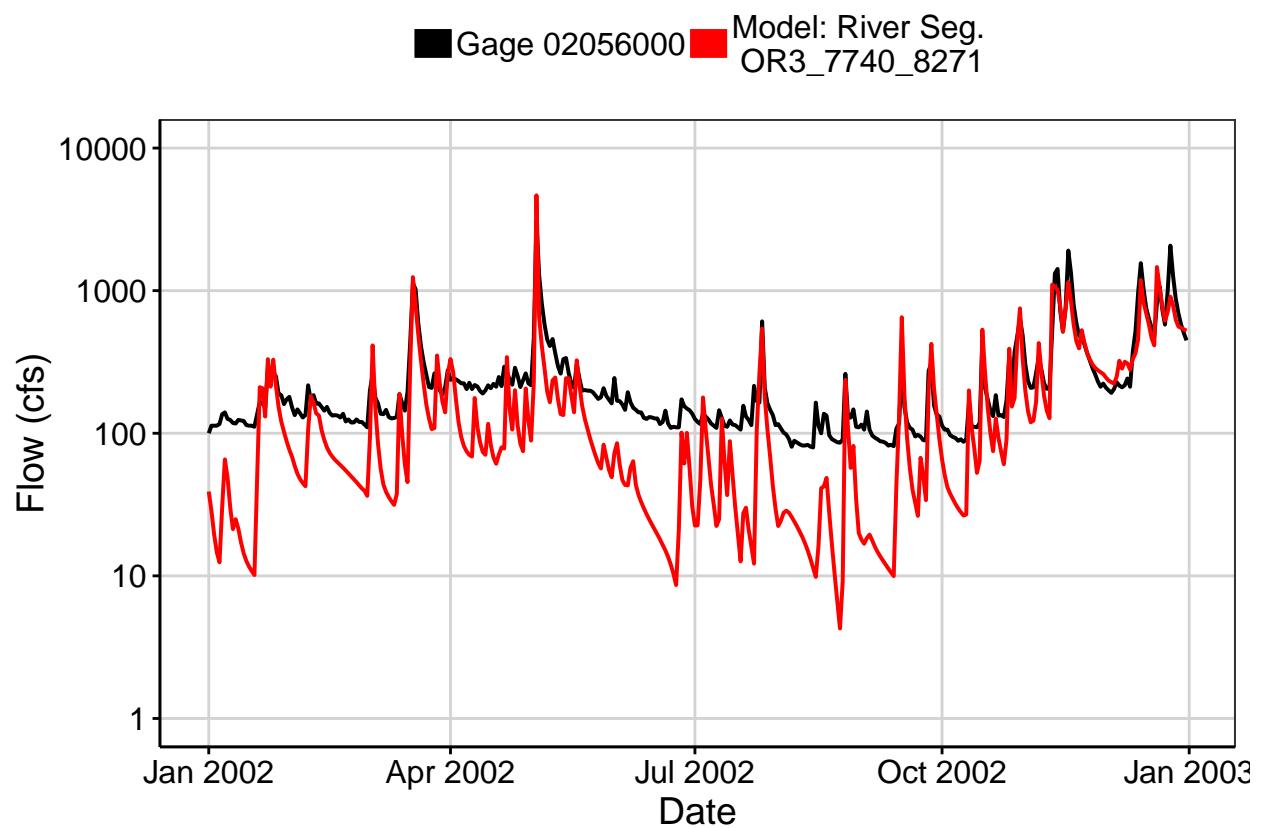


Fig. 3: Flow Exceedance

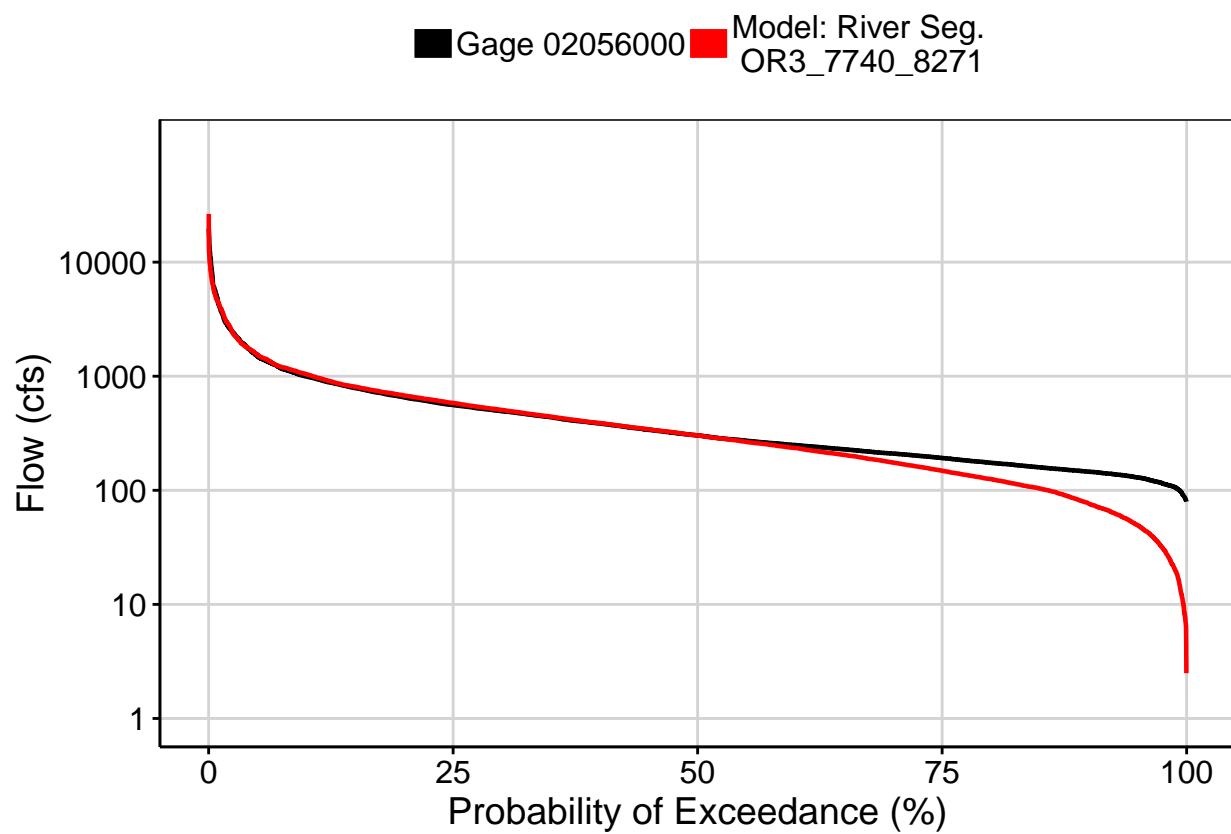


Fig. 4: Baseflow

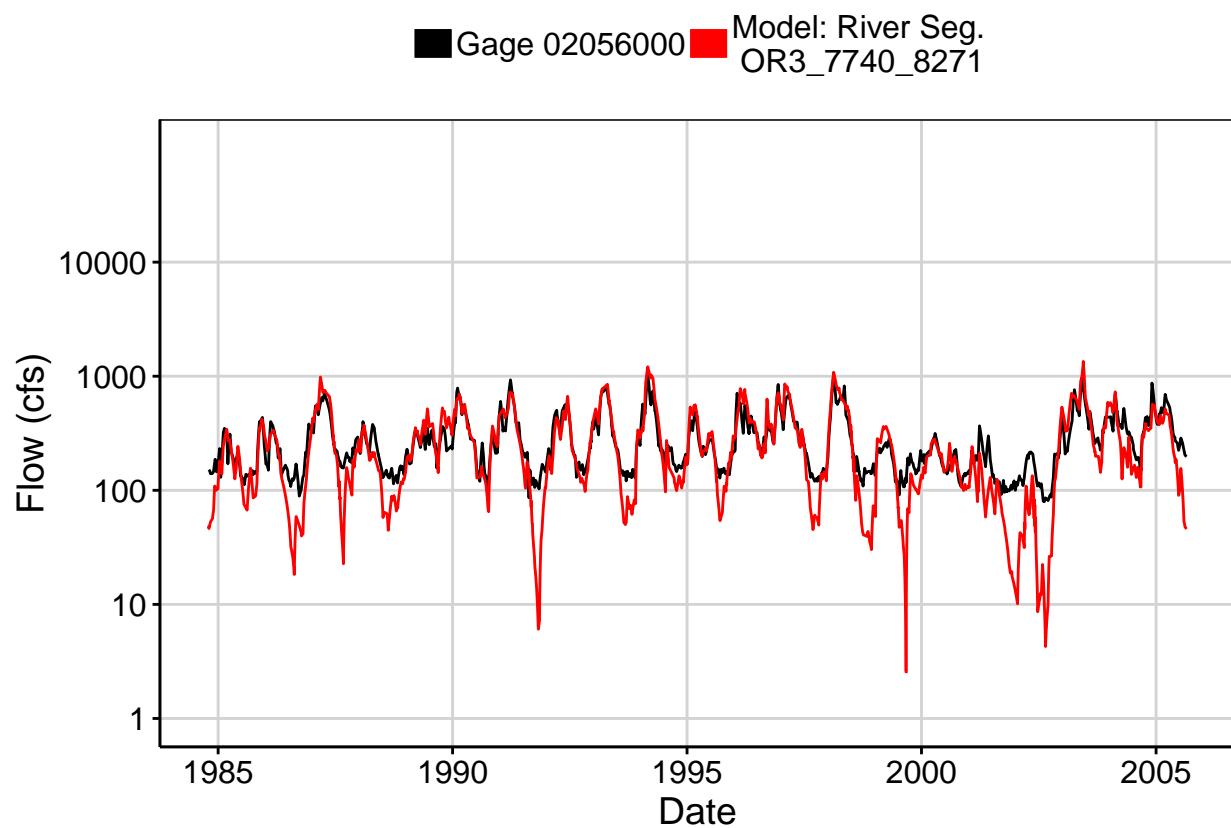


Fig. 5: Combined Baseflow

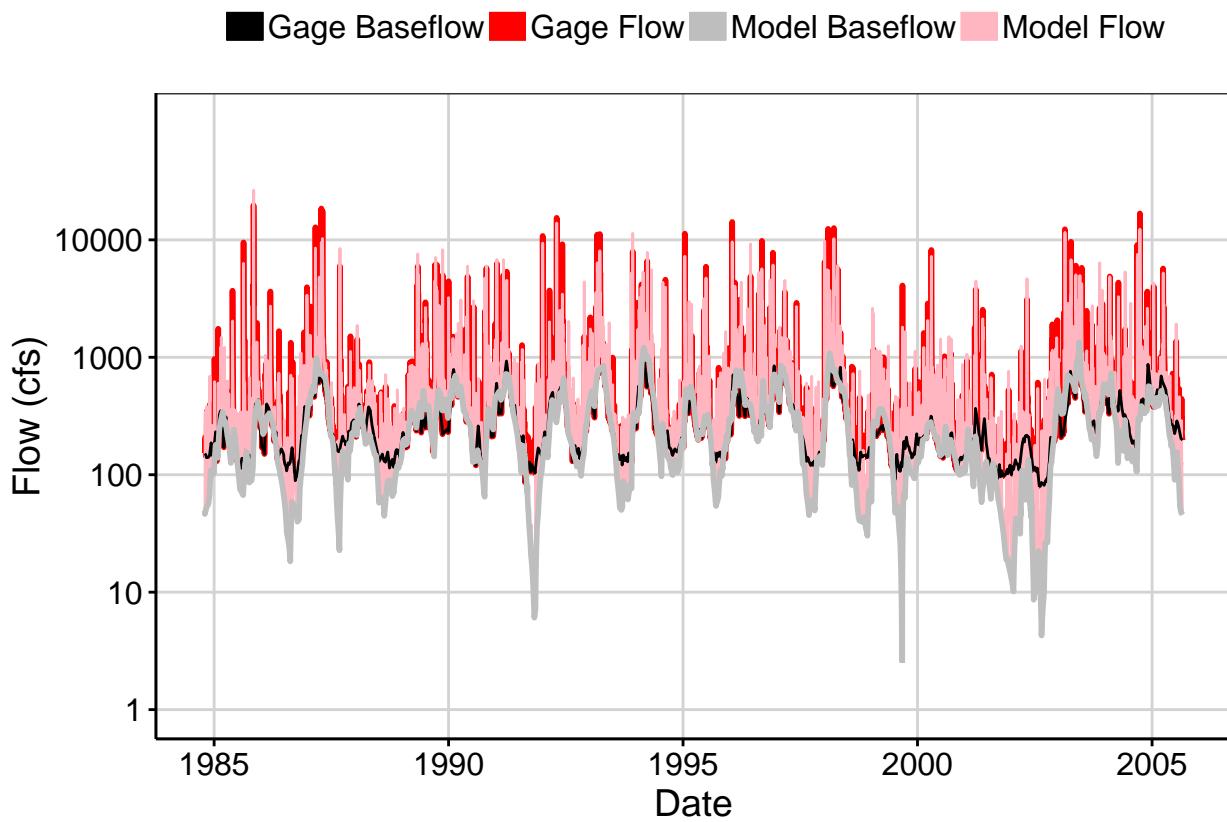


Fig. 6: Largest Error Segment

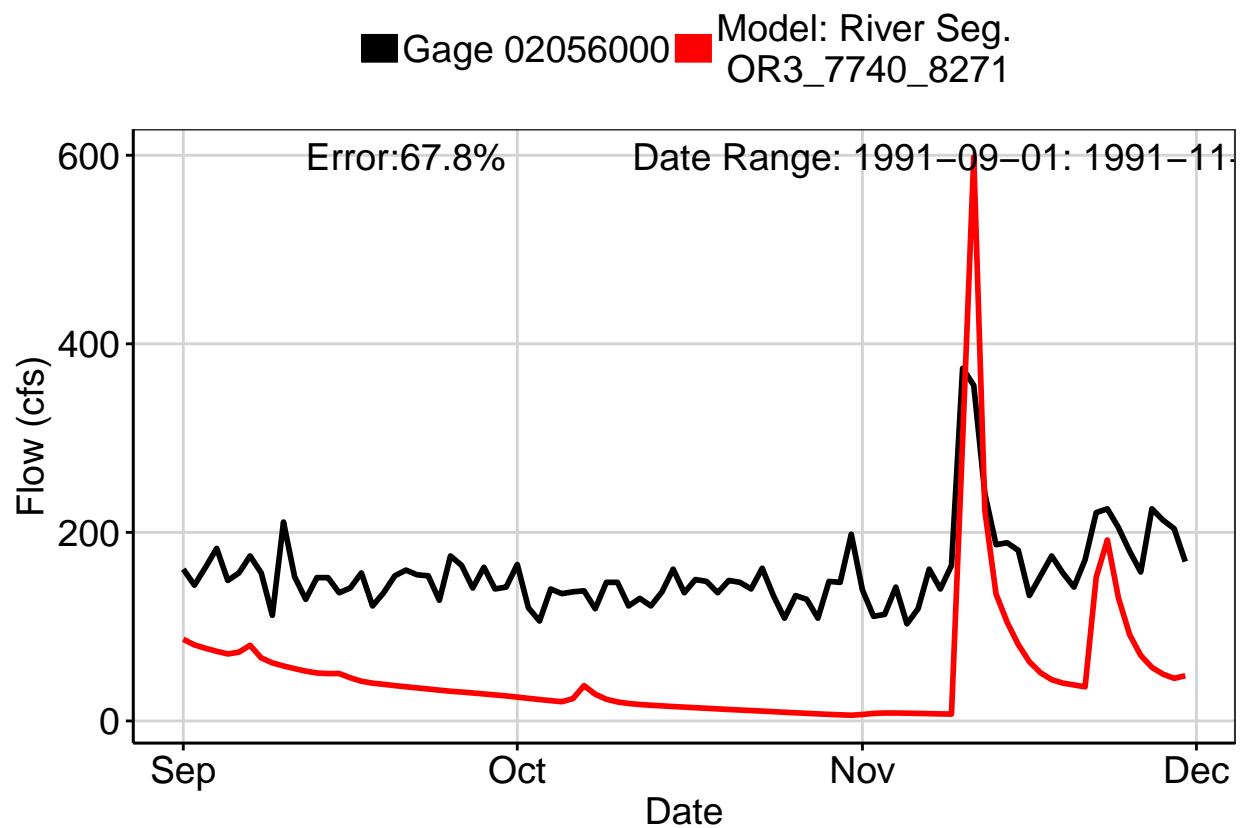


Fig. 7: Second Largest Error Segment

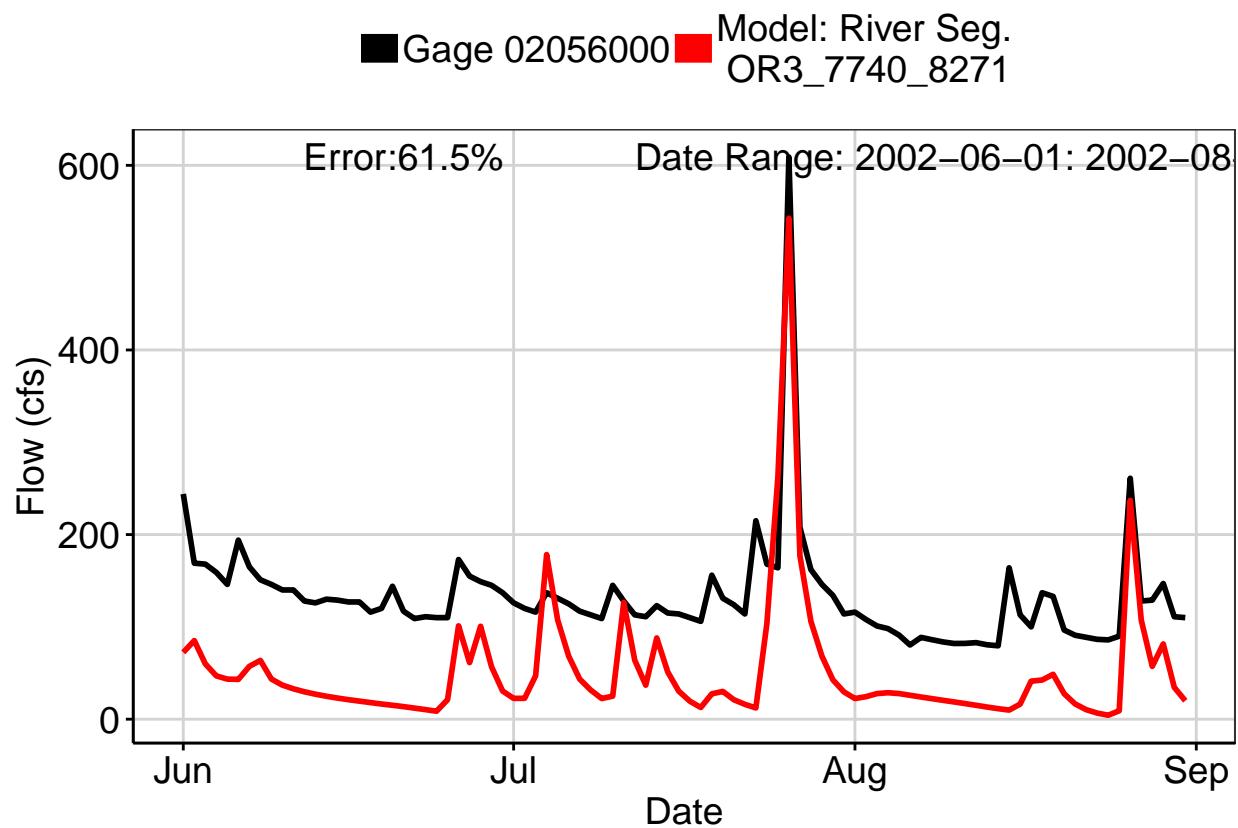


Fig. 8: Third Largest Error Segment

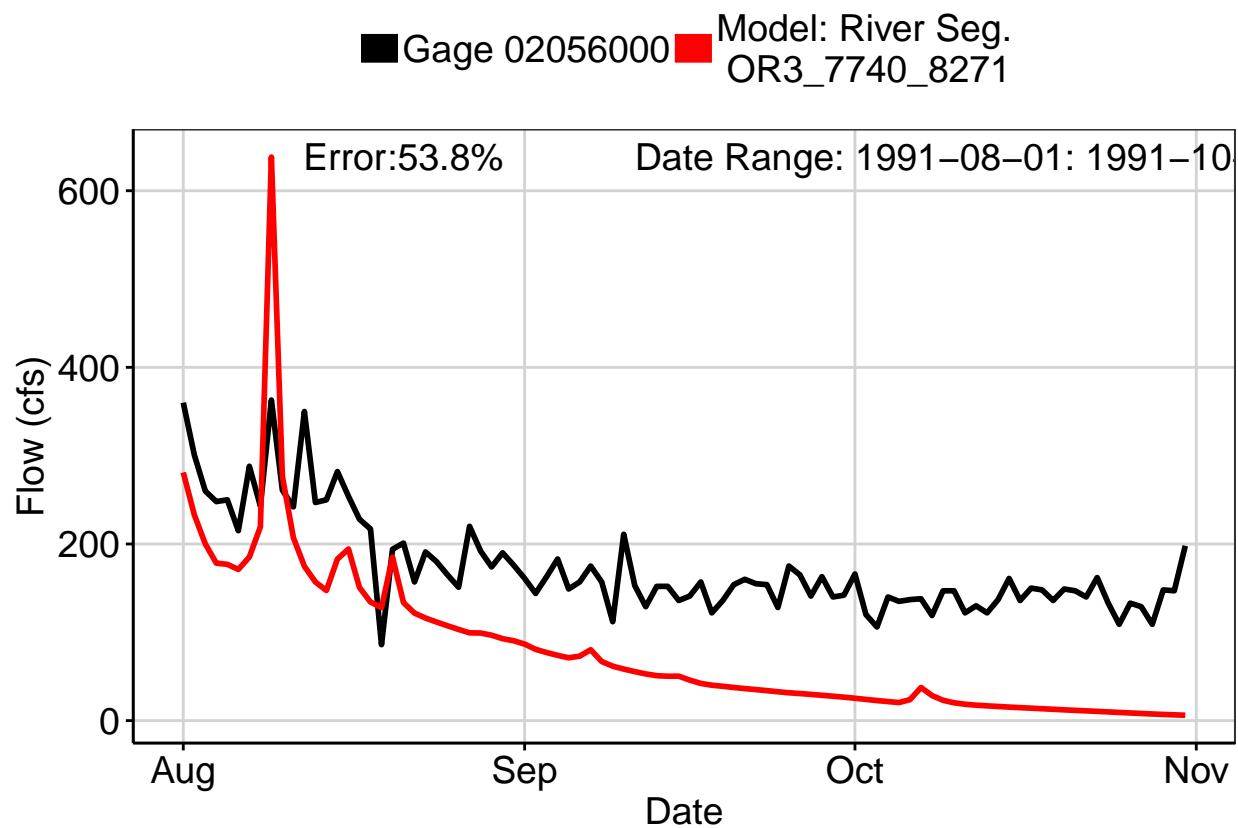
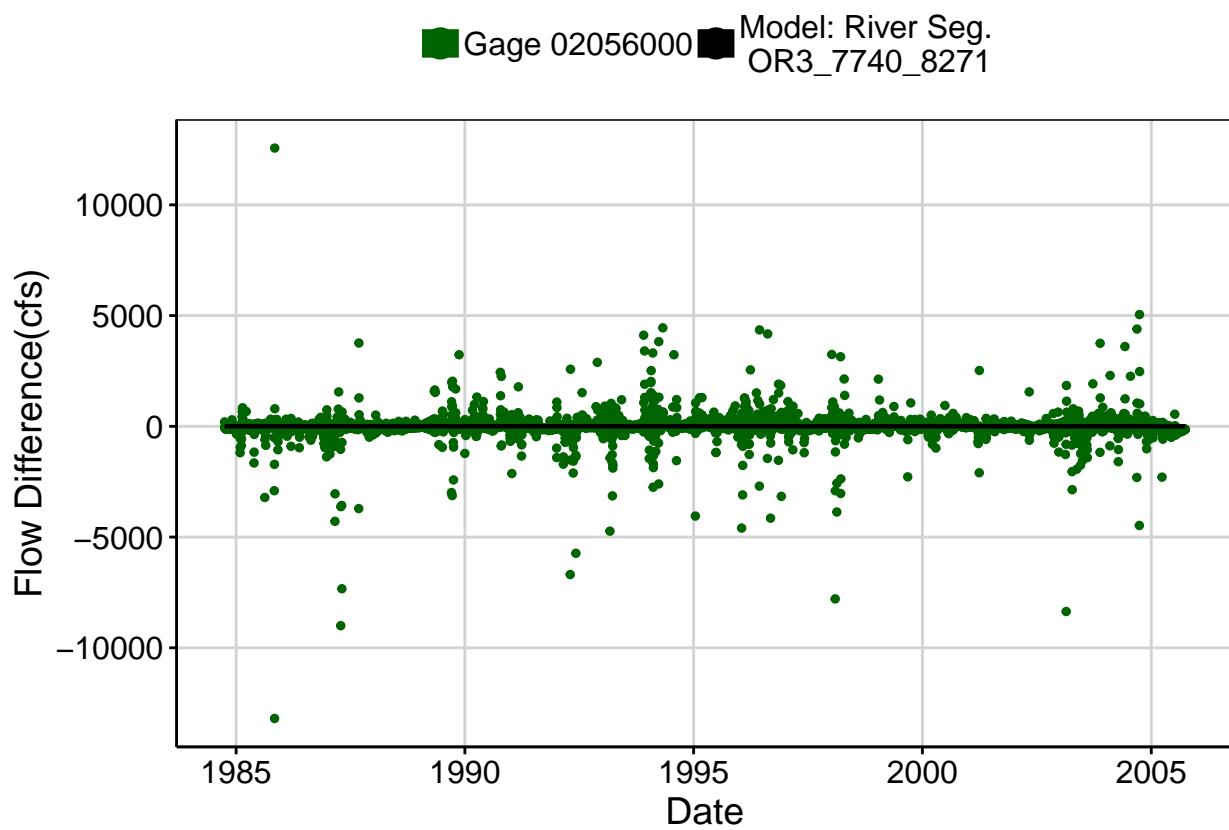
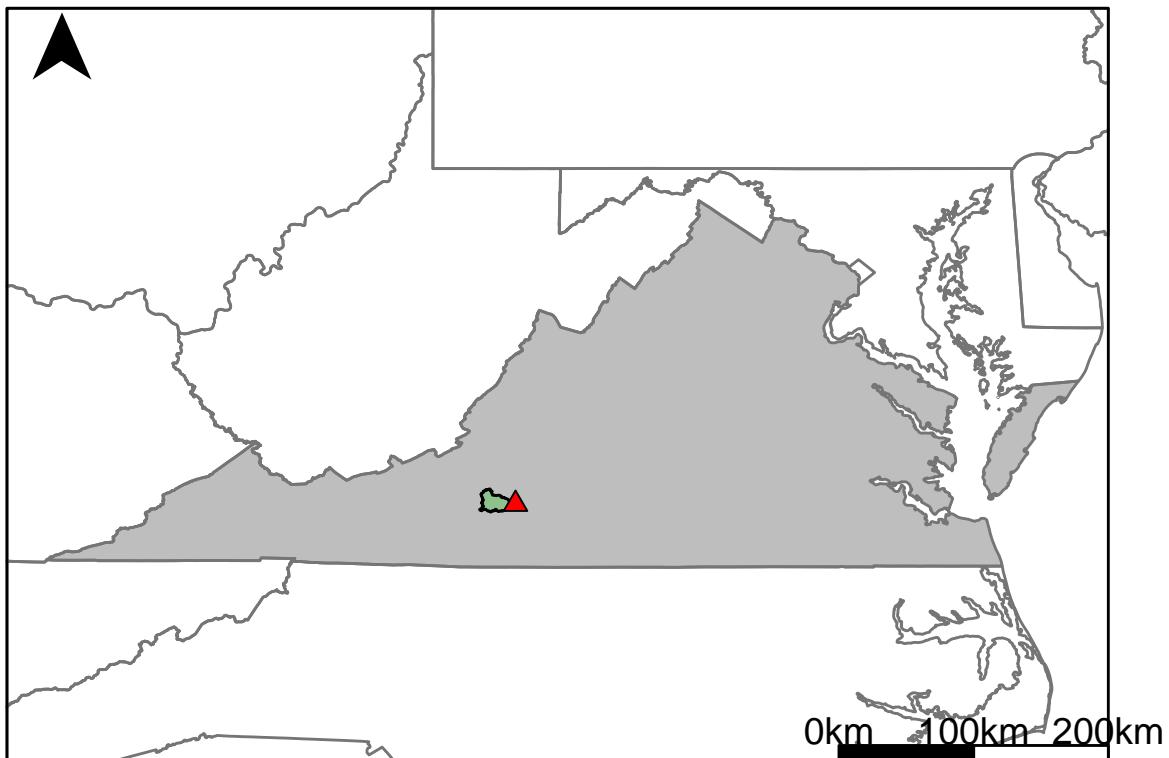


Fig. 9: Residuals Plot



## Appendix H.6: USGS Gage 02056900 vs. OR1\_8320\_8271



This river segment follows part of the flow of the Blackwater River, a tributary of the Roanoke River. The gage is located in Franklin County, VA (Lat 37°02'42", Long 79°50'40") approximately 20 miles southeast of Salem, VA. Drainage area is 115 sq. miles. This gage started taking data in 1976 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 0%, with 42.1% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	36	21.7	39.7
Feb. Low Flow	50	35.8	28.4
Mar. Low Flow	59	67.6	-14.6
Apr. Low Flow	58	81.3	-40.2
May Low Flow	89	104	-16.9
Jun. Low Flow	104	105	-0.96
Jul. Low Flow	95	64.3	32.3
Aug. Low Flow	81	52.1	35.7
Sep. Low Flow	59	48.8	17.3
Oct. Low Flow	40	32.7	18.2
Nov. Low Flow	32	30.7	4.06
Dec. Low Flow	34	25.8	24.1

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	131	131	0
Jan. Mean Flow	155	164	-5.81
Feb. Mean Flow	165	193	-17
Mar. Mean Flow	207	242	-16.9
Apr. Mean Flow	201	192	4.48
May Mean Flow	128	125	2.34
Jun. Mean Flow	129	108	16.3
Jul. Mean Flow	88.5	75.1	15.1
Aug. Mean Flow	77.6	67.7	12.8
Sep. Mean Flow	110	109	0.91
Oct. Mean Flow	79.8	79.7	0.12
Nov. Mean Flow	120	105	12.5
Dec. Mean Flow	115	119	-3.48

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	131	73.5	43.9
Feb. High Flow	289	290	-0.35
Mar. High Flow	250	236	5.6
Apr. High Flow	388	365	5.93
May High Flow	393	330	16
Jun. High Flow	714	769	-7.7
Jul. High Flow	323	423	-31
Aug. High Flow	240	232	3.33
Sep. High Flow	156	113	27.6
Oct. High Flow	168	89.9	46.5
Nov. High Flow	130	73.8	43.2
Dec. High Flow	209	81.9	60.8

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	3.83	2.51	34.5
Med. 1 Day Min	24	13.8	42.5
Min. 3 Day Min	4.2	2.61	37.9
Med. 3 Day Min	26	14.1	45.8
Min. 7 Day Min	4.61	2.88	37.5
Med. 7 Day Min	28.6	15	47.6
Min. 30 Day Min	12.7	5.29	58.3
Med. 30 Day Min	39.6	21.8	44.9
Min. 90 Day Min	17.9	14.8	17.3
Med. 90 Day Min	52.3	38.5	26.4
7Q10	12	6.21	48.2
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	37.1	131	-253
Mean Baseflow	76.8	77	-0.26

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	5410	6430	-18.9
Med. 1 Day Max	2270	1950	14.1
Max. 3 Day Max	3370	3030	10.1
Med. 3 Day Max	1190	1310	-10.1
Max. 7 Day Max	1860	1530	17.7
Med. 7 Day Max	632	778	-23.1
Max. 30 Day Max	842	795	5.58
Med. 30 Day Max	319	326	-2.19
Max. 90 Day Max	505	487	3.56
Med. 90 Day Max	220	239	-8.64

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	13	8.68	33.2
5% Non-Exceedance	25	15.1	39.6
50% Non-Exceedance	85	77.7	8.59
95% Non-Exceedance	330	349	-5.76
99% Non-Exceedance	915	1060	-15.8
Sept. 10% Non-Exceedance	14.2	14.2	0

**Fig. 1: Hydrograph**

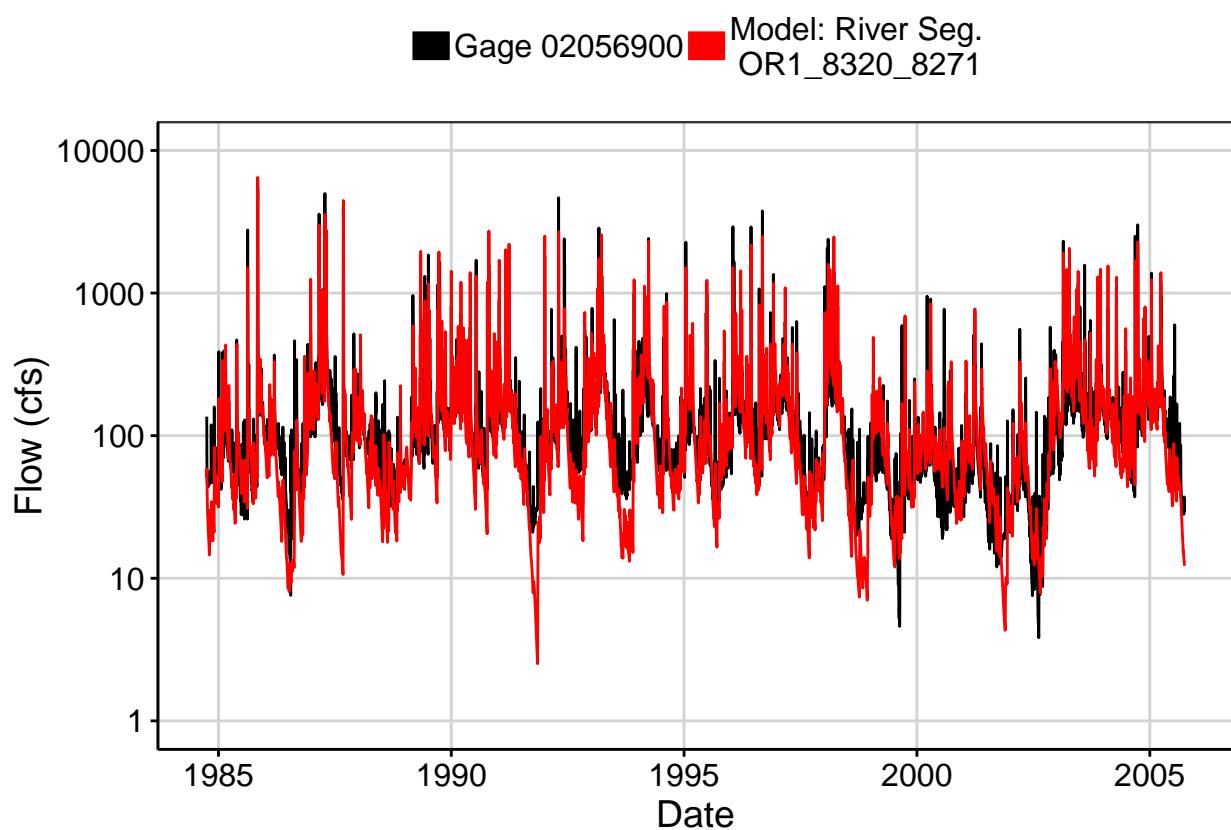


Fig. 2: Zoomed Hydrograph

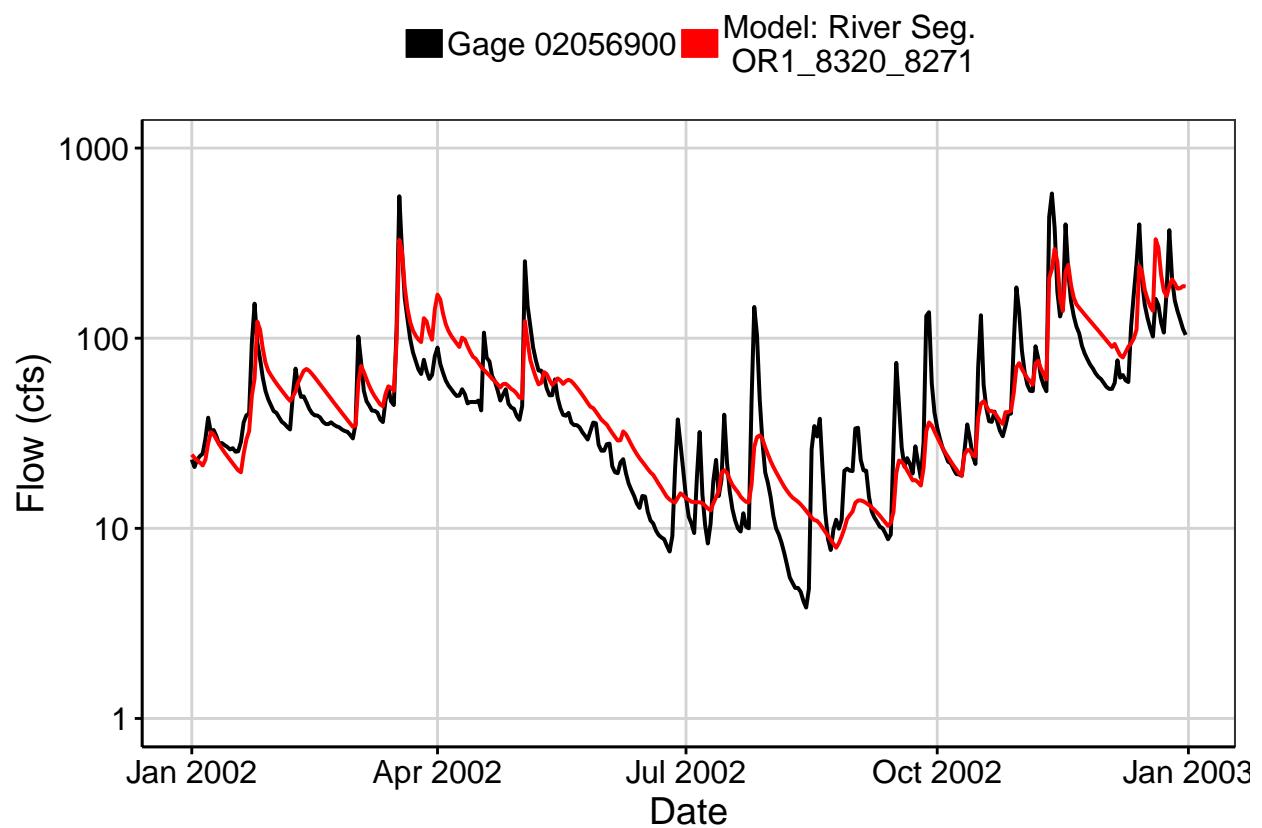


Fig. 3: Flow Exceedance

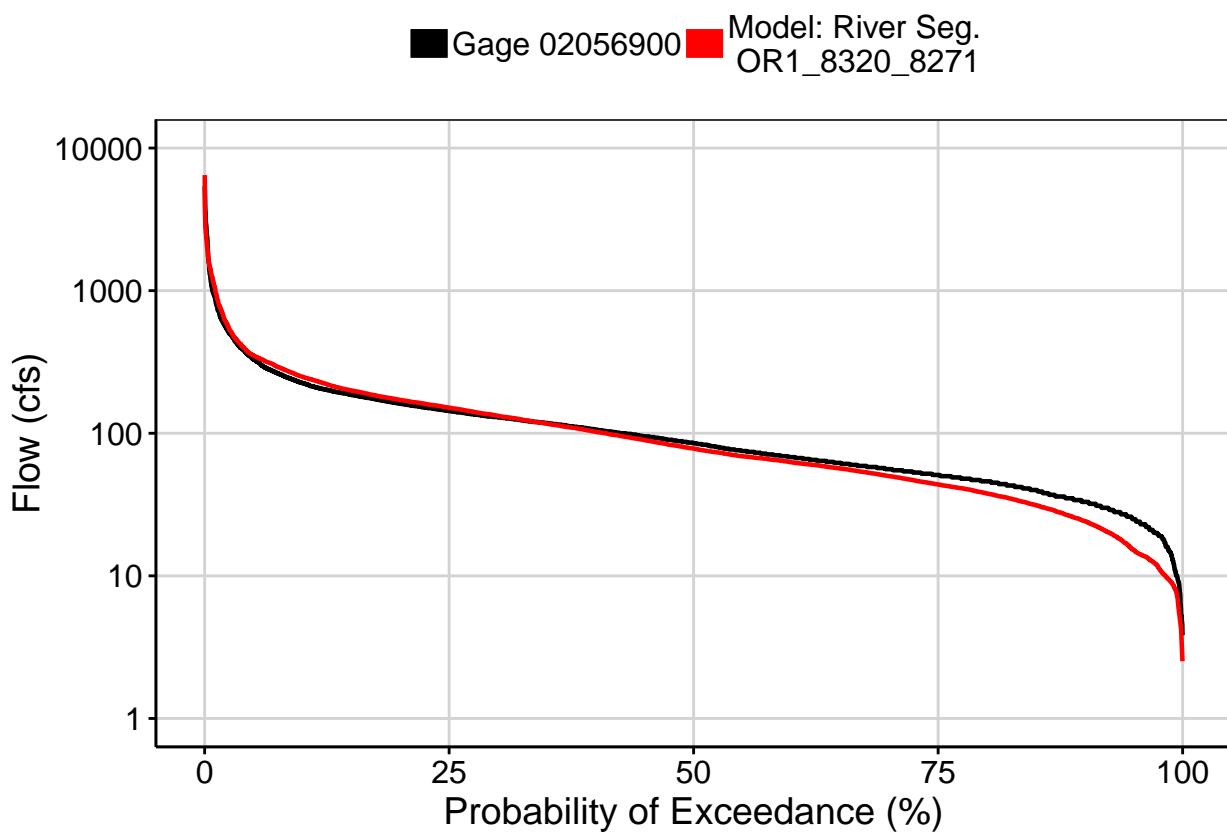


Fig. 4: Baseflow

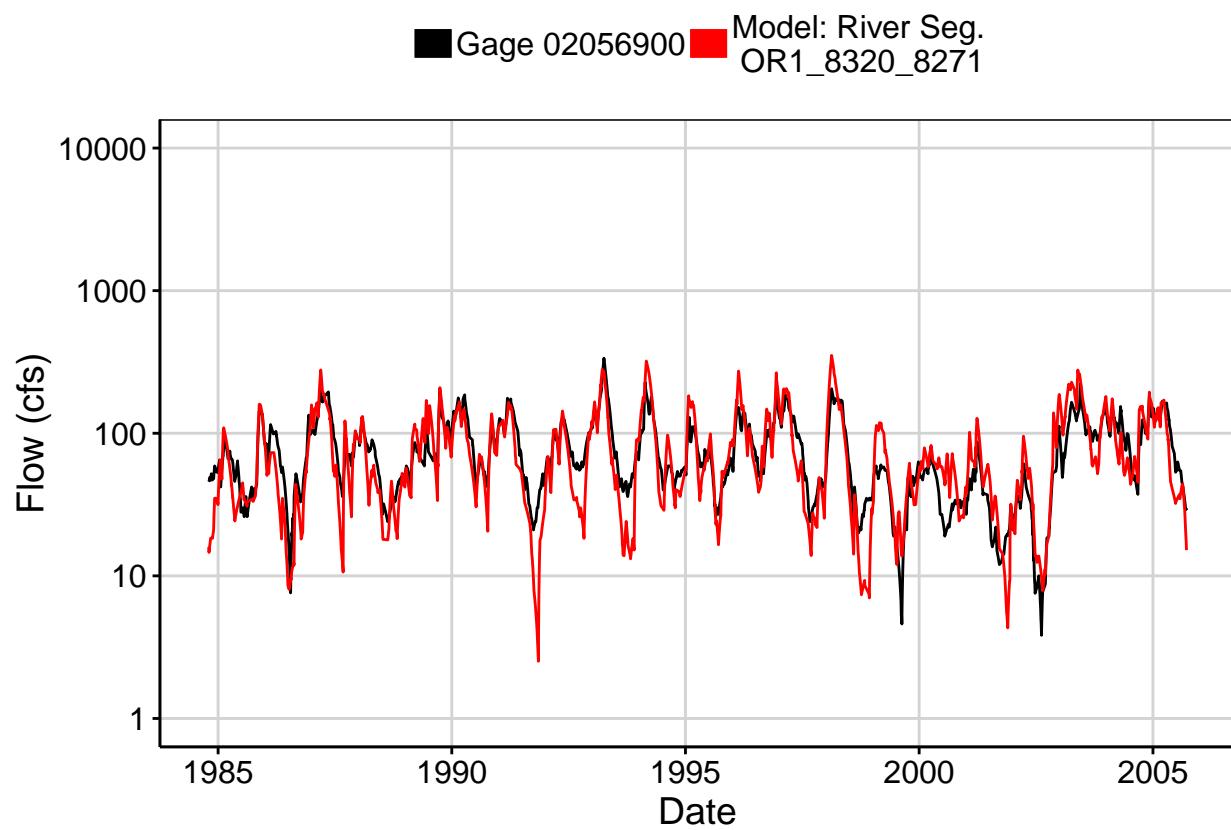


Fig. 5: Combined Baseflow

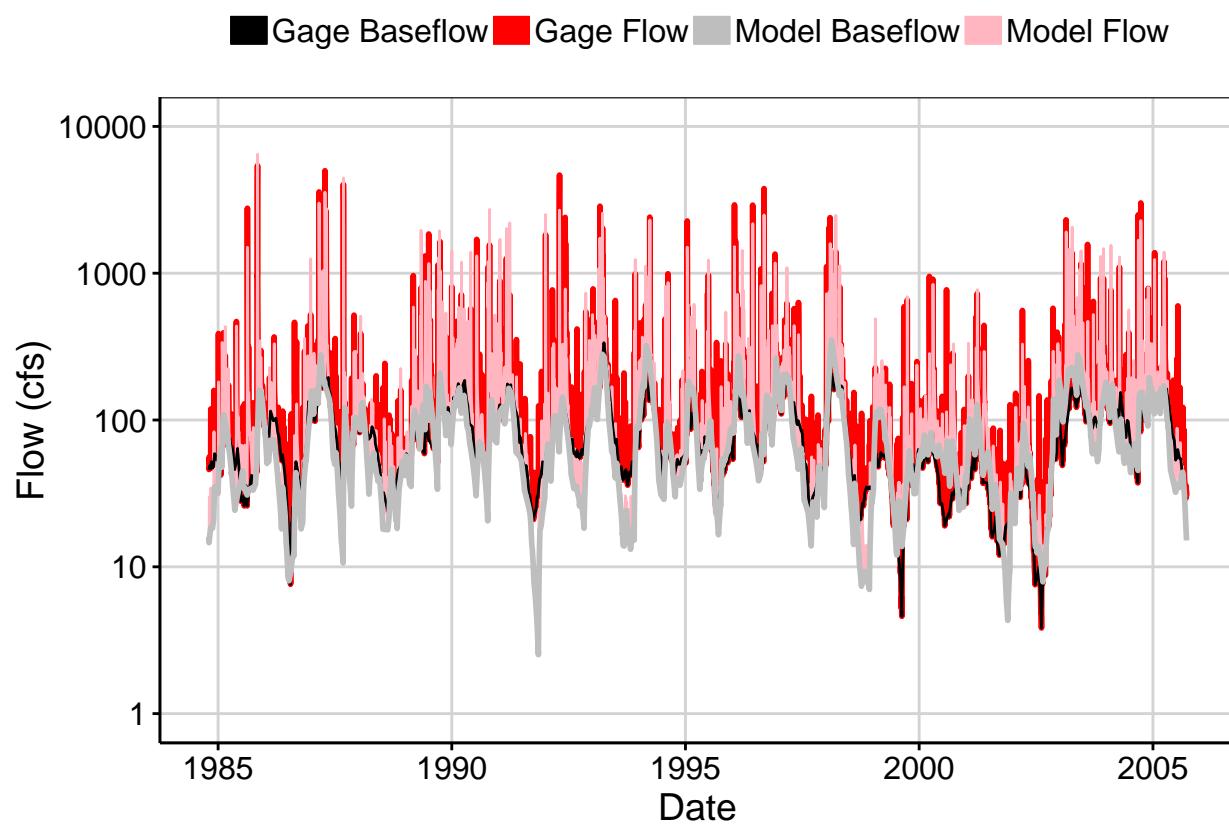


Fig. 6: Largest Error Segment

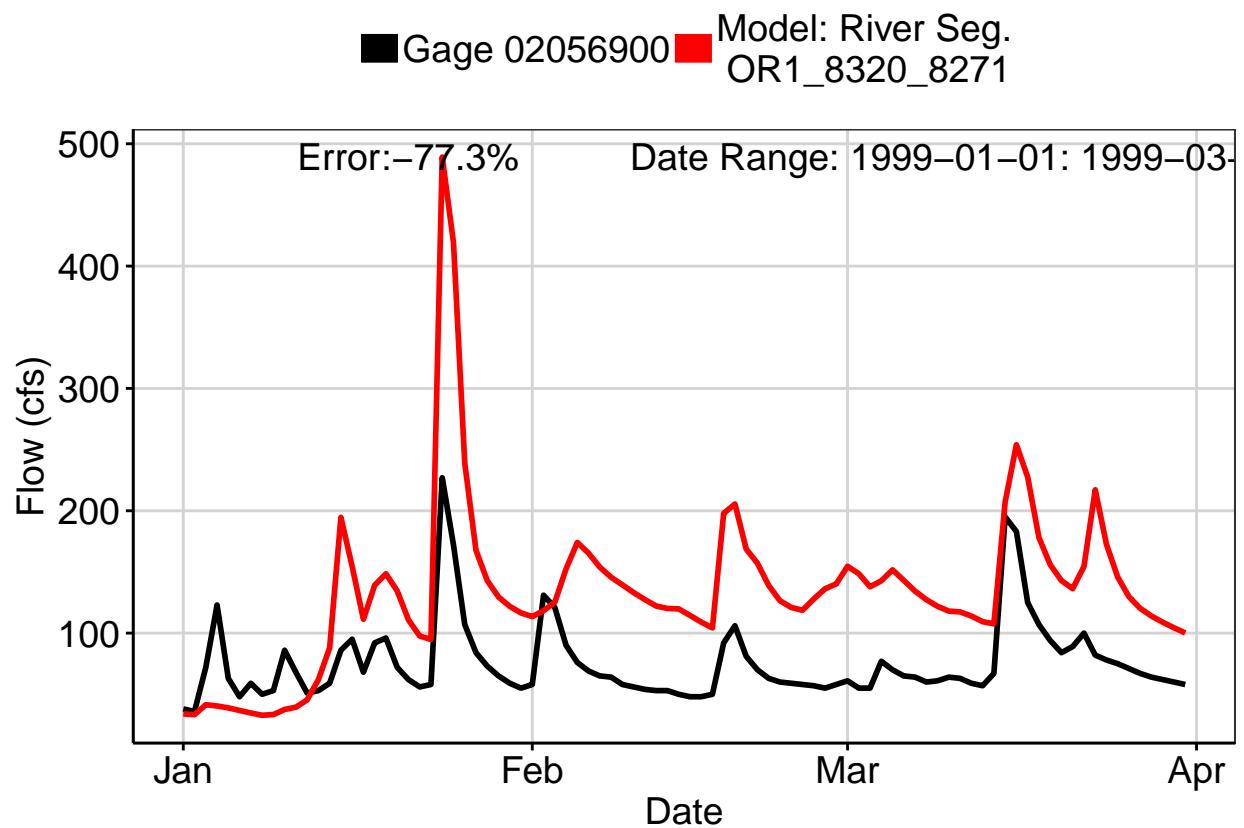


Fig. 7: Second Largest Error Segment

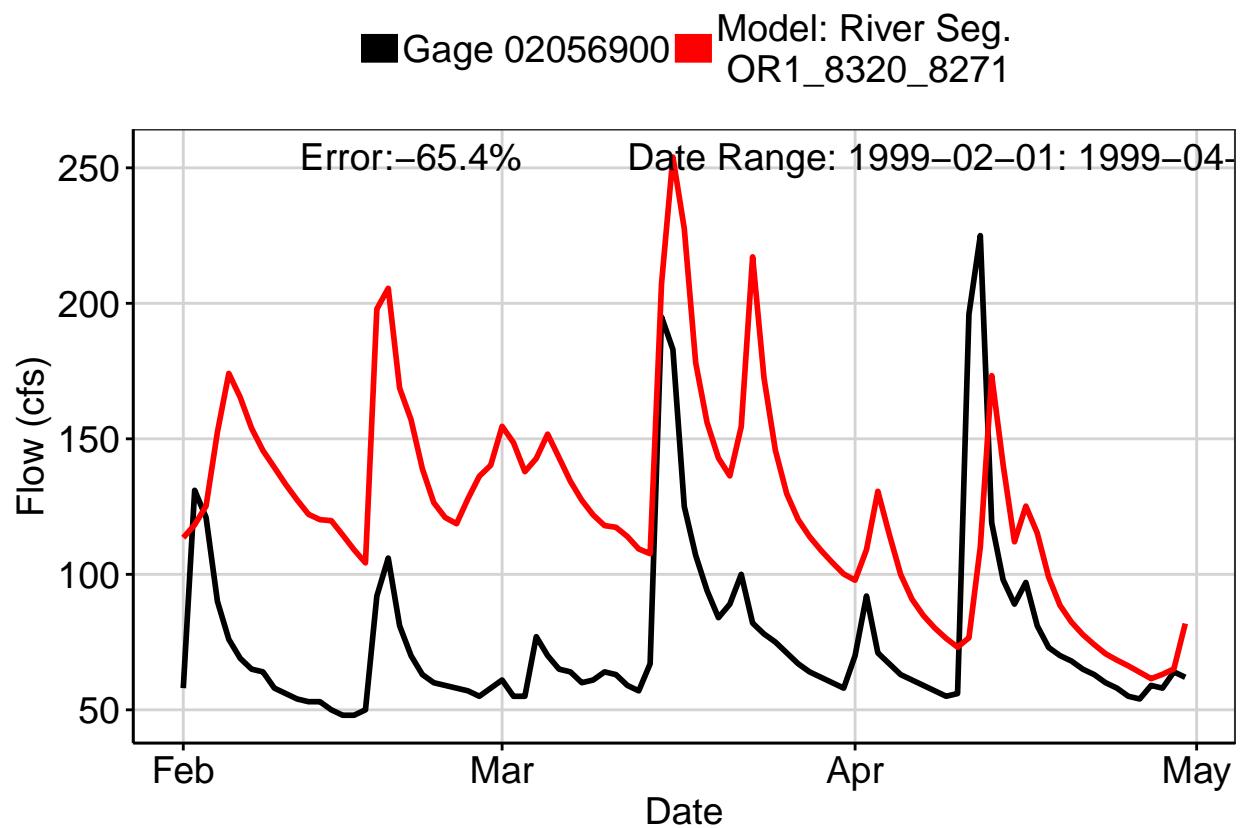


Fig. 8: Third Largest Error Segment

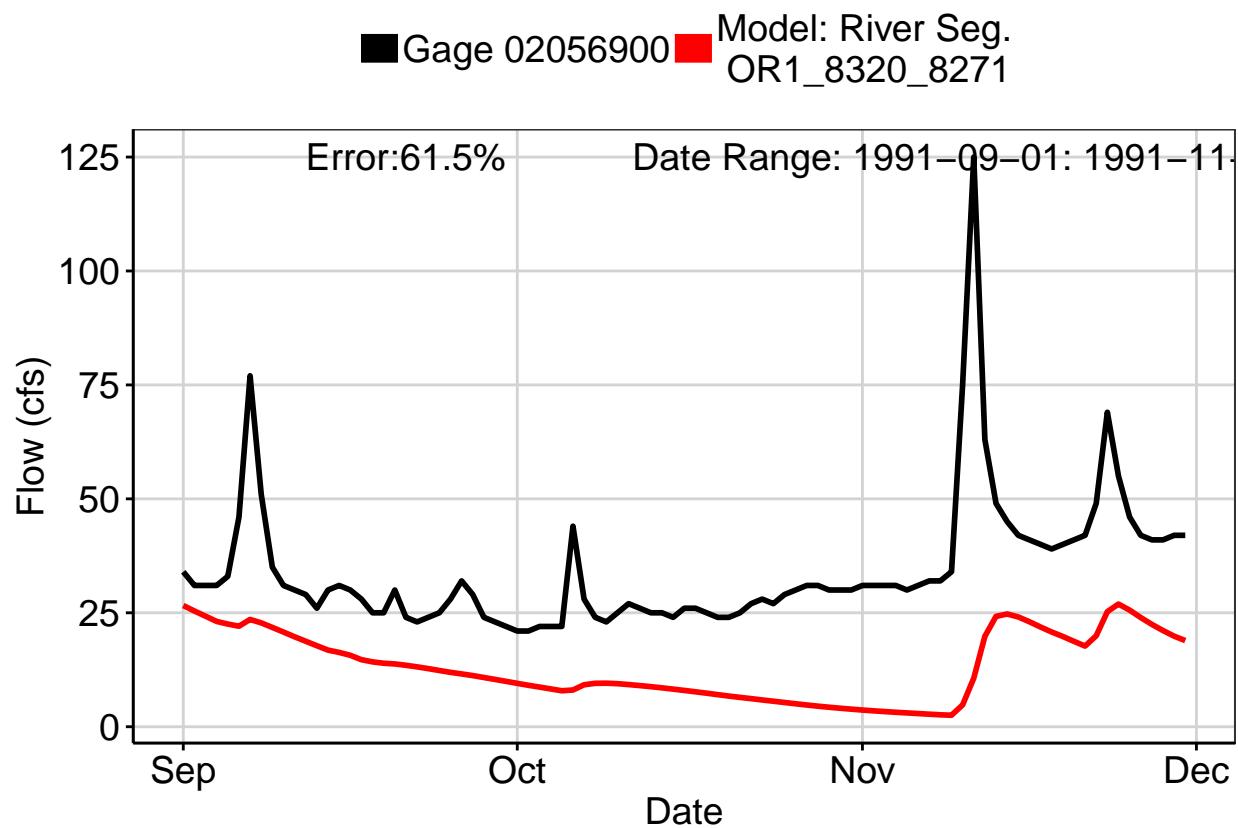
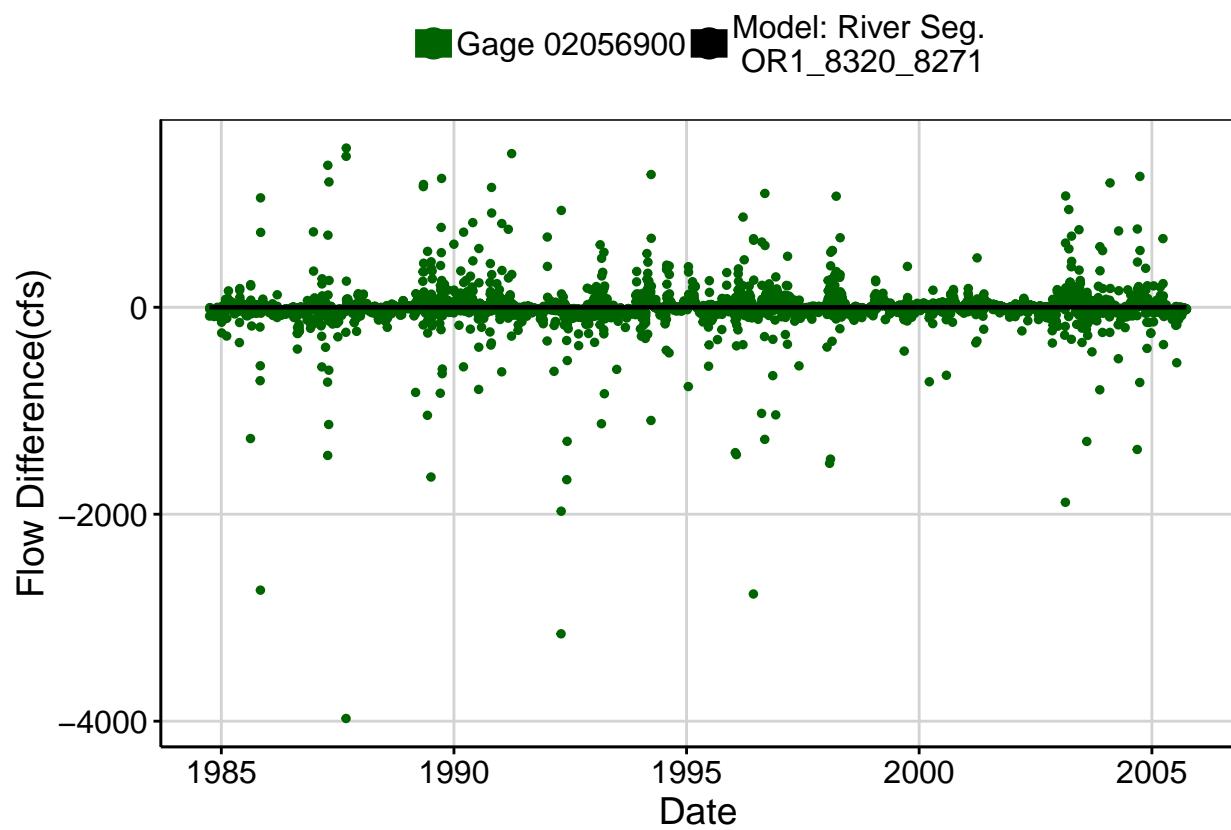
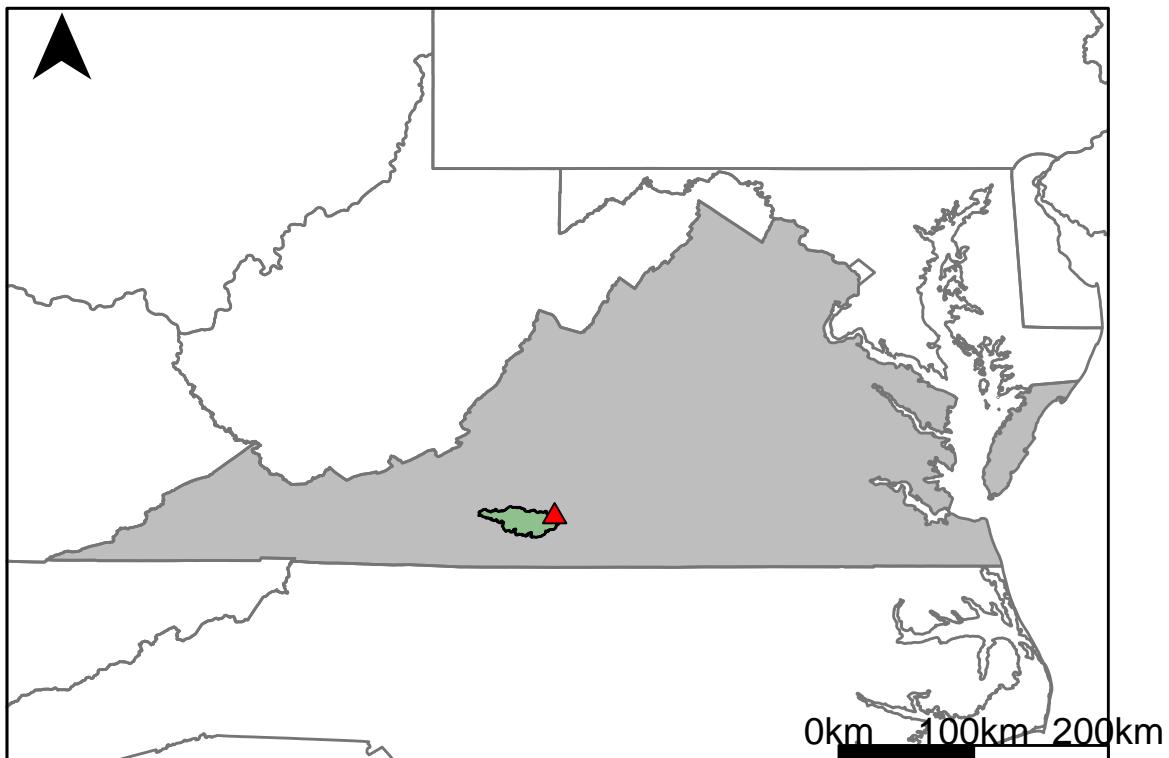


Fig. 9: Residuals Plot



## Appendix H.7: USGS Gage 02058400 vs. OR2\_8460\_8271



This river segment follows part of the flow of the Pigg River, a tributary of the Roanoke River. The gage is located in Pittsylvania County, VA (Lat 36°56'45", Long 79°31'30") approximately 26 miles northeast of Martinsville, VA. Drainage area is 351 sq. miles. This gage started taking data in 1963 and is still taking data. There is a small amount of diurnal fluctuation that has been recorded but the source is unknown. The average daily discharge error between the model and gage data for the 20 year timespan was 1.26%, with 42.9% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	152	71.6	52.9
Feb. Low Flow	189	99.3	47.5
Mar. Low Flow	201	178	11.4
Apr. Low Flow	215	227	-5.58
May Low Flow	282	322	-14.2
Jun. Low Flow	319	338	-5.96
Jul. Low Flow	304	225	26
Aug. Low Flow	237	174	26.6
Sep. Low Flow	185	153	17.3
Oct. Low Flow	167	106	36.5
Nov. Low Flow	136	96	29.4
Dec. Low Flow	122	79.6	34.8

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	396	391	1.26
Jan. Mean Flow	468	478	-2.14
Feb. Mean Flow	474	571	-20.5
Mar. Mean Flow	597	738	-23.6
Apr. Mean Flow	546	586	-7.33
May Mean Flow	388	383	1.29
Jun. Mean Flow	353	331	6.23
Jul. Mean Flow	286	217	24.1
Aug. Mean Flow	255	194	23.9
Sep. Mean Flow	413	319	22.8
Oct. Mean Flow	285	241	15.4
Nov. Mean Flow	341	299	12.3
Dec. Mean Flow	357	345	3.36

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	444	228	48.6
Feb. High Flow	822	923	-12.3
Mar. High Flow	879	791	10
Apr. High Flow	1190	1090	8.4
May High Flow	1710	887	48.1
Jun. High Flow	2190	2140	2.28
Jul. High Flow	1330	1410	-6.02
Aug. High Flow	755	673	10.9
Sep. High Flow	502	403	19.7
Oct. High Flow	620	275	55.6
Nov. High Flow	450	210	53.3
Dec. High Flow	679	239	64.8

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	17.5	12.8	26.9
Med. 1 Day Min	105	49.7	52.7
Min. 3 Day Min	17.9	13.1	26.8
Med. 3 Day Min	115	51.4	55.3
Min. 7 Day Min	19.3	13.9	28
Med. 7 Day Min	124	54.7	55.9
Min. 30 Day Min	32.6	20.6	36.8
Med. 30 Day Min	142	70.6	50.3
Min. 90 Day Min	56.2	42.7	24
Med. 90 Day Min	205	113	44.9
7Q10	51.5	22.6	56.1
Year of 90-Day Min. Flow	2002	1999	100
Drought Year Mean	133	391	-194
Mean Baseflow	235	232	1.28

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	34900	13000	62.8
Med. 1 Day Max	6360	5190	18.4
Max. 3 Day Max	15100	8680	42.5
Med. 3 Day Max	3670	3920	-6.81
Max. 7 Day Max	6930	4790	30.9
Med. 7 Day Max	1870	2070	-10.7
Max. 30 Day Max	2300	2320	-0.87
Med. 30 Day Max	887	964	-8.68
Max. 90 Day Max	1340	1420	-5.97
Med. 90 Day Max	561	690	-23

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	56.4	27.2	51.8
5% Non-Exceedance	103	49.7	51.7
50% Non-Exceedance	268	234	12.7
95% Non-Exceedance	892	1090	-22.2
99% Non-Exceedance	2940	3210	-9.18
Sept. 10% Non-Exceedance	50.1	50	0.2

**Fig. 1: Hydrograph**

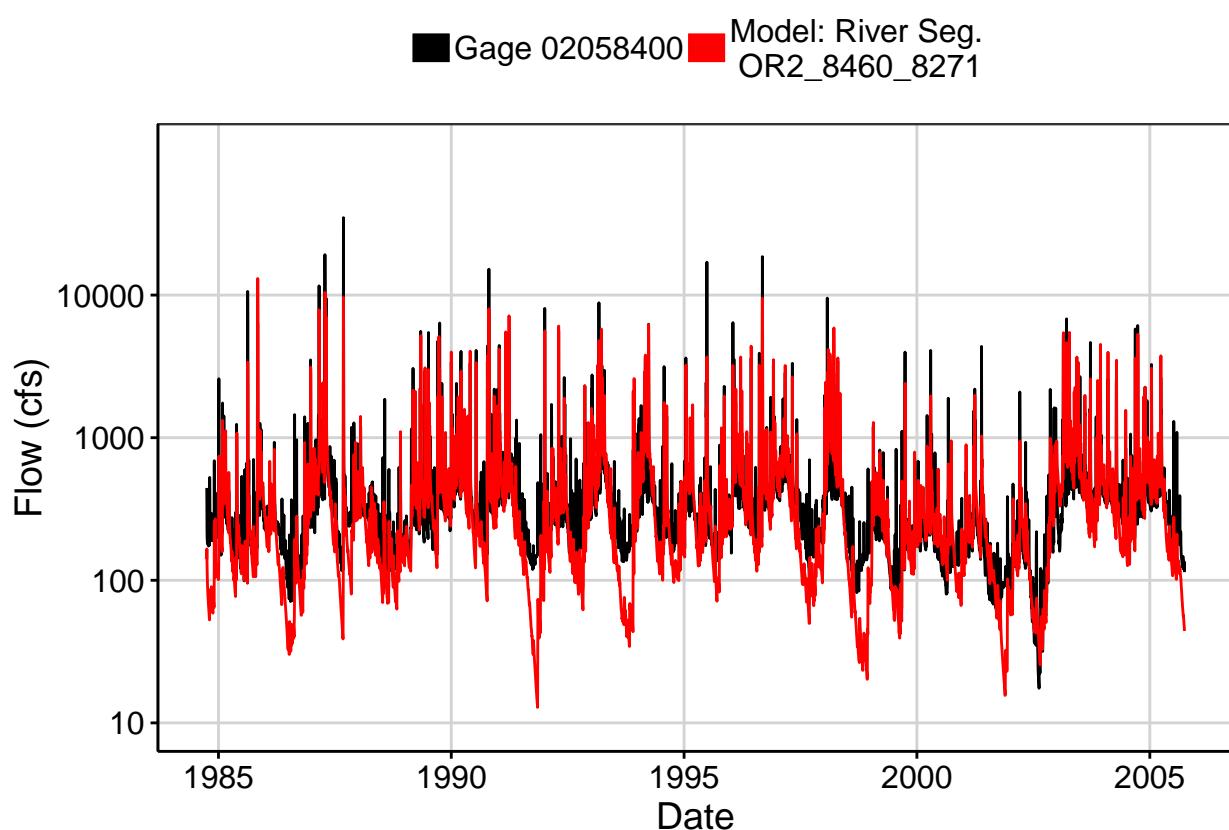


Fig. 2: Zoomed Hydrograph

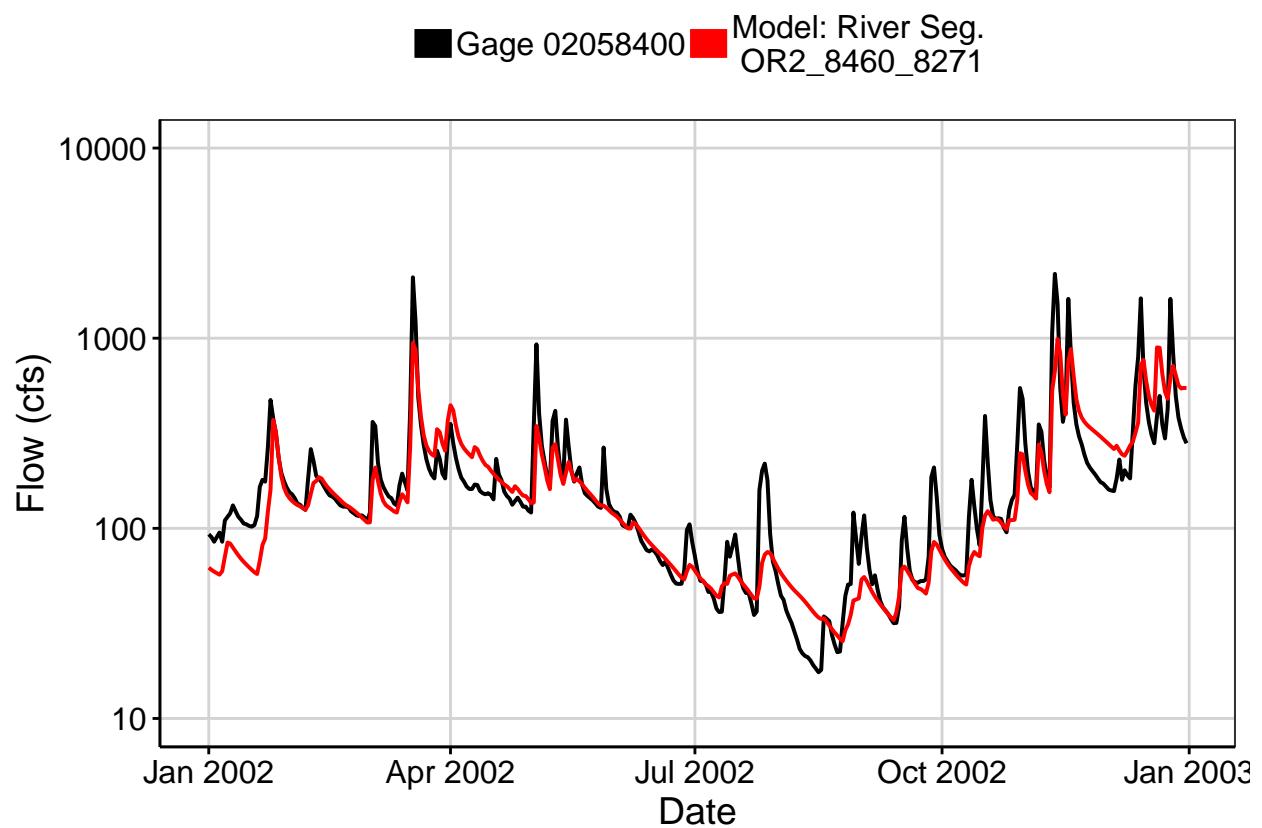


Fig. 3: Flow Exceedance

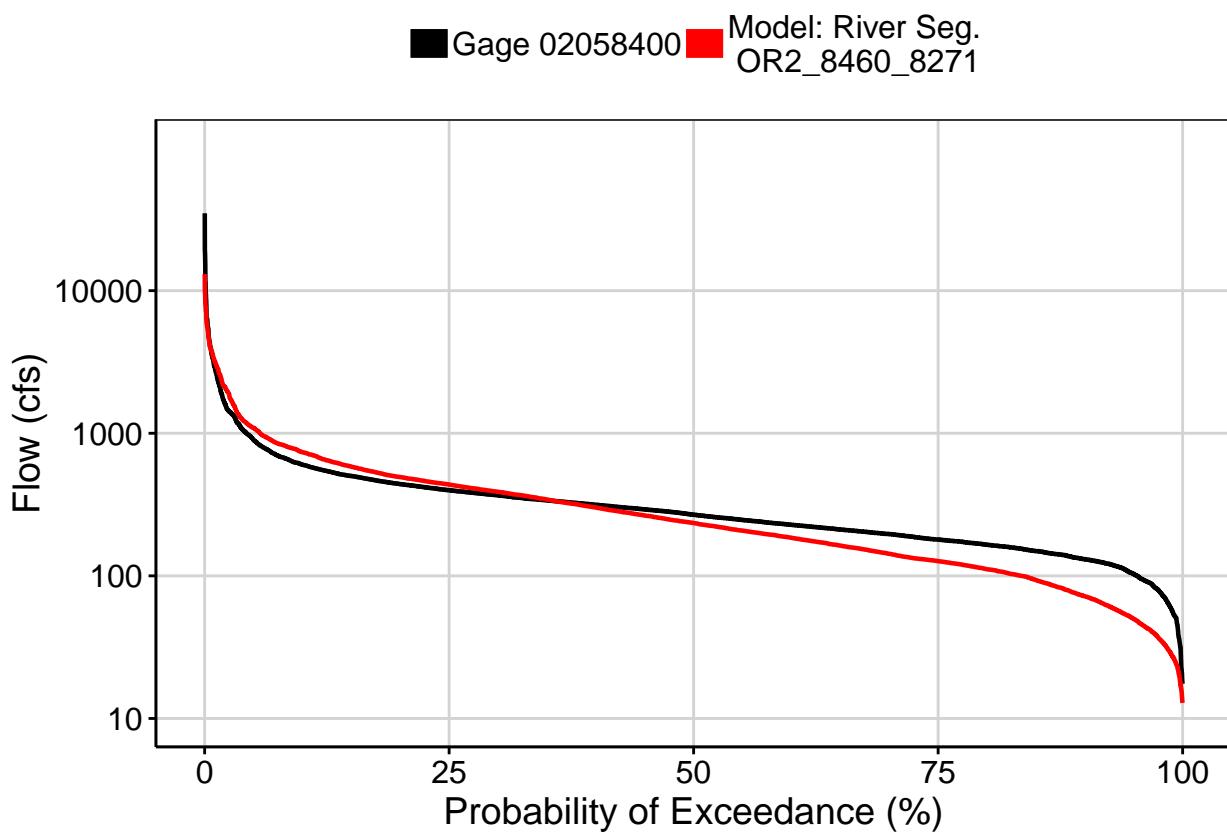


Fig. 4: Baseflow

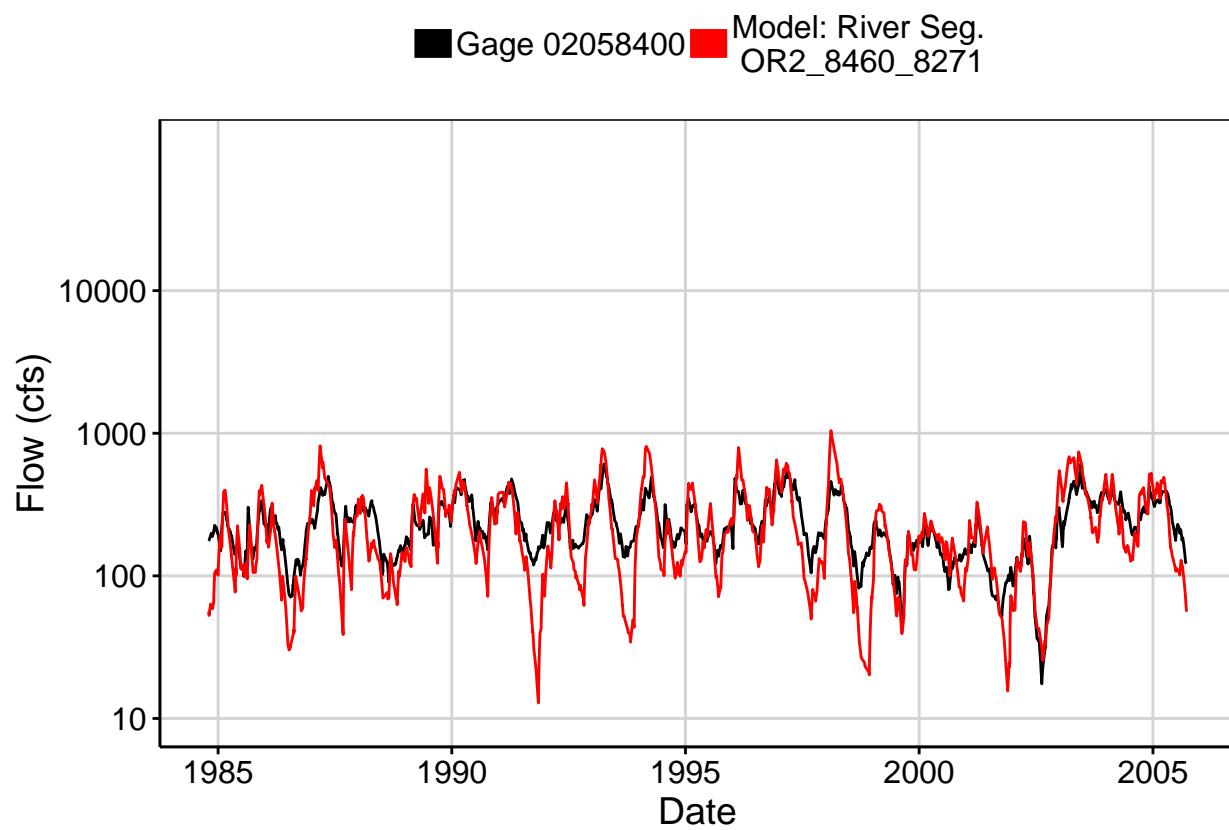


Fig. 5: Combined Baseflow

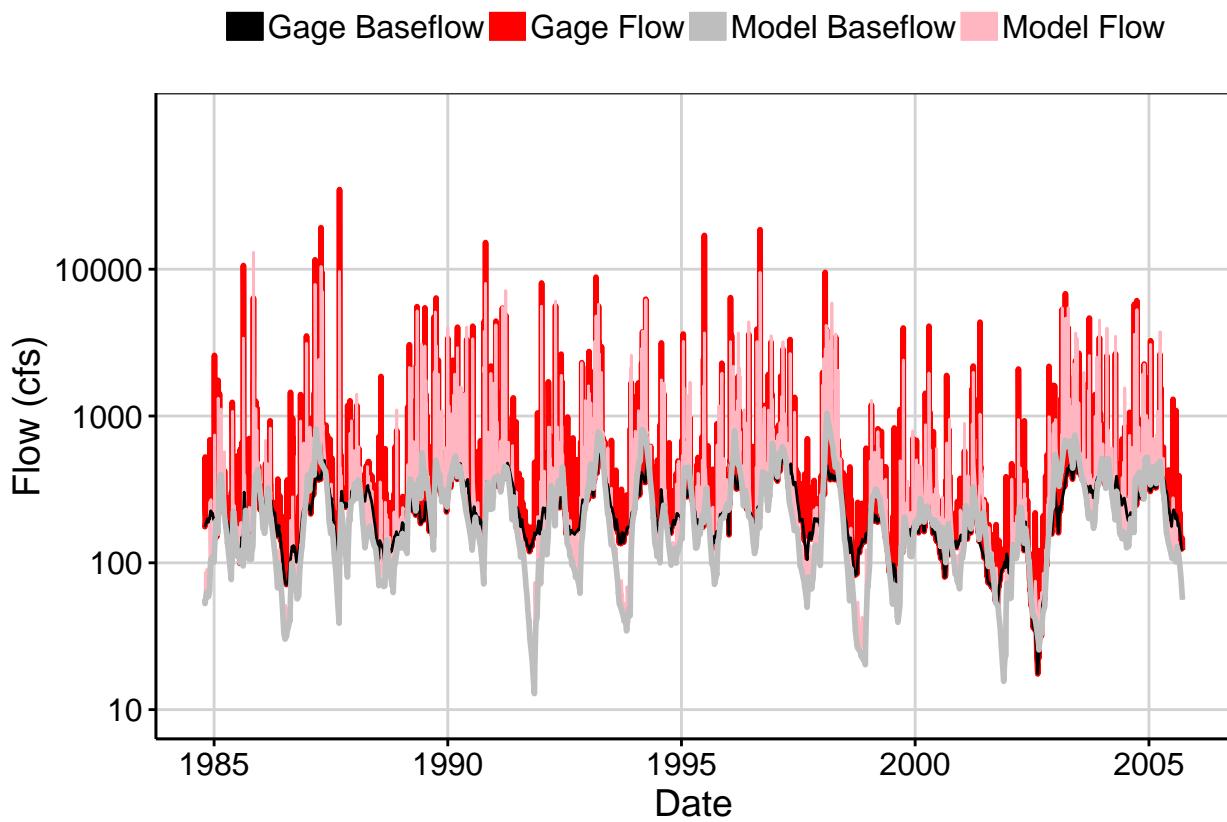


Fig. 6: Largest Error Segment

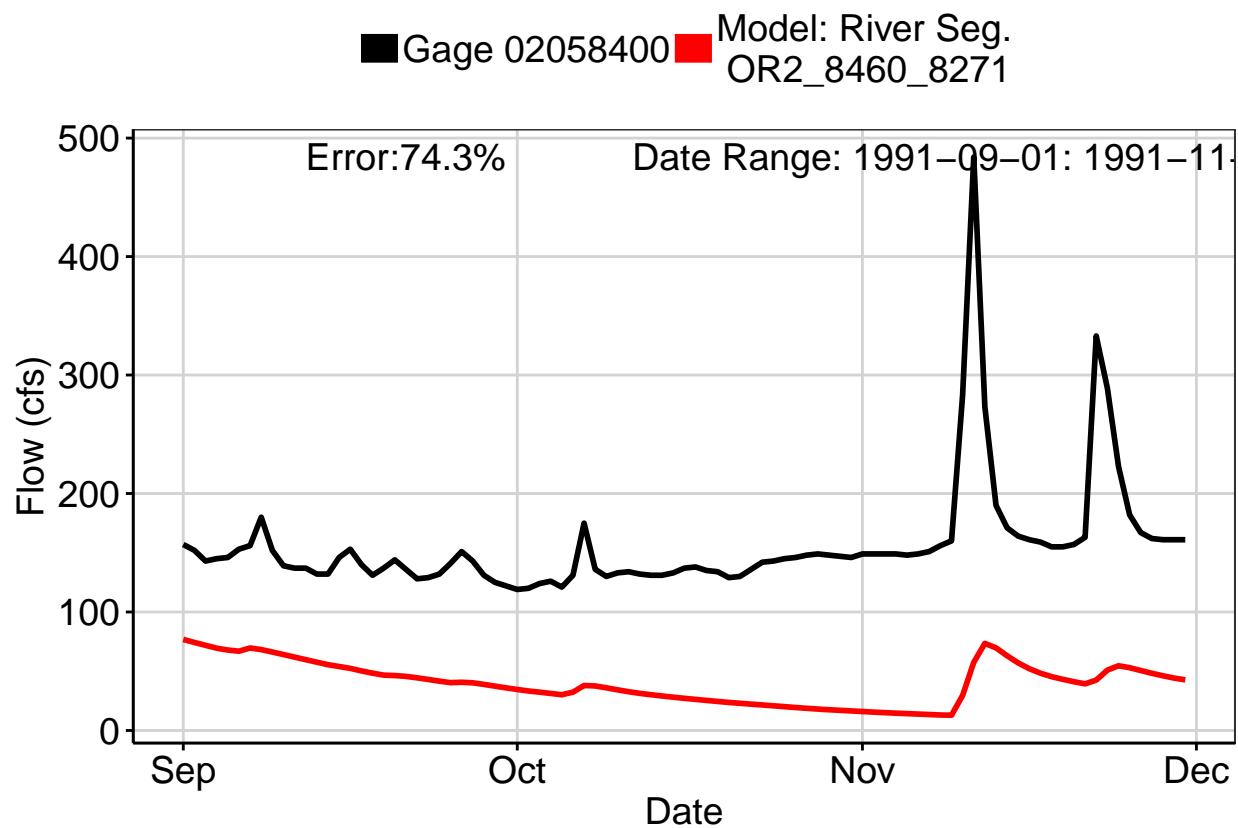


Fig. 7: Second Largest Error Segment

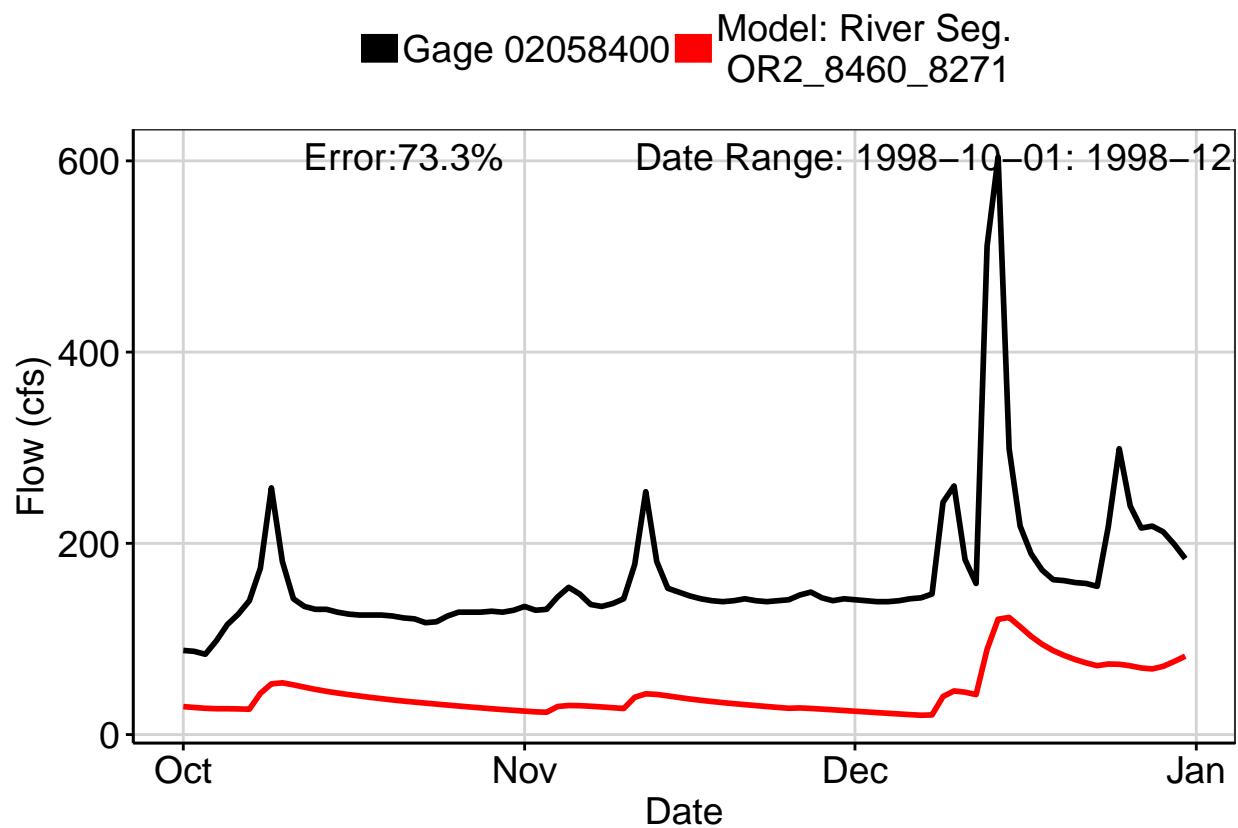


Fig. 8: Third Largest Error Segment

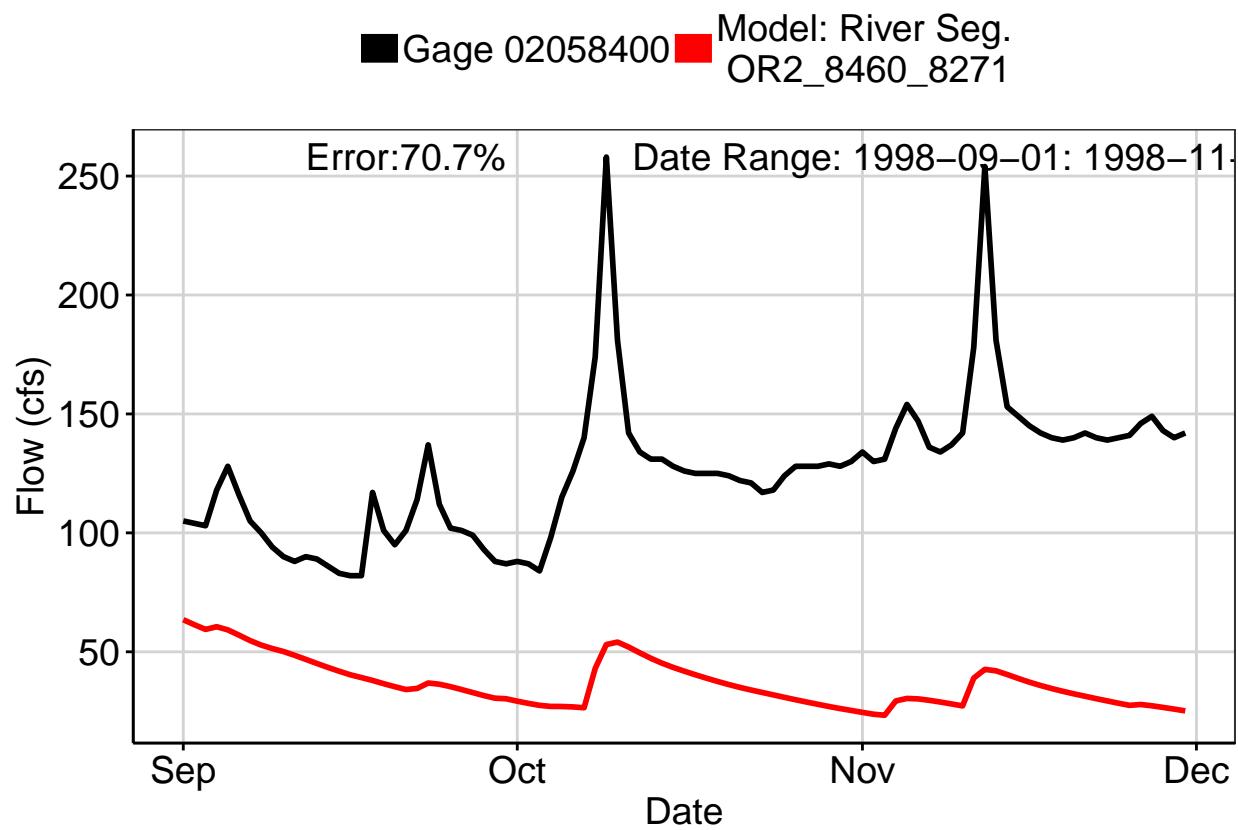
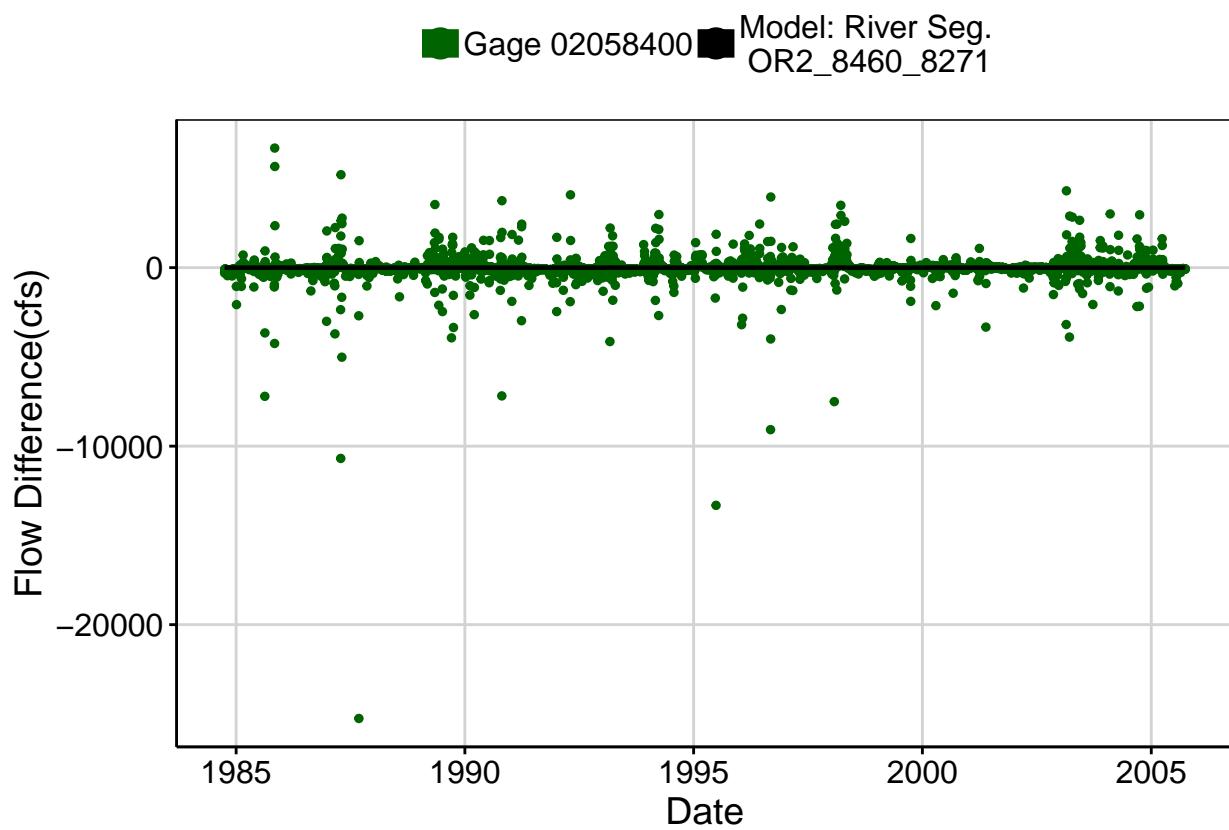
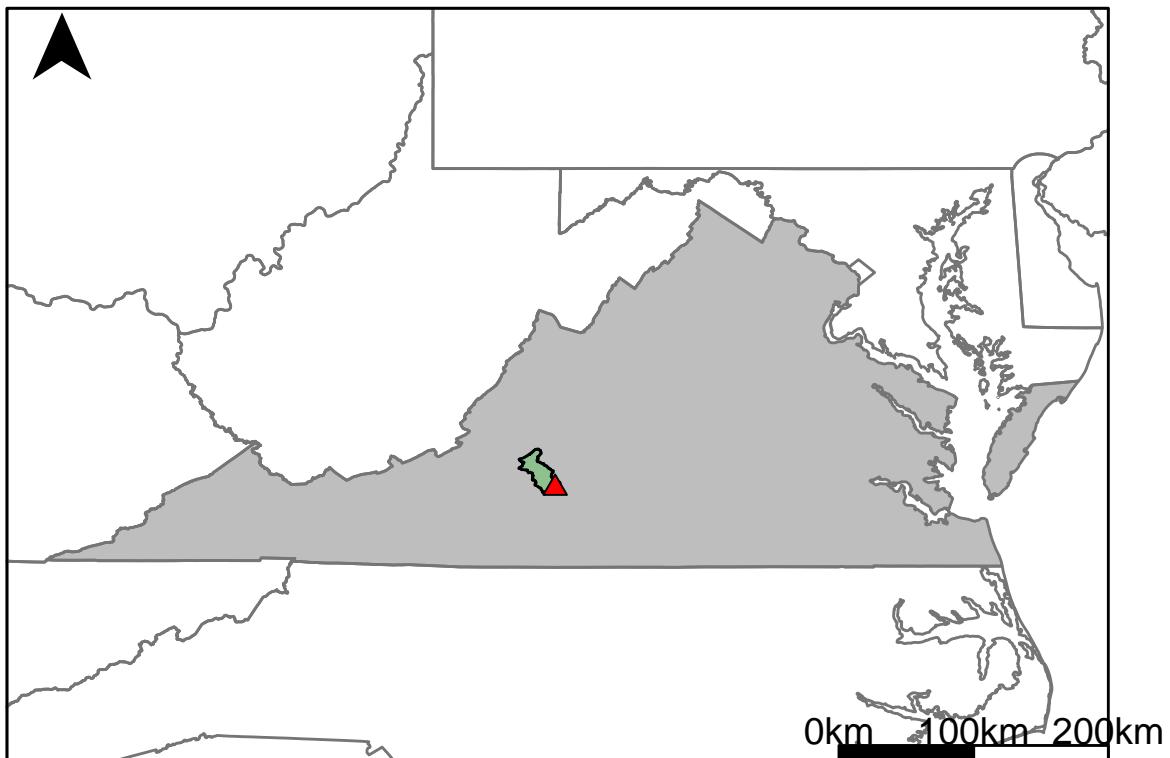


Fig. 9: Residuals Plot



## Appendix H.8: USGS Gage 02059500 vs. OR2\_7650\_8070



This river segment follows part of the flow of the Goose Creek, a tributary of the Roanoke River. The gage is located in Bedford County, VA (Lat 3710'23", Long 7931'14") approximately 27 miles southwest of Lynchburg, VA. Drainage area is 188 sq. miles. This gage started taking data in 1930 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. Prior to 1954 there was a mill upstream but it has since been decommissioned. The average daily discharge error between the model and gage data for the 20 year timespan was -1.04%, with 46.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	49	34.9	28.8
Feb. Low Flow	67	40.9	39
Mar. Low Flow	91	65.7	27.8
Apr. Low Flow	76	113	-48.7
May Low Flow	118	139	-17.8
Jun. Low Flow	132	142	-7.58
Jul. Low Flow	126	105	16.7
Aug. Low Flow	111	80.9	27.1
Sep. Low Flow	86	67.8	21.2
Oct. Low Flow	58	43.9	24.3
Nov. Low Flow	48	38.9	19
Dec. Low Flow	47	32.3	31.3

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	192	194	-1.04
Jan. Mean Flow	229	247	-7.86
Feb. Mean Flow	253	288	-13.8
Mar. Mean Flow	290	331	-14.1
Apr. Mean Flow	278	290	-4.32
May Mean Flow	210	203	3.33
Jun. Mean Flow	193	178	7.77
Jul. Mean Flow	122	106	13.1
Aug. Mean Flow	104	91	12.5
Sep. Mean Flow	180	154	14.4
Oct. Mean Flow	119	130	-9.24
Nov. Mean Flow	150	151	-0.67
Dec. Mean Flow	176	173	1.7

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	127	135	-6.3
Feb. High Flow	306	470	-53.6
Mar. High Flow	577	403	30.2
Apr. High Flow	733	524	28.5
May High Flow	576	496	13.9
Jun. High Flow	899	870	3.23
Jul. High Flow	607	580	4.45
Aug. High Flow	303	323	-6.6
Sep. High Flow	295	200	32.2
Oct. High Flow	280	149	46.8
Nov. High Flow	229	146	36.2
Dec. High Flow	211	123	41.7

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	6.04	3.12	48.3
Med. 1 Day Min	38	20.5	46.1
Min. 3 Day Min	6.42	3.23	49.7
Med. 3 Day Min	38.7	20.8	46.3
Min. 7 Day Min	7.18	3.51	51.1
Med. 7 Day Min	44.1	22.2	49.7
Min. 30 Day Min	10.7	6.33	40.8
Med. 30 Day Min	50	34.8	30.4
Min. 90 Day Min	17.8	15.7	11.8
Med. 90 Day Min	74.1	57.3	22.7
7Q10	15.7	8.41	46.4
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	39.3	194	-394
Mean Baseflow	100	111	-11

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	26000	10200	60.8
Med. 1 Day Max	2710	2810	-3.69
Max. 3 Day Max	10700	4990	53.4
Med. 3 Day Max	1580	1950	-23.4
Max. 7 Day Max	4810	2610	45.7
Med. 7 Day Max	972	1010	-3.91
Max. 30 Day Max	1340	1250	6.72
Med. 30 Day Max	475	510	-7.37
Max. 90 Day Max	750	793	-5.73
Med. 90 Day Max	313	346	-10.5

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	15	10.1	32.7
5% Non-Exceedance	35	20.5	41.4
50% Non-Exceedance	113	115	-1.77
95% Non-Exceedance	510	529	-3.73
99% Non-Exceedance	1550	1480	4.52
Sept. 10% Non-Exceedance	20.6	20.6	0

**Fig. 1: Hydrograph**

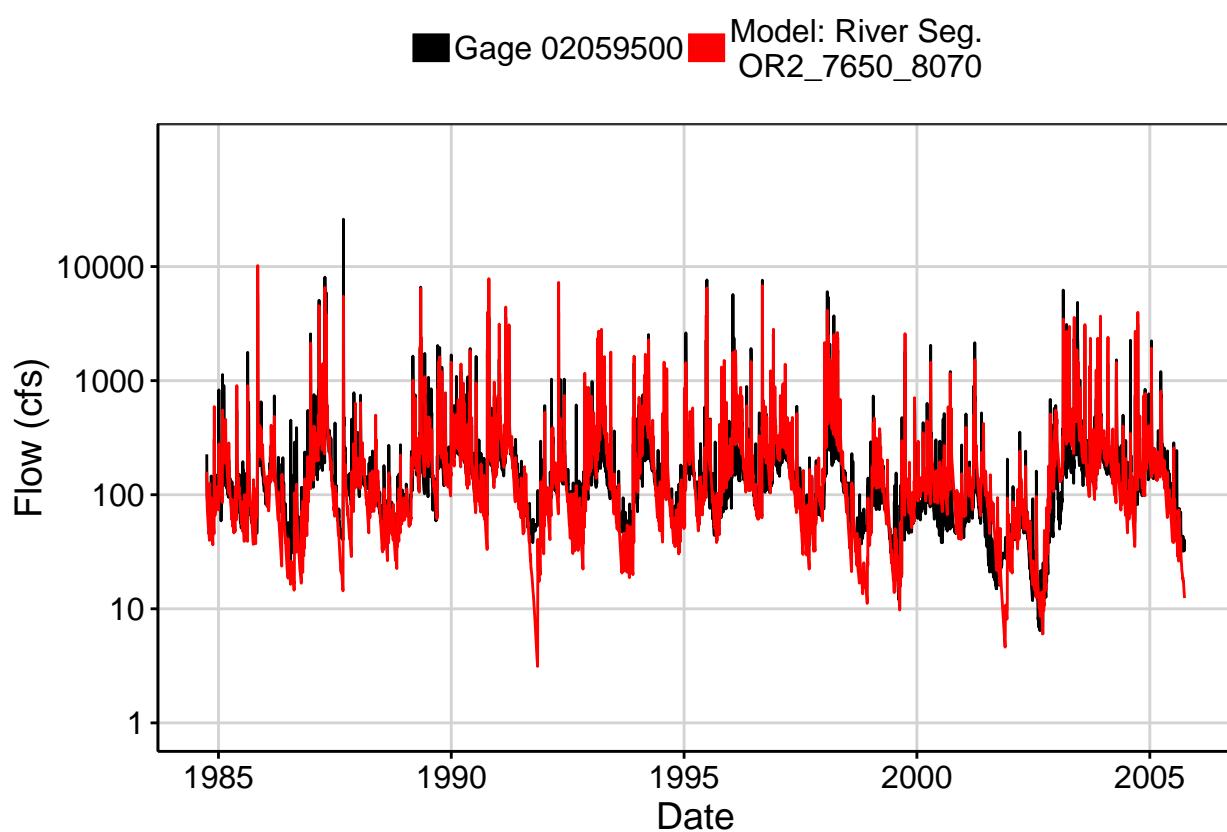


Fig. 2: Zoomed Hydrograph

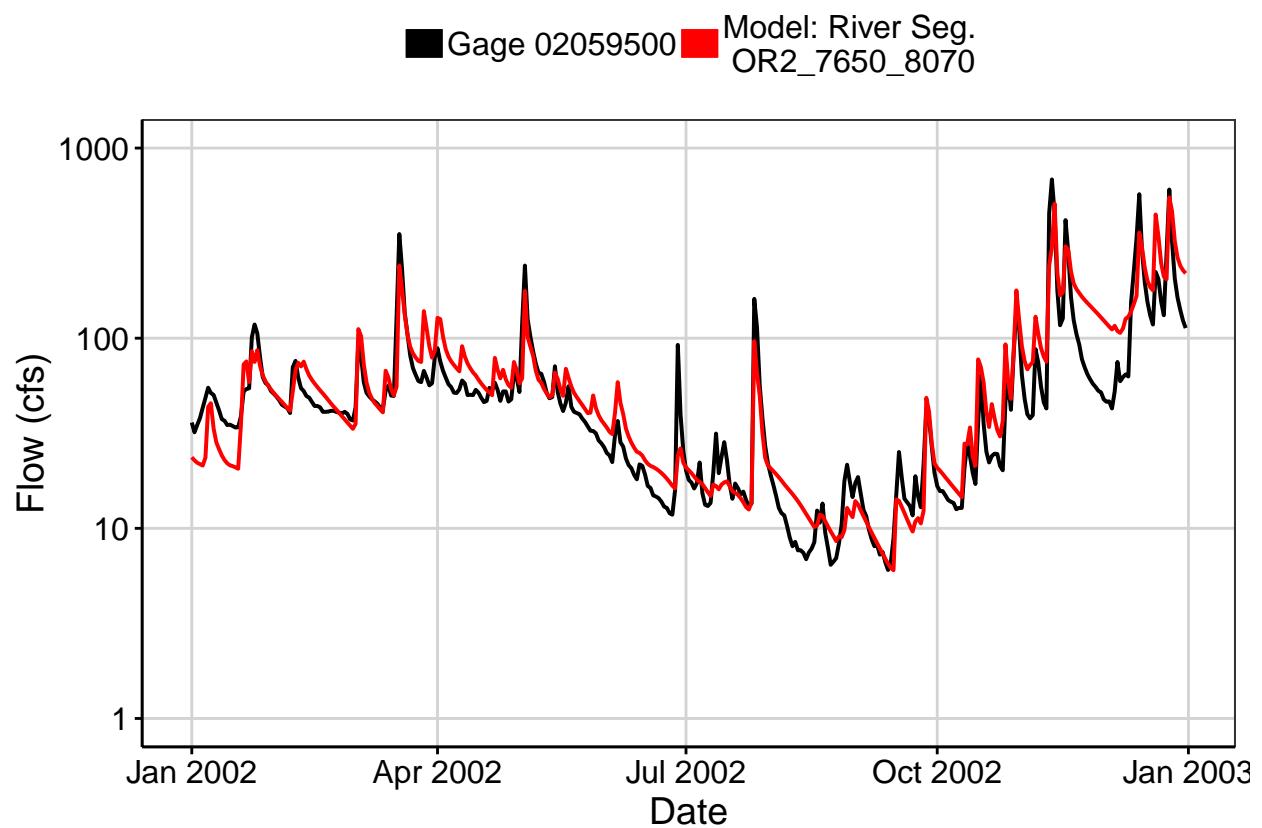


Fig. 3: Flow Exceedance

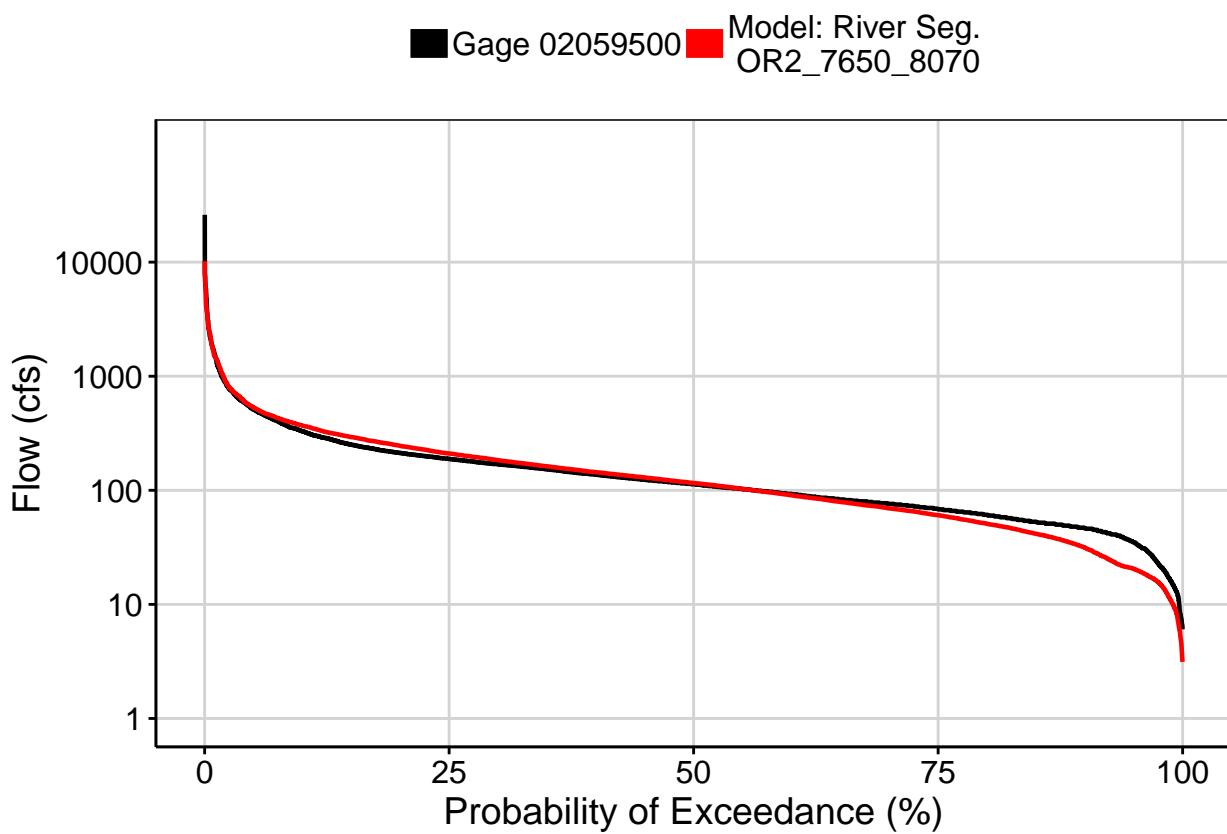
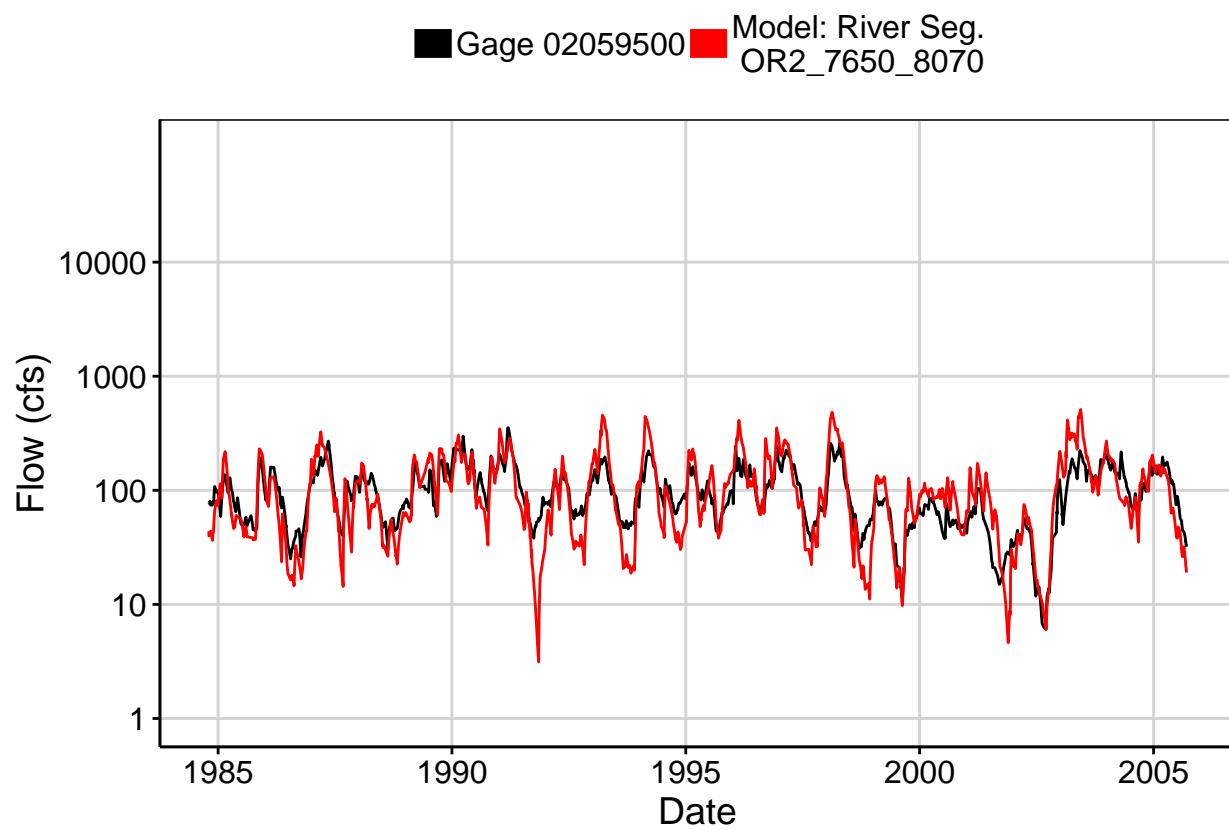


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

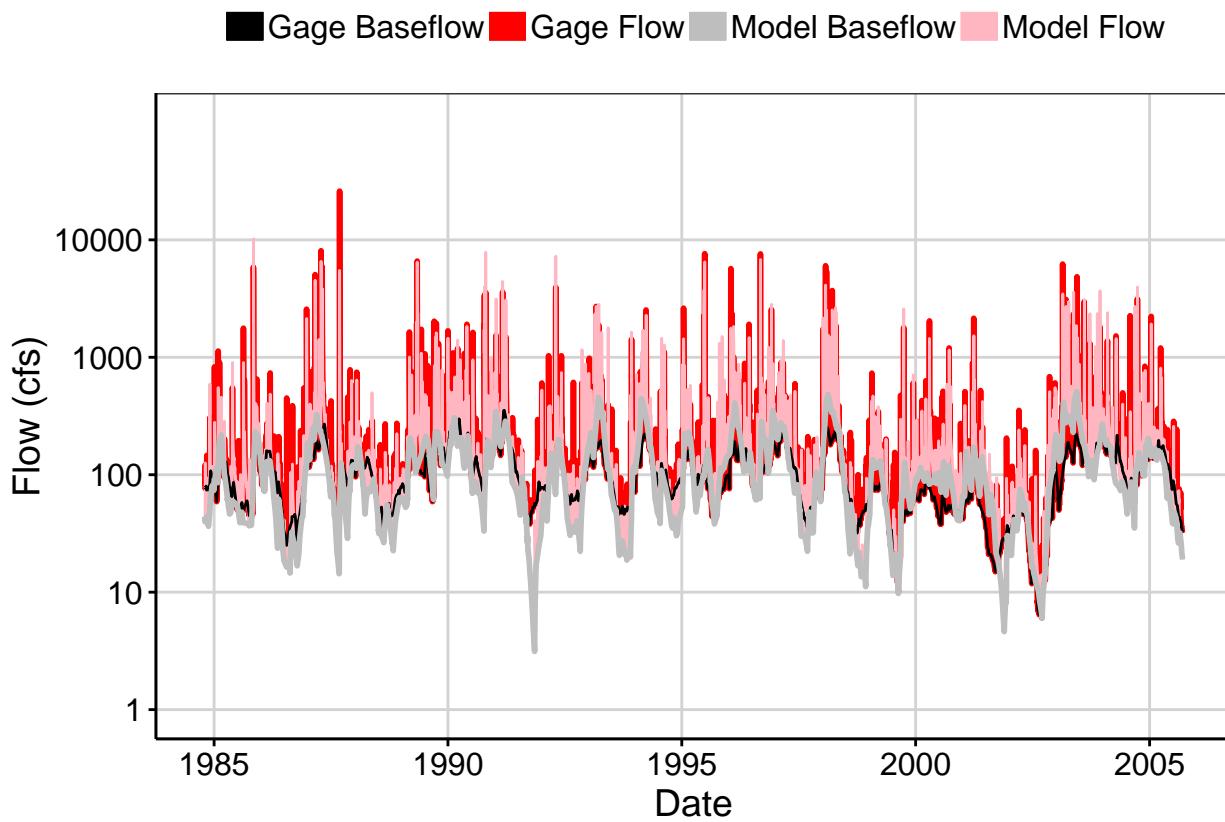


Fig. 6: Largest Error Segment

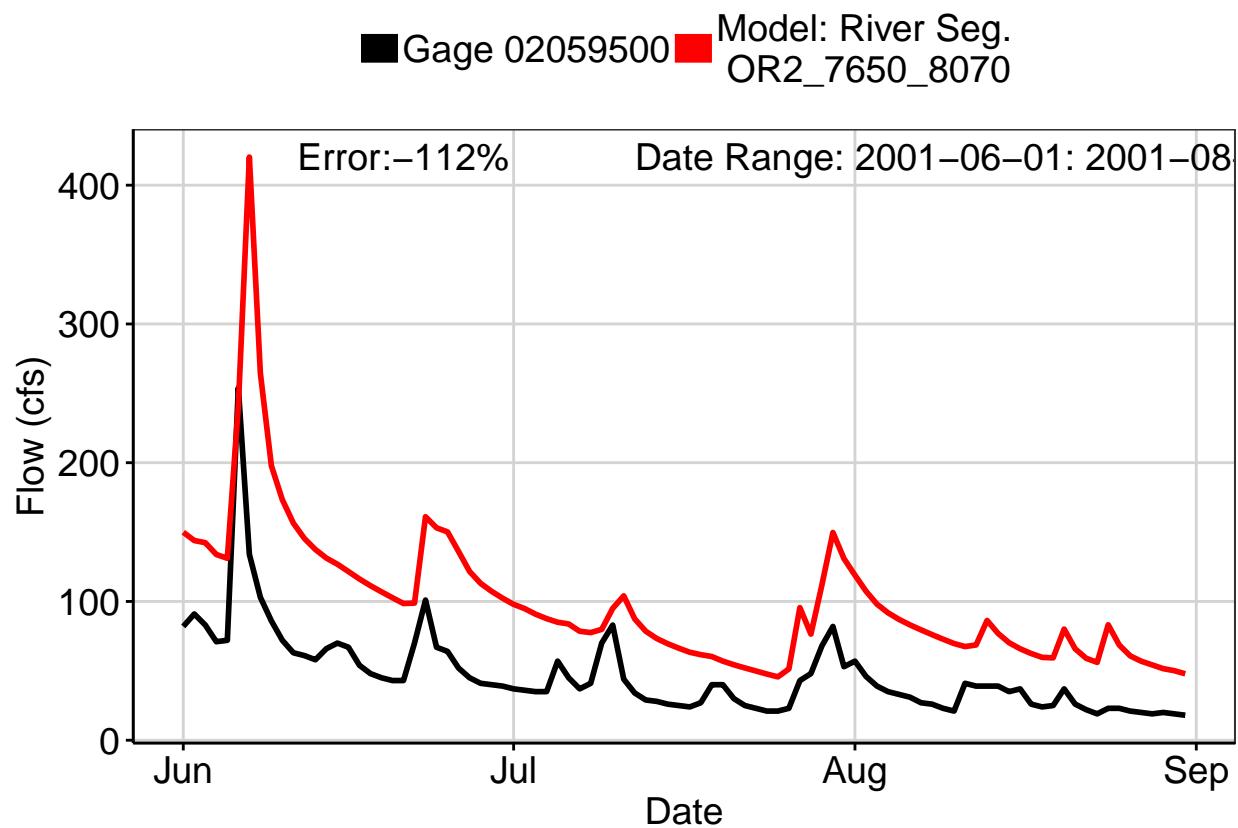


Fig. 7: Second Largest Error Segment

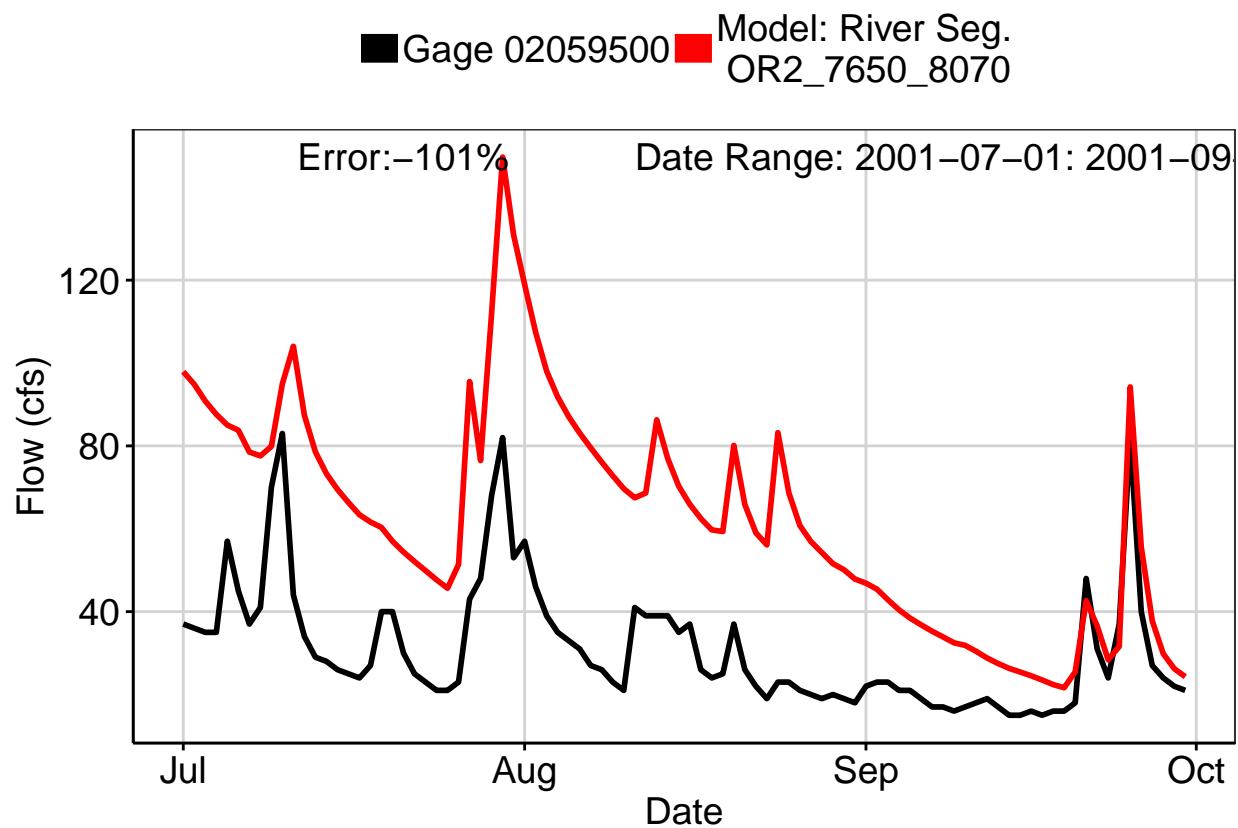


Fig. 8: Third Largest Error Segment

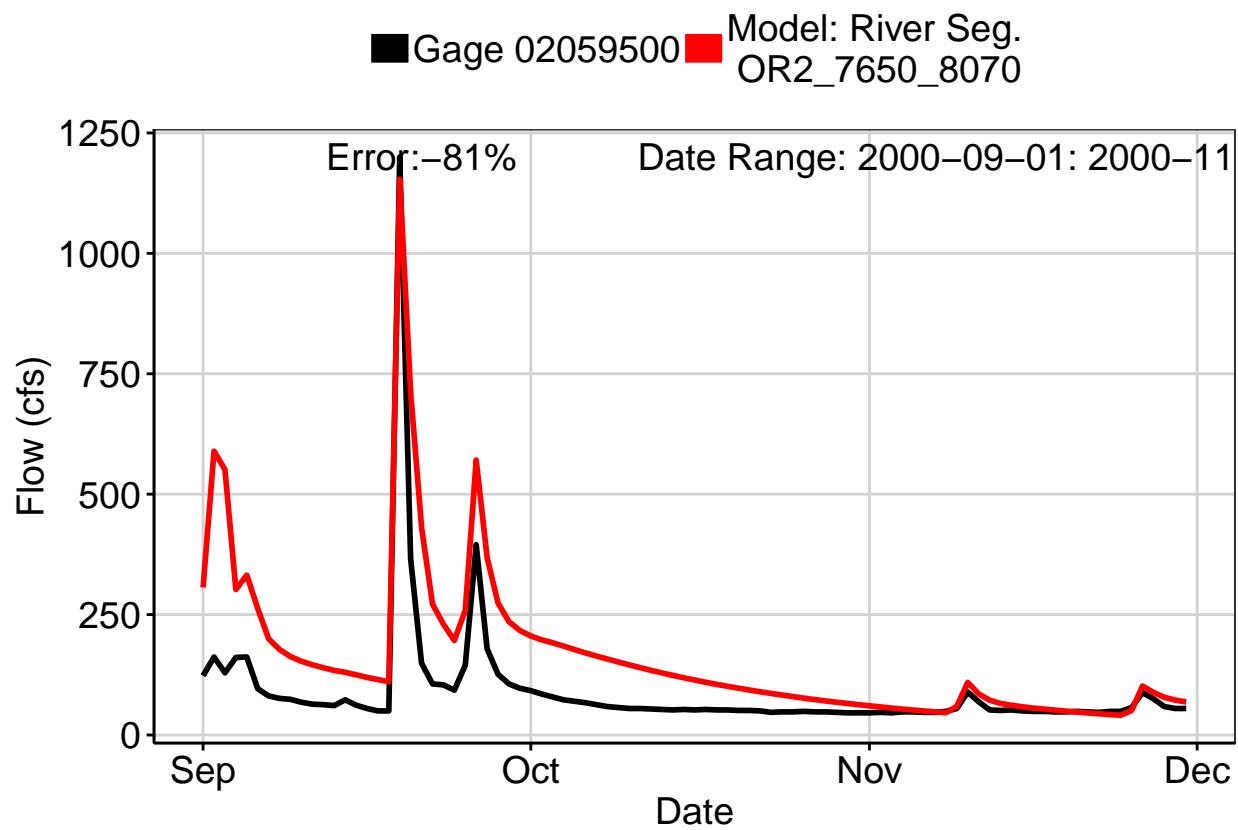
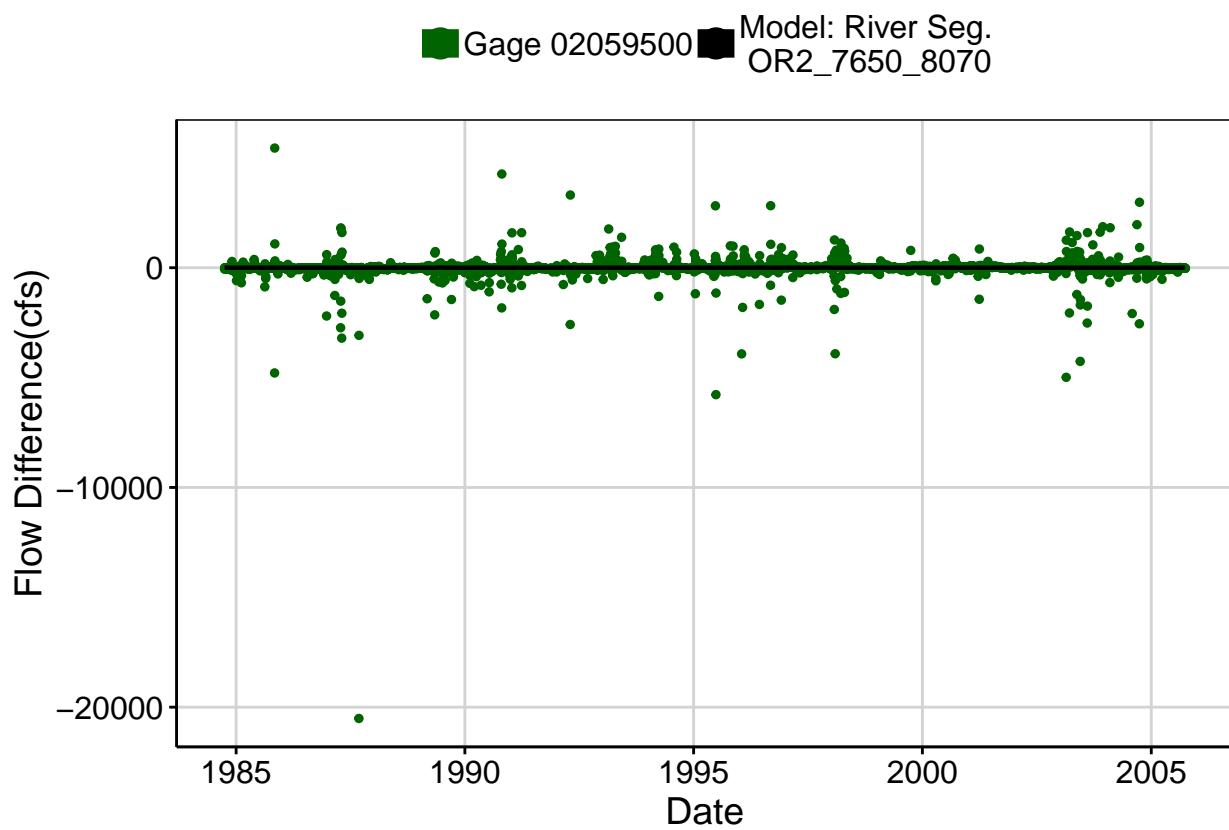
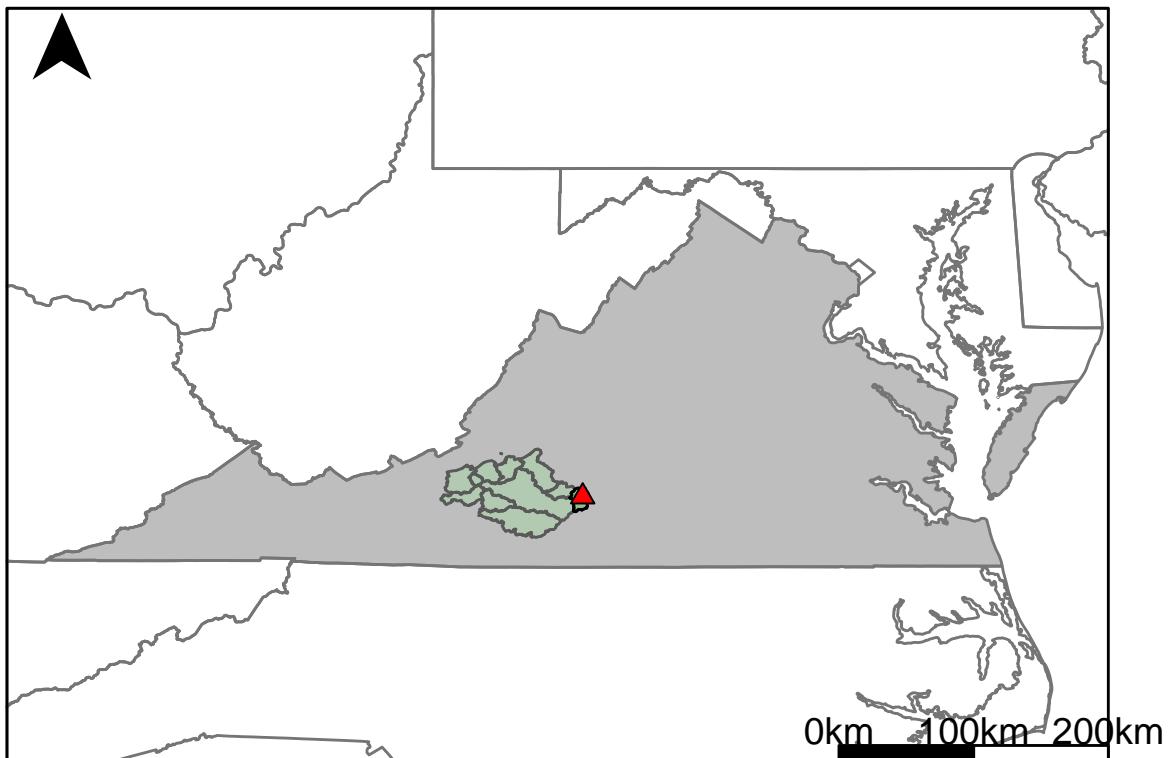


Fig. 9: Residuals Plot



## Appendix H.9: USGS Gage 02060500 vs. OR4\_8120\_7890



This river segment follows part of the flow of the Roanoke River. The gage is located in Pittsylvania County, VA (Lat 37°06'16", Long 79°17'44") approximately 23 miles south of Lynchburg, VA. Drainage area is 1782 sq. miles. This gage started taking data in 1930 and is still taking data. This area is regulated by the Smith Mount and Leesville power plants. The average daily discharge error between the model and gage data for the 20 year timespan was -7.26%, with 46.7% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	719	456	36.6
Feb. Low Flow	796	511	35.8
Mar. Low Flow	786	912	-16
Apr. Low Flow	826	1100	-33.2
May Low Flow	921	1610	-74.8
Jun. Low Flow	852	1520	-78.4
Jul. Low Flow	889	973	-9.45
Aug. Low Flow	1020	786	22.9
Sep. Low Flow	820	746	9.02
Oct. Low Flow	746	528	29.2
Nov. Low Flow	782	496	36.6
Dec. Low Flow	759	473	37.7

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	1790	1920	-7.26
Jan. Mean Flow	2010	2410	-19.9
Feb. Mean Flow	2350	2880	-22.6
Mar. Mean Flow	2730	3470	-27.1
Apr. Mean Flow	2670	2900	-8.61
May Mean Flow	2000	1990	0.5
Jun. Mean Flow	1670	1690	-1.2
Jul. Mean Flow	1260	1060	15.9
Aug. Mean Flow	1190	921	22.6
Sep. Mean Flow	1560	1520	2.56
Oct. Mean Flow	1210	1170	3.31
Nov. Mean Flow	1400	1470	-5
Dec. Mean Flow	1490	1680	-12.8

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	1060	708	33.2
Feb. High Flow	1550	2930	-89
Mar. High Flow	2480	3090	-24.6
Apr. High Flow	5660	5610	0.88
May High Flow	5590	4610	17.5
Jun. High Flow	8290	9680	-16.8
Jul. High Flow	5700	7210	-26.5
Aug. High Flow	3580	3980	-11.2
Sep. High Flow	2470	2130	13.8
Oct. High Flow	2570	1480	42.4
Nov. High Flow	2210	925	58.1
Dec. High Flow	1230	769	37.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	142	84.5	40.5
Med. 1 Day Min	513	277	46
Min. 3 Day Min	186	85.1	54.2
Med. 3 Day Min	570	287	49.6
Min. 7 Day Min	411	86.3	79
Med. 7 Day Min	693	312	55
Min. 30 Day Min	420	99	76.4
Med. 30 Day Min	751	364	51.5
Min. 90 Day Min	449	144	67.9
Med. 90 Day Min	863	567	34.3
7Q10	482	107	77.8
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	583	1920	-229
Mean Baseflow	930	1110	-19.4

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	46700	82600	-76.9
Med. 1 Day Max	16800	26000	-54.8
Max. 3 Day Max	32300	40800	-26.3
Med. 3 Day Max	15300	19500	-27.5
Max. 7 Day Max	21400	22200	-3.74
Med. 7 Day Max	9860	11200	-13.6
Max. 30 Day Max	11100	11400	-2.7
Med. 30 Day Max	4180	4840	-15.8
Max. 90 Day Max	6320	7140	-13
Med. 90 Day Max	3020	3480	-15.2

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	246	115	53.3
5% Non-Exceedance	464	284	38.8
50% Non-Exceedance	1030	1070	-3.88
95% Non-Exceedance	5260	5590	-6.27
99% Non-Exceedance	13000	14300	-10
Sept. 10% Non-Exceedance	302	306	-1.32

**Fig. 1: Hydrograph**

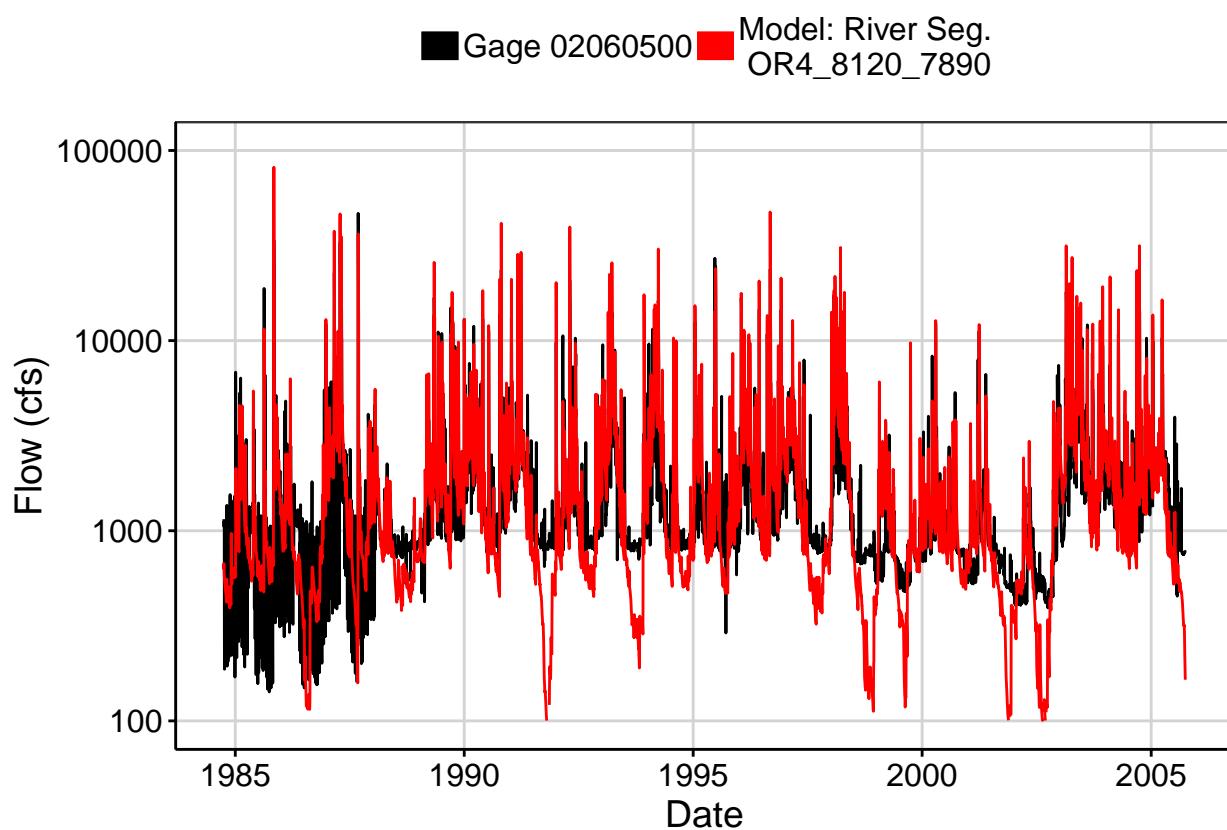


Fig. 2: Zoomed Hydrograph

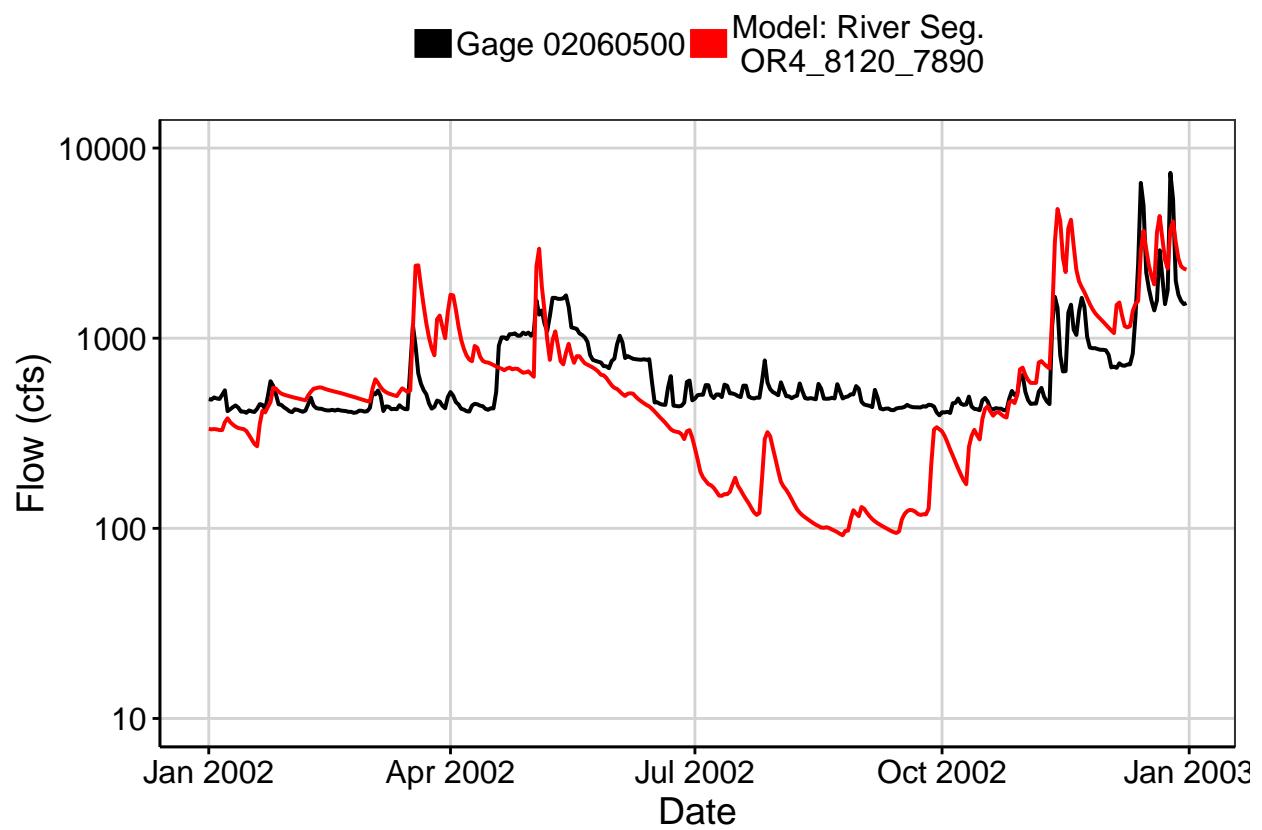


Fig. 3: Flow Exceedance

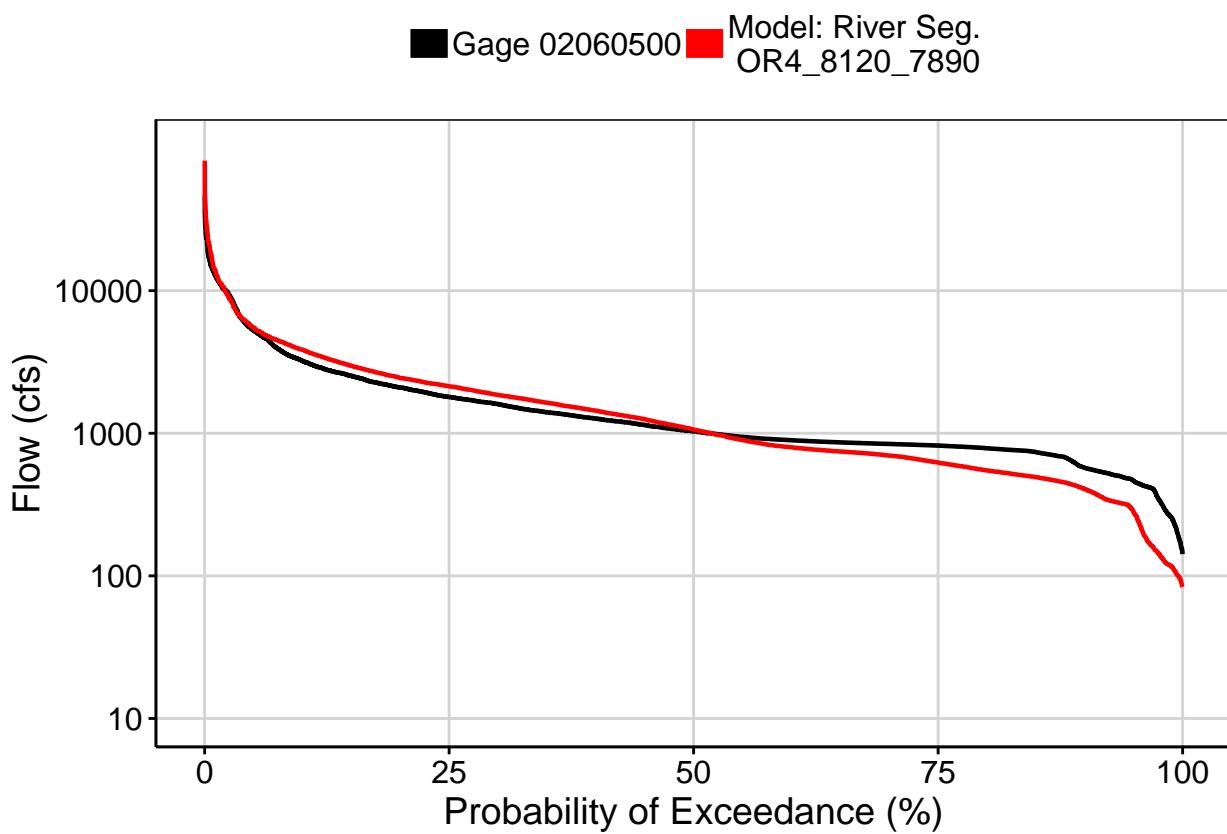
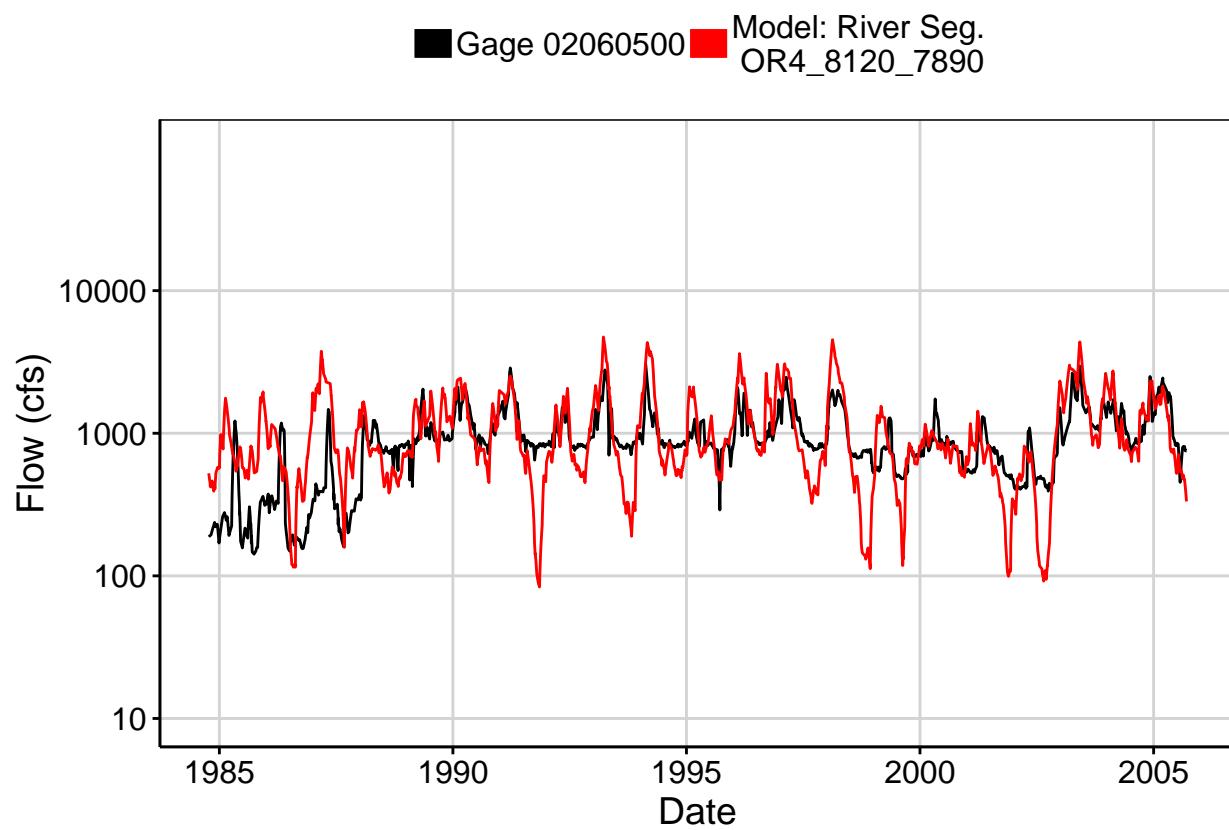


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

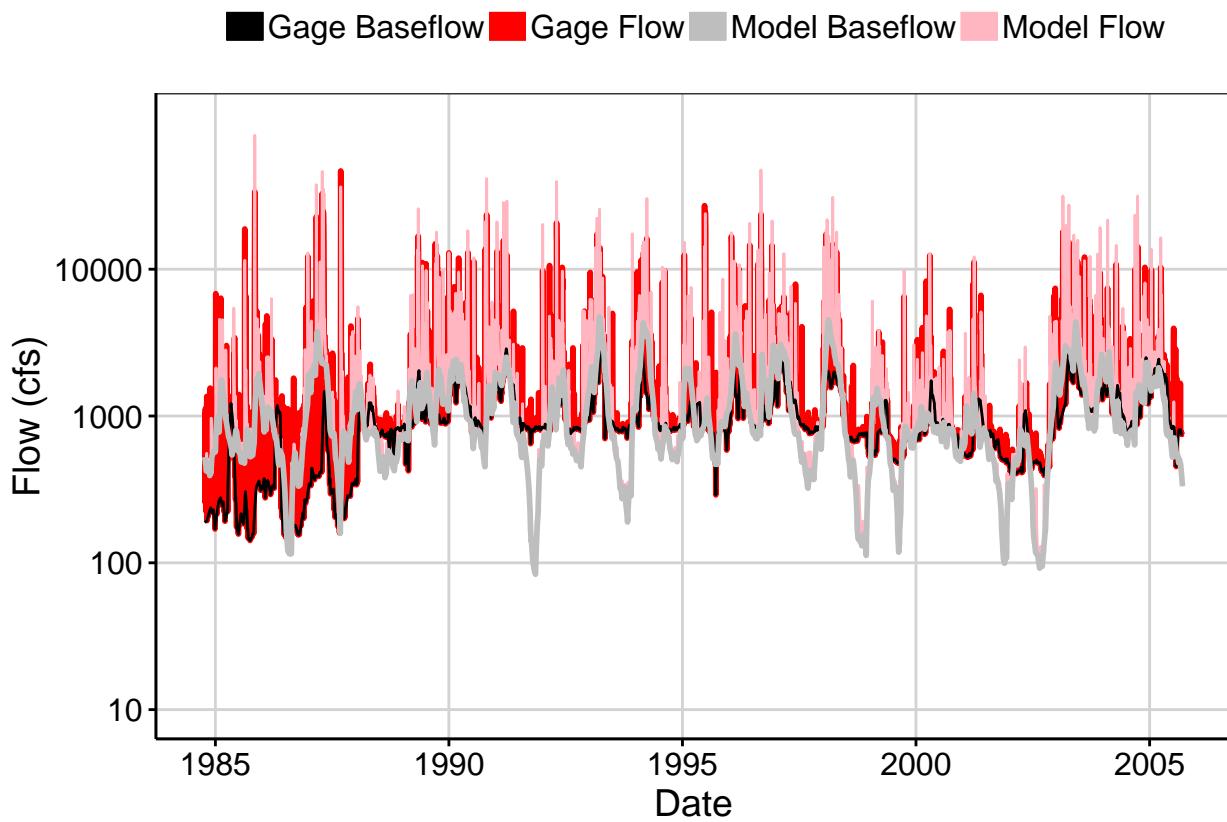


Fig. 6: Largest Error Segment

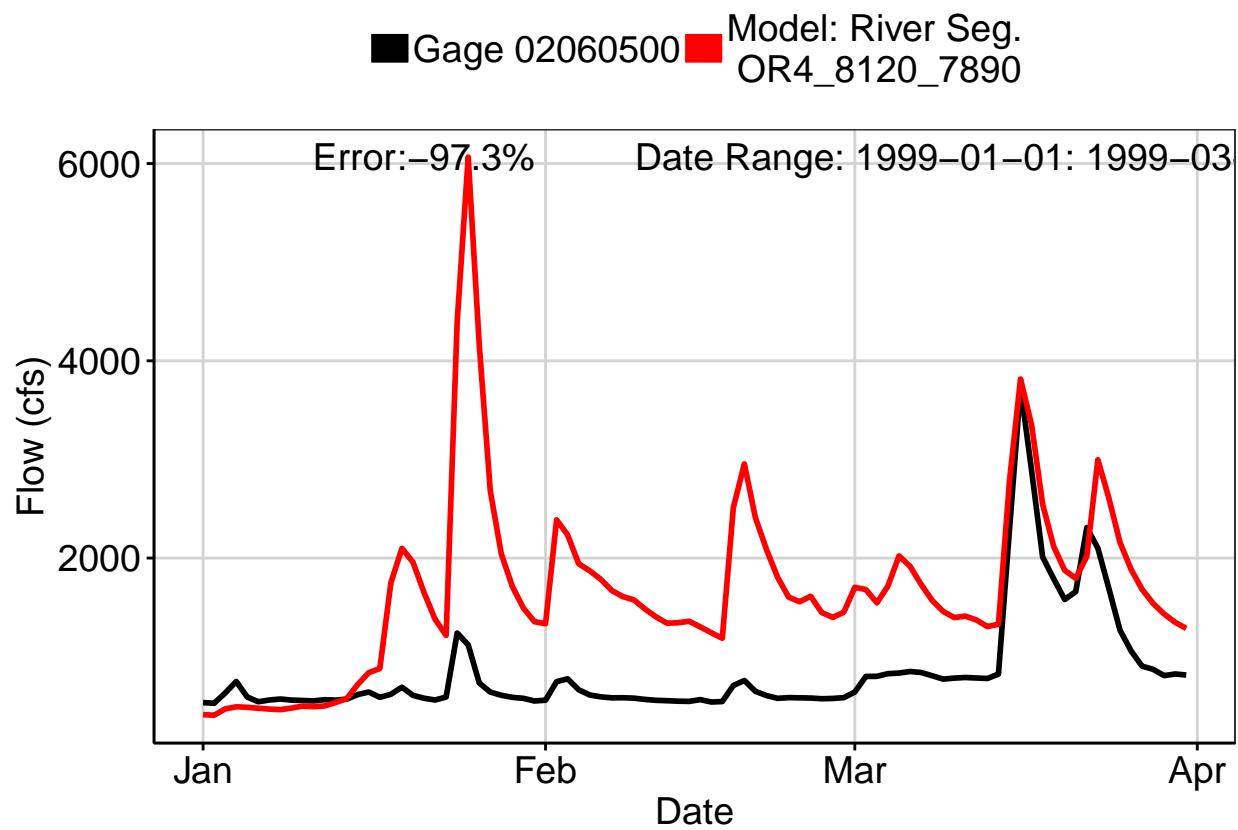


Fig. 7: Second Largest Error Segment

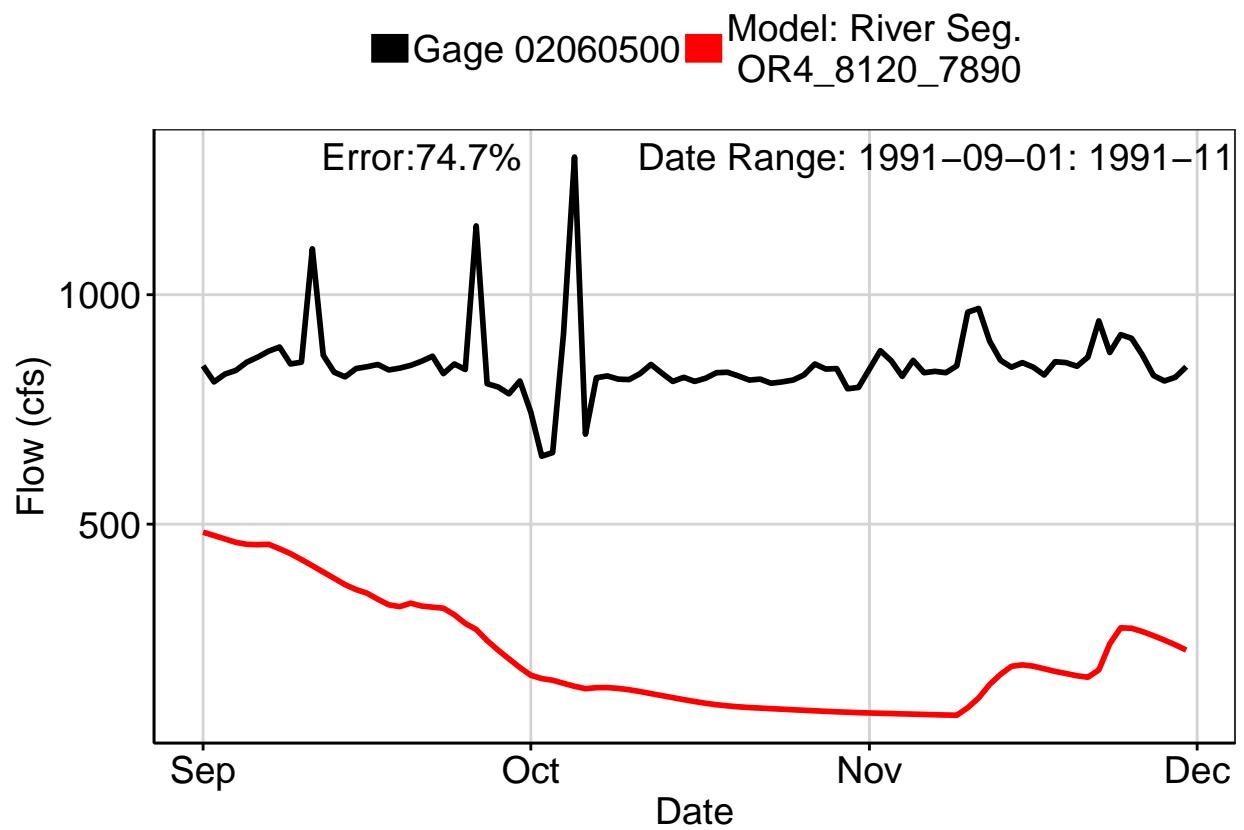


Fig. 8: Third Largest Error Segment

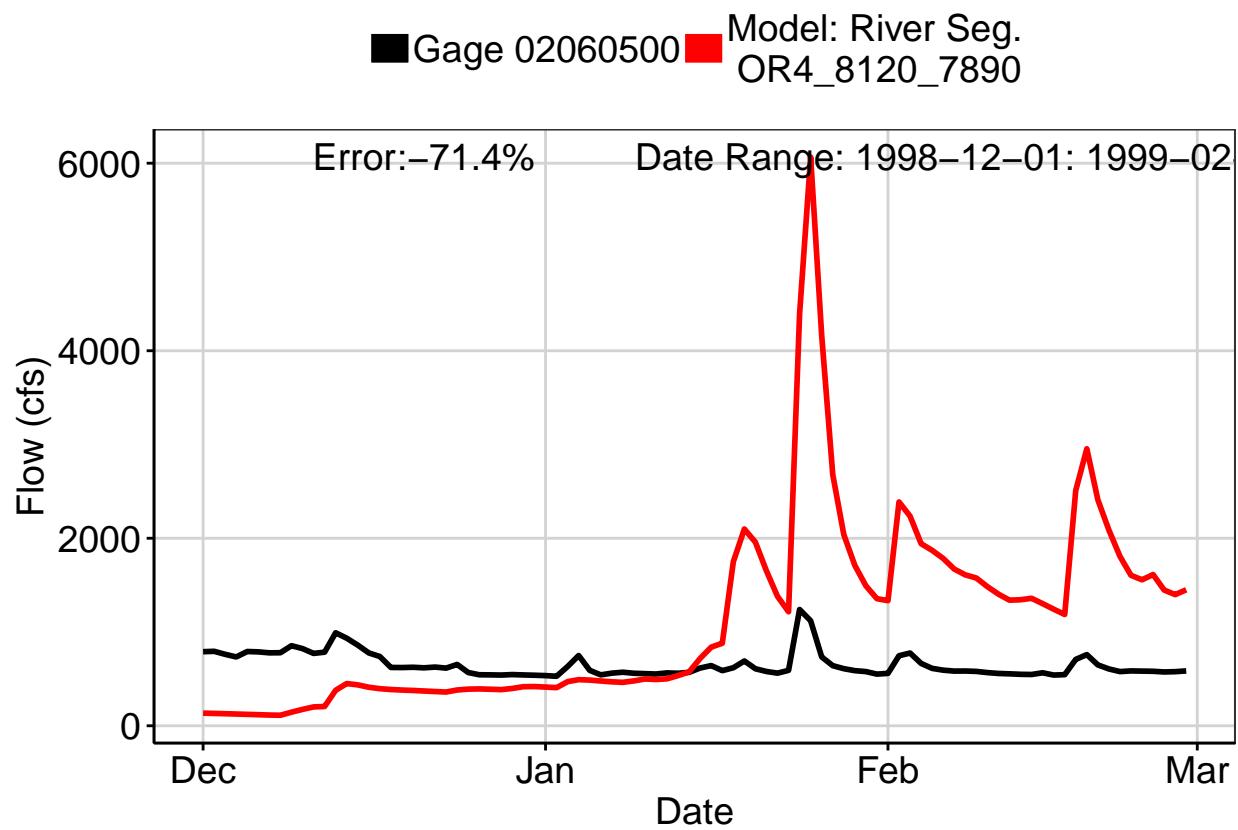
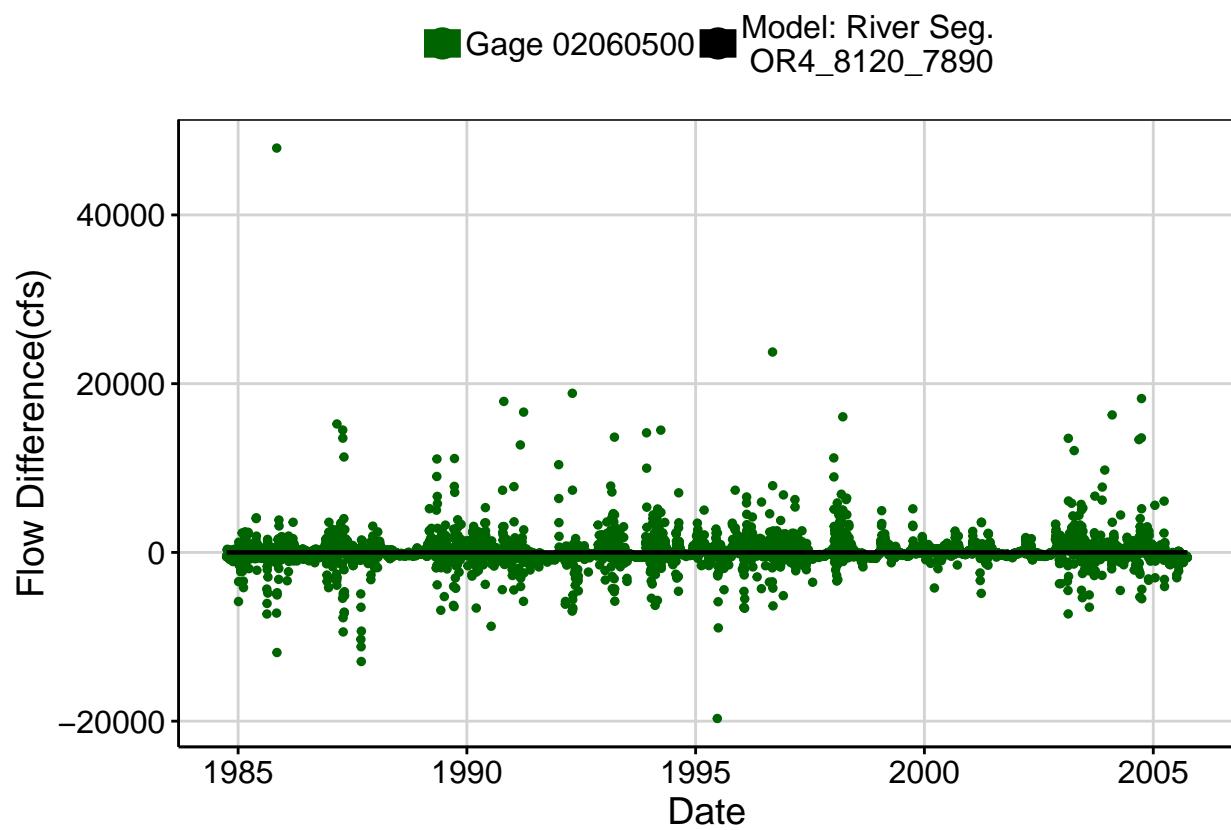
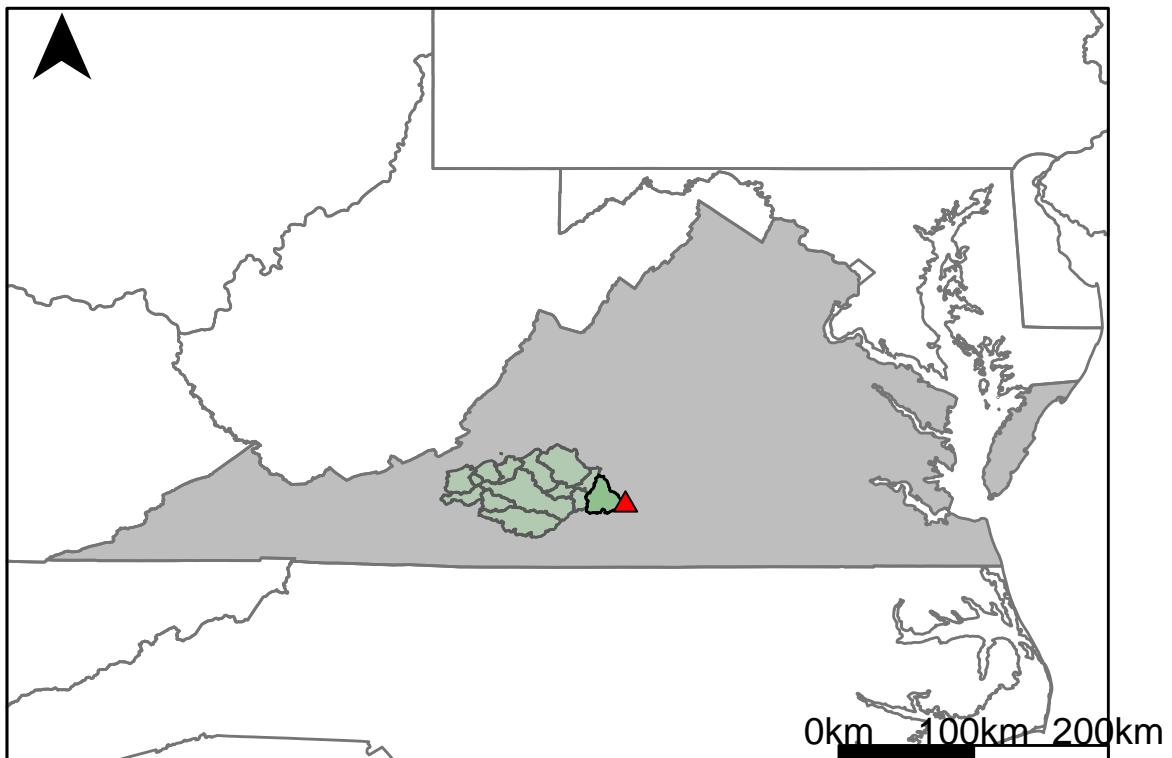


Fig. 9: Residuals Plot



## Appendix H.10: USGS Gage 02062500 vs. OR5\_7890\_7970



This river segment follows part of the flow of the Roanoke River. The gage is located in Campbell County, VA (Lat 37°02'22.0", Long 78°56'44.6") approximately 28 miles southeast of Lynchburg, VA. Drainage area is 2404 sq. miles. This gage started taking data in 1923 and is still taking data. The Smith Mountain and Leesville Dams are located in this area and may affect the flow. The average daily discharge error between the model and gage data for the 20 year timespan was -2.01%, with 39.6% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	962	544	43.5
Feb. Low Flow	971	628	35.3
Mar. Low Flow	1030	1230	-19.4
Apr. Low Flow	1140	1500	-31.6
May Low Flow	1340	2120	-58.2
Jun. Low Flow	1460	2170	-48.6
Jul. Low Flow	1370	1320	3.65
Aug. Low Flow	1540	1050	31.8
Sep. Low Flow	1170	940	19.7
Oct. Low Flow	1010	651	35.5
Nov. Low Flow	972	611	37.1
Dec. Low Flow	911	583	36

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	2490	2540	-2.01
Jan. Mean Flow	2850	3180	-11.6
Feb. Mean Flow	3270	3820	-16.8
Mar. Mean Flow	3900	4580	-17.4
Apr. Mean Flow	3730	3840	-2.95
May Mean Flow	2750	2630	4.36
Jun. Mean Flow	2330	2210	5.15
Jul. Mean Flow	1660	1370	17.5
Aug. Mean Flow	1570	1190	24.2
Sep. Mean Flow	2170	2010	7.37
Oct. Mean Flow	1630	1610	1.23
Nov. Mean Flow	1970	1920	2.54
Dec. Mean Flow	2160	2250	-4.17

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	1440	1130	21.5
Feb. High Flow	4520	3930	13.1
Mar. High Flow	3390	3810	-12.4
Apr. High Flow	8660	7070	18.4
May High Flow	7710	5450	29.3
Jun. High Flow	10800	11200	-3.7
Jul. High Flow	9690	8850	8.67
Aug. High Flow	5310	5000	5.84
Sep. High Flow	3060	2550	16.7
Oct. High Flow	2560	1640	35.9
Nov. High Flow	2380	1180	50.4
Dec. High Flow	1860	1070	42.5

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	229	93.8	59
Med. 1 Day Min	637	340	46.6
Min. 3 Day Min	276	94.5	65.8
Med. 3 Day Min	831	349	58
Min. 7 Day Min	350	96.3	72.5
Med. 7 Day Min	888	376	57.7
Min. 30 Day Min	401	118	70.6
Med. 30 Day Min	932	501	46.2
Min. 90 Day Min	468	203	56.6
Med. 90 Day Min	1180	742	37.1
7Q10	497	141	71.6
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	741	2540	-243
Mean Baseflow	1360	1480	-8.82

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	65600	82200	-25.3
Med. 1 Day Max	29200	31400	-7.53
Max. 3 Day Max	48800	51400	-5.33
Med. 3 Day Max	25200	24400	3.17
Max. 7 Day Max	30100	29500	1.99
Med. 7 Day Max	15100	14500	3.97
Max. 30 Day Max	14600	14400	1.37
Med. 30 Day Max	6810	6540	3.96
Max. 90 Day Max	8240	9660	-17.2
Med. 90 Day Max	4320	4650	-7.64

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	389	146	62.5
5% Non-Exceedance	619	354	42.8
50% Non-Exceedance	1480	1460	1.35
95% Non-Exceedance	7070	7530	-6.51
99% Non-Exceedance	18800	18300	2.66
Sept. 10% Non-Exceedance	362	363	-0.28

**Fig. 1: Hydrograph**

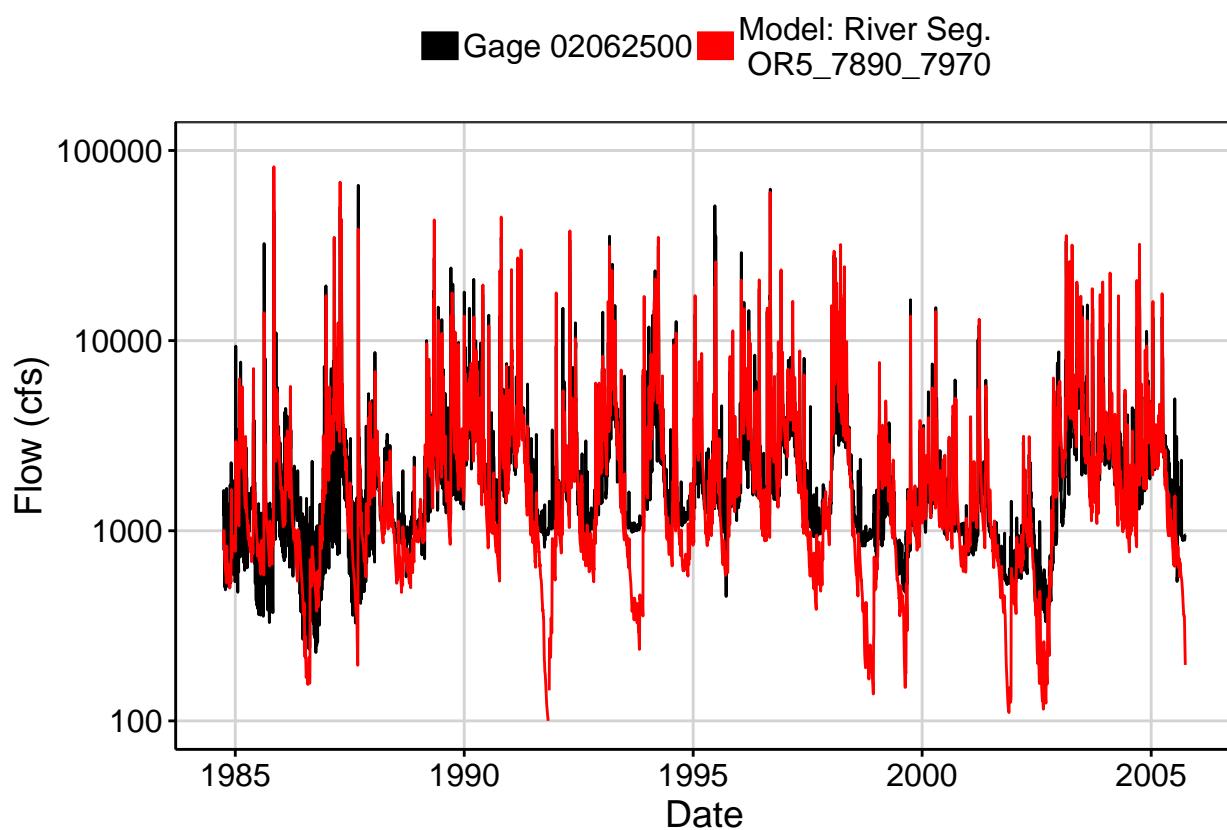


Fig. 2: Zoomed Hydrograph

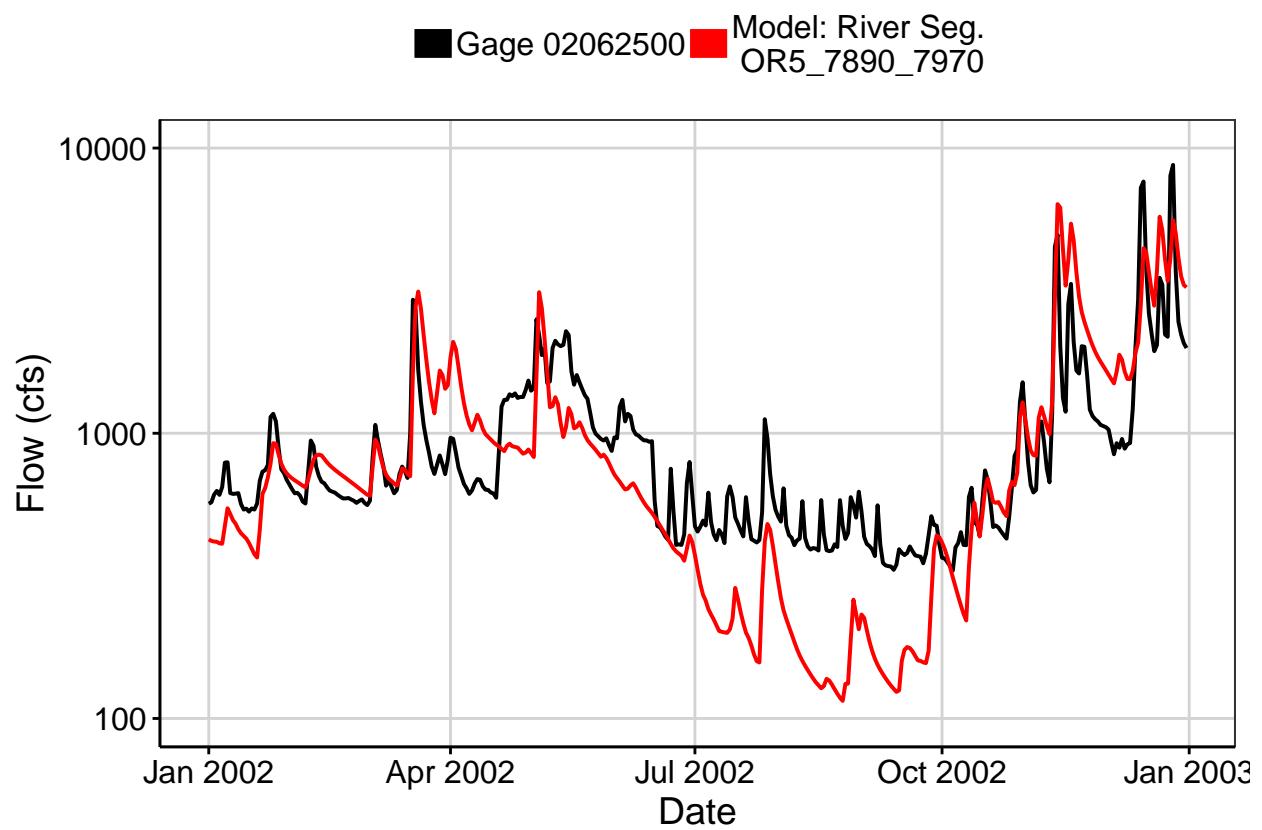


Fig. 3: Flow Exceedance

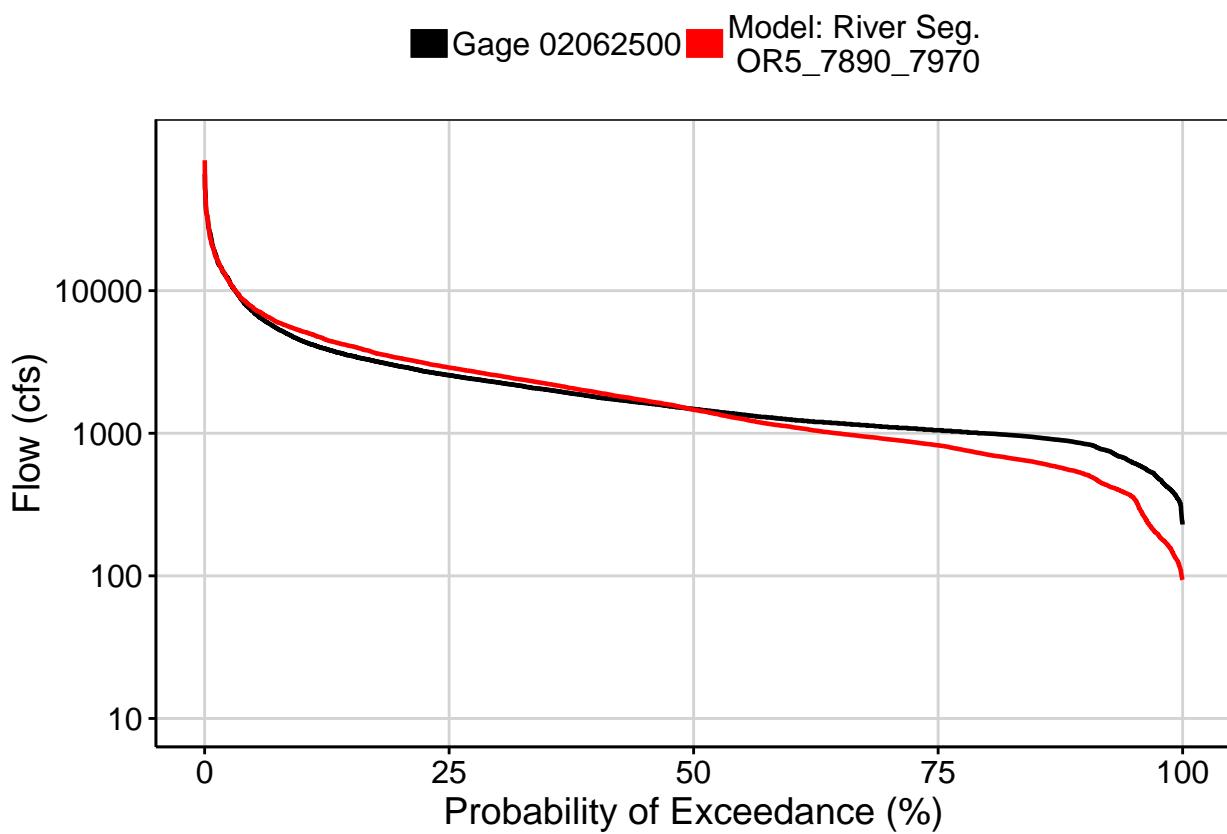
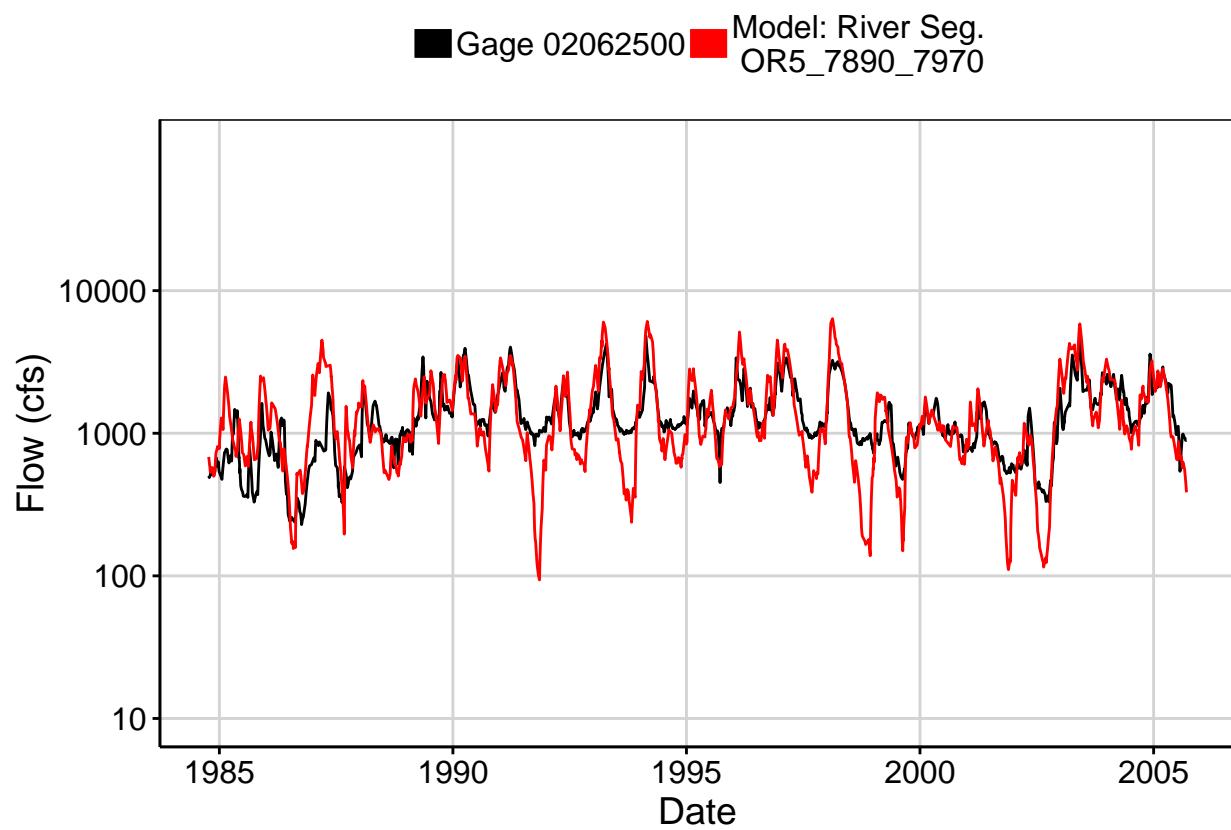


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

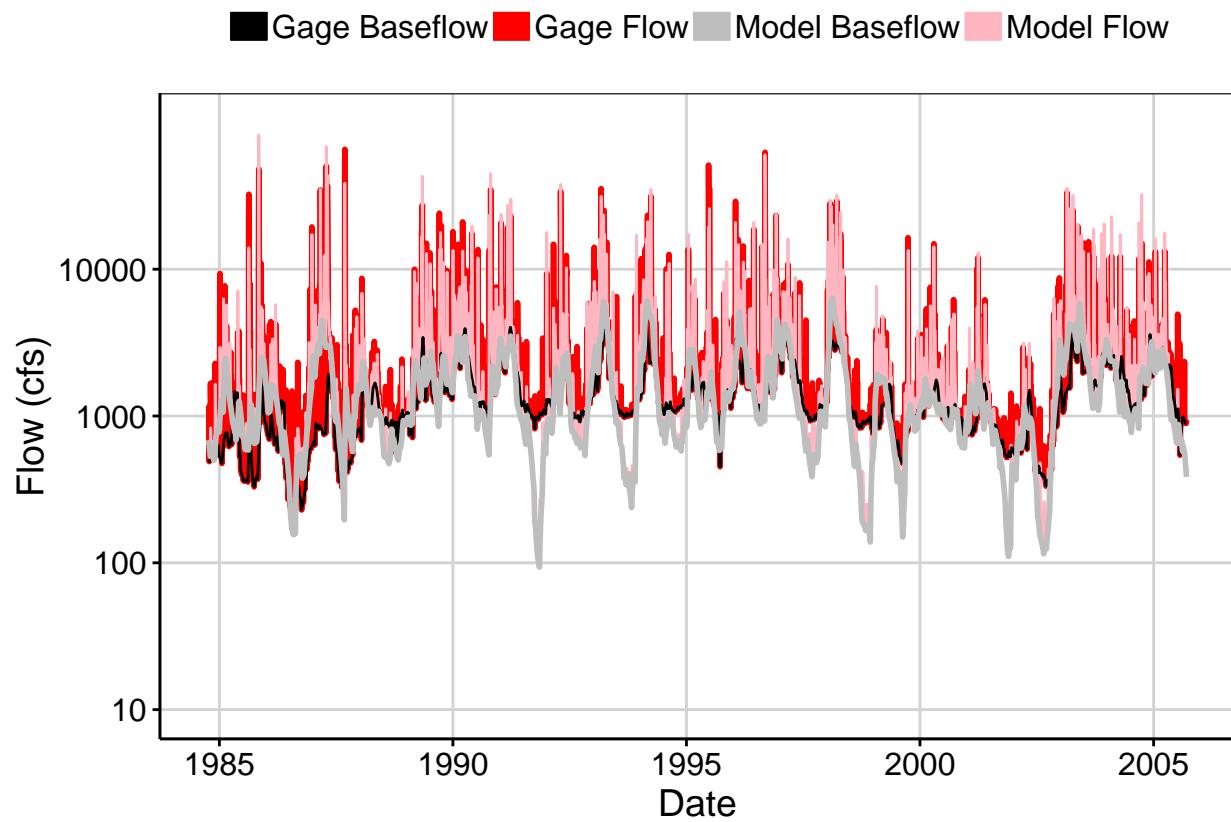


Fig. 6: Largest Error Segment

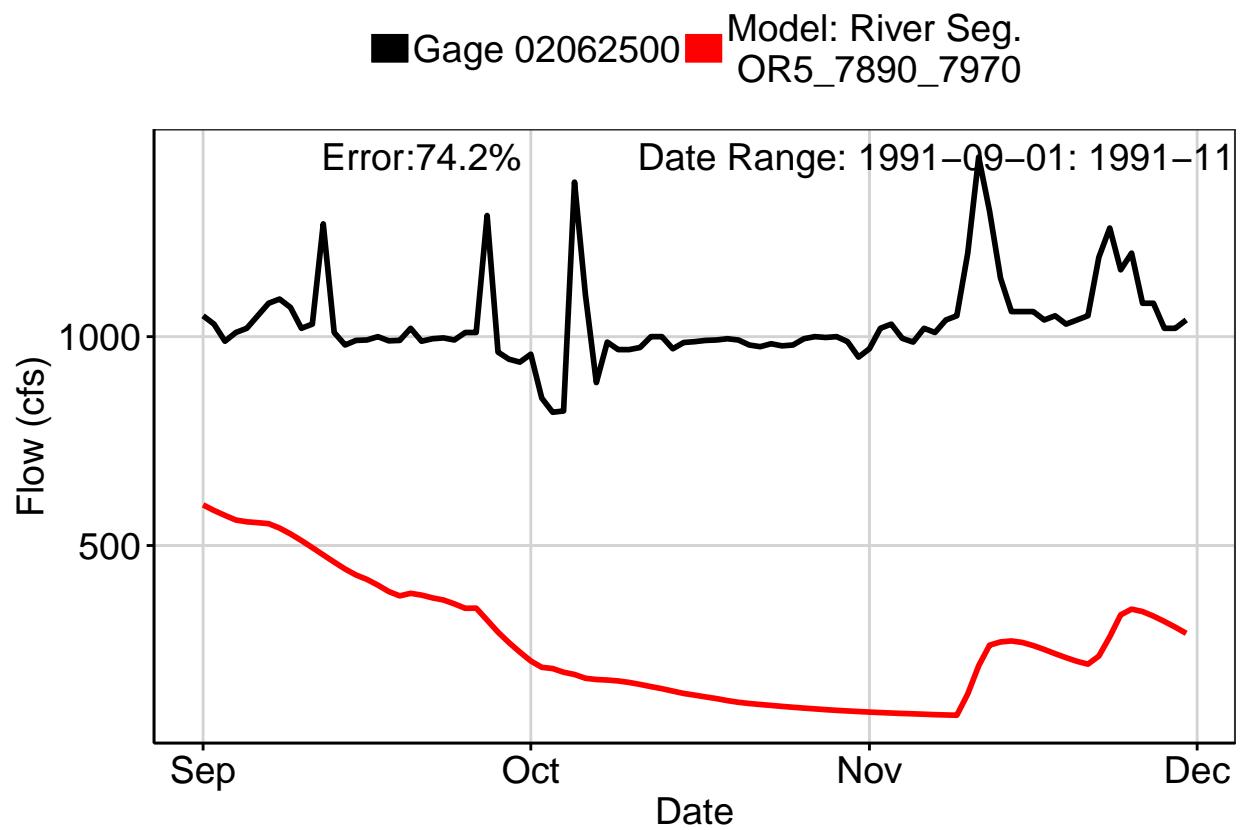


Fig. 7: Second Largest Error Segment

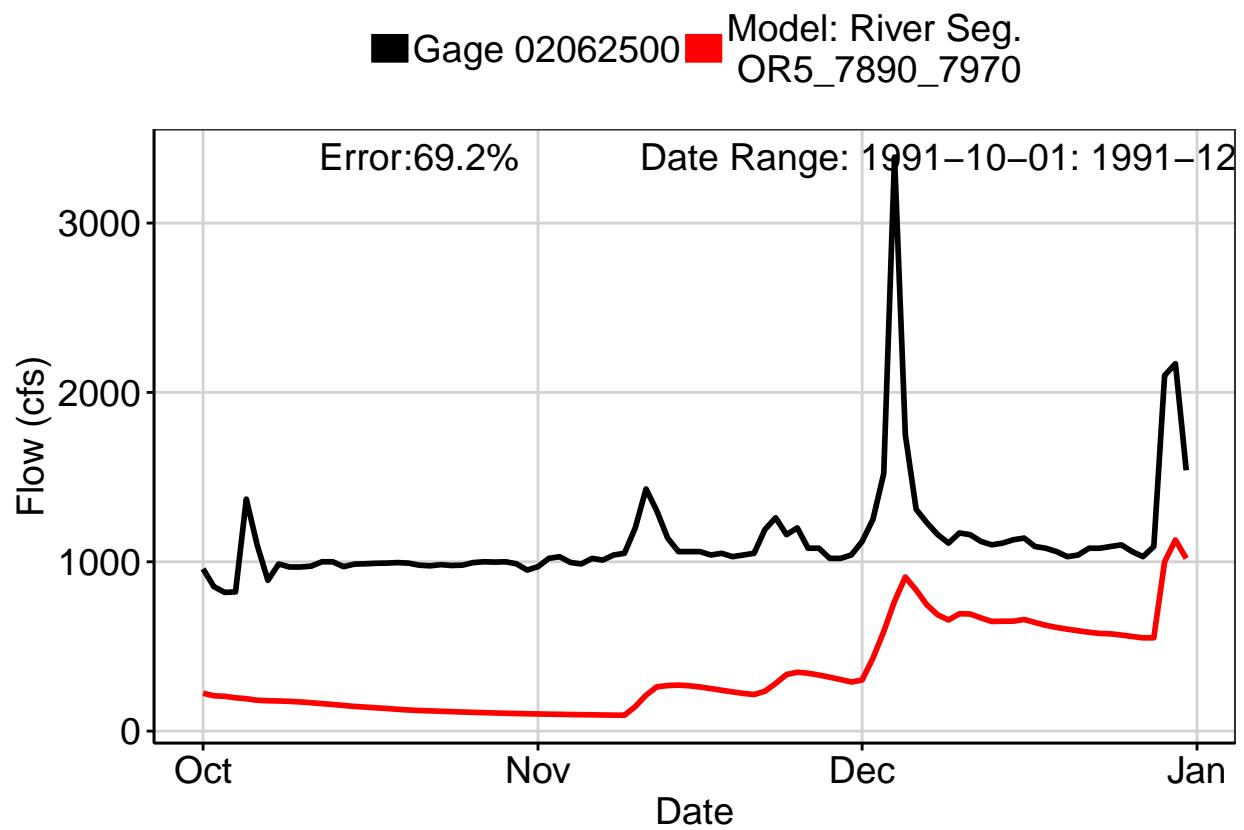


Fig. 8: Third Largest Error Segment

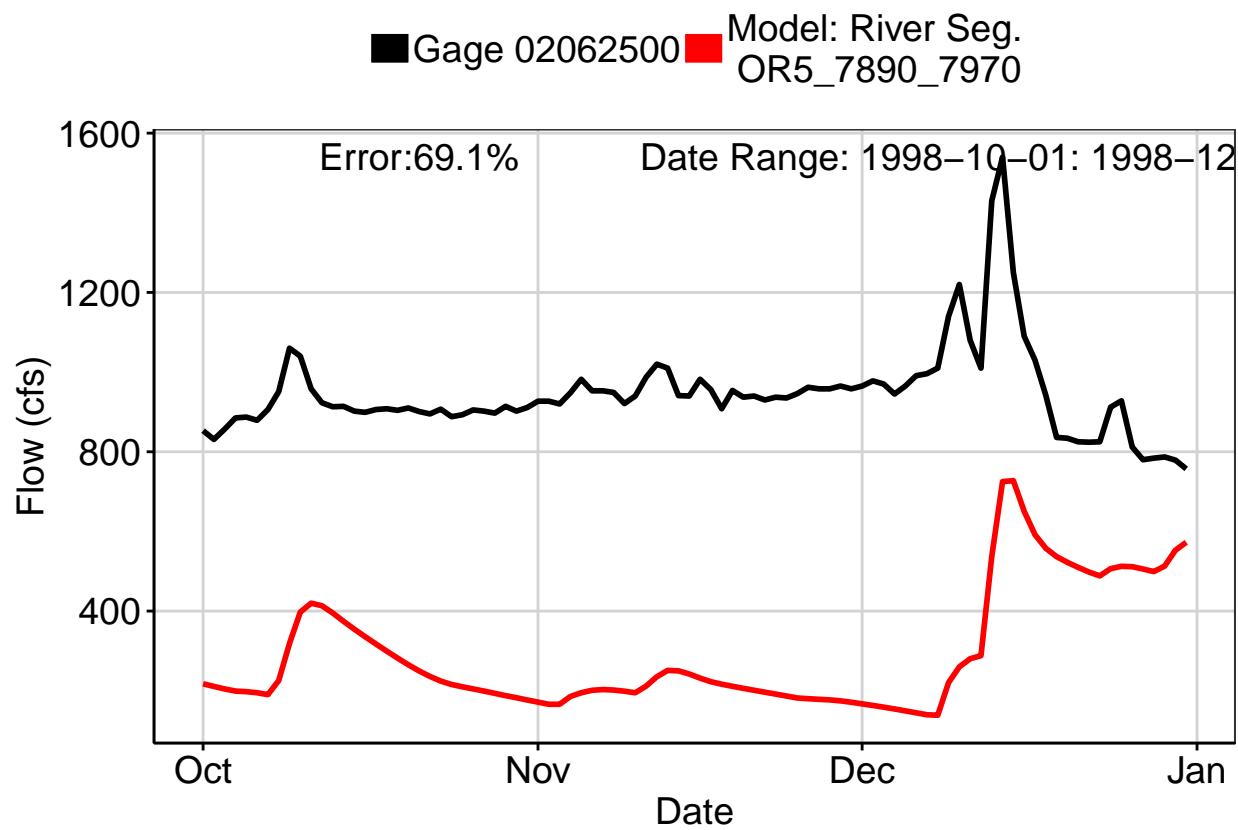
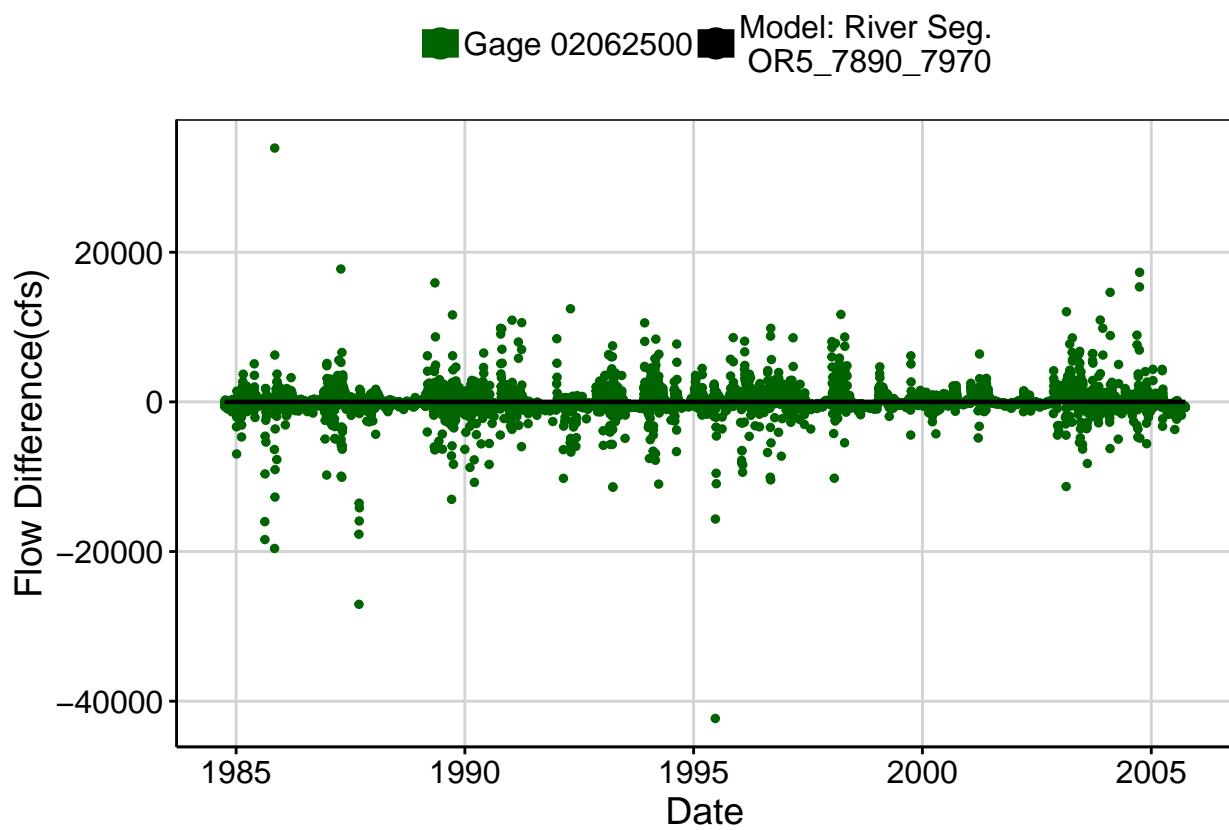
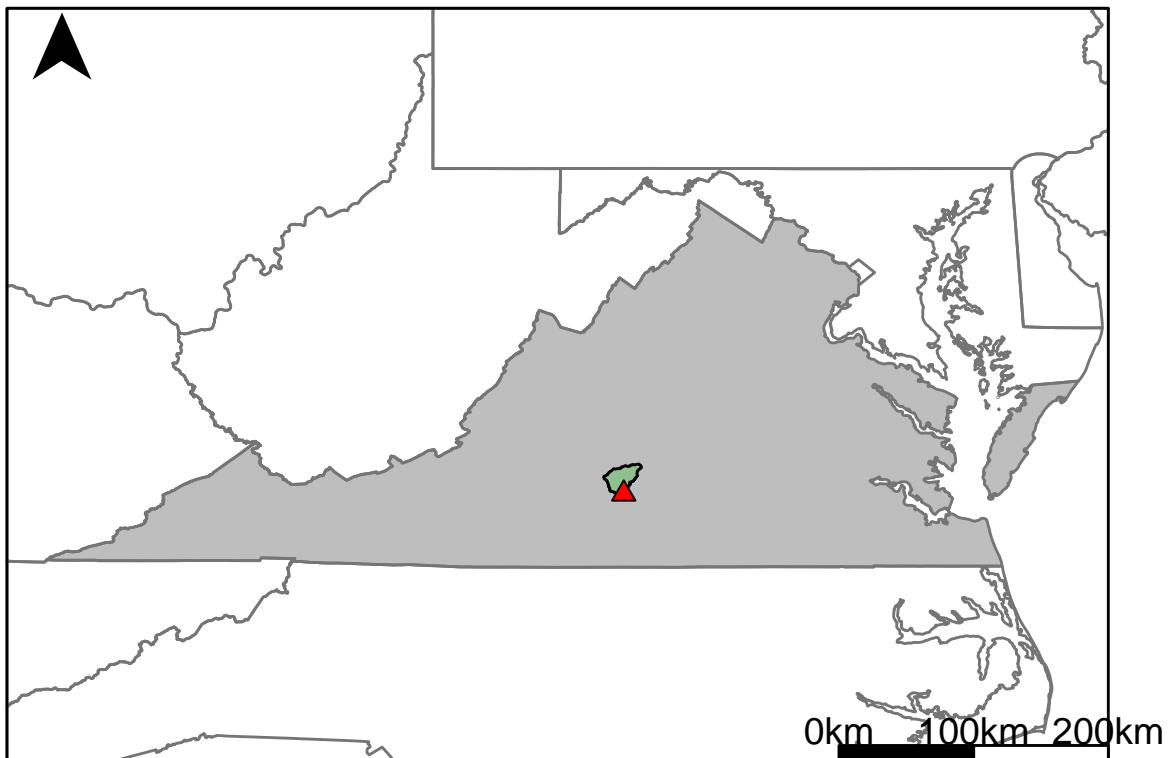


Fig. 9: Residuals Plot



## Appendix H.11: USGS Gage 02064000 vs. OR2\_7670\_7840



This river segment follows part of the flow of the Falling River, a tributary of the Roanoke River. The gage is located in Campbell County, VA (Lat 37°07'36", Long 78°57'36") approximately 22 miles southeast of Lynchburg, VA. Drainage area is 165 sq. miles. This gage started taking data in 1929 and is still taking data. Prior to 1958 there was diurnal fluctuation caused by gristmill upstream at Spring Mills, but there should not be any recent alterations or problems with flow. The average daily discharge error between the model and gage data for the 20 year timespan was 0.59%, with 50.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	46	19.4	57.8
Feb. Low Flow	57	38.6	32.3
Mar. Low Flow	79	75.1	4.94
Apr. Low Flow	90	92.7	-3
May Low Flow	106	131	-23.6
Jun. Low Flow	101	128	-26.7
Jul. Low Flow	96	86.2	10.2
Aug. Low Flow	78	62.7	19.6
Sep. Low Flow	60.6	39.4	35
Oct. Low Flow	38	23.6	37.9
Nov. Low Flow	37	19.8	46.5
Dec. Low Flow	37	17.5	52.7

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	169	168	0.59
Jan. Mean Flow	211	216	-2.37
Feb. Mean Flow	233	268	-15
Mar. Mean Flow	276	325	-17.8
Apr. Mean Flow	215	223	-3.72
May Mean Flow	169	171	-1.18
Jun. Mean Flow	130	120	7.69
Jul. Mean Flow	95.9	72.3	24.6
Aug. Mean Flow	89.8	61.5	31.5
Sep. Mean Flow	188	159	15.4
Oct. Mean Flow	104	103	0.96
Nov. Mean Flow	157	141	10.2
Dec. Mean Flow	167	160	4.19

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	203	116	42.9
Feb. High Flow	553	417	24.6
Mar. High Flow	584	497	14.9
Apr. High Flow	630	603	4.29
May High Flow	657	620	5.63
Jun. High Flow	906	1330	-46.8
Jul. High Flow	460	580	-26.1
Aug. High Flow	332	201	39.5
Sep. High Flow	271	163	39.9
Oct. High Flow	322	132	59
Nov. High Flow	195	92.8	52.4
Dec. High Flow	133	91.8	31

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	1	1.83	-83
Med. 1 Day Min	31	13	58.1
Min. 3 Day Min	1.12	1.88	-67.9
Med. 3 Day Min	32.7	13.2	59.6
Min. 7 Day Min	1.41	2.03	-44
Med. 7 Day Min	33.4	14.3	57.2
Min. 30 Day Min	5.02	3.77	24.9
Med. 30 Day Min	43.2	19.7	54.4
Min. 90 Day Min	10.7	13.8	-29
Med. 90 Day Min	63.4	34.6	45.4
7Q10	9.41	4.25	54.8
Year of 90-Day Min. Flow	2002	1986	100
Drought Year Mean	42.7	168	-293
Mean Baseflow	87.1	86.5	0.69

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	20000	11000	45
Med. 1 Day Max	3140	3170	-0.96
Max. 3 Day Max	11400	6090	46.6
Med. 3 Day Max	1680	1570	6.55
Max. 7 Day Max	5550	3120	43.8
Med. 7 Day Max	887	904	-1.92
Max. 30 Day Max	1480	979	33.9
Med. 30 Day Max	494	501	-1.42
Max. 90 Day Max	584	705	-20.7
Med. 90 Day Max	292	328	-12.3

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	10.6	5.75	45.8
5% Non-Exceedance	27.3	13.8	49.5
50% Non-Exceedance	97.6	90.9	6.86
95% Non-Exceedance	457	502	-9.85
99% Non-Exceedance	1330	1530	-15
Sept. 10% Non-Exceedance	13.6	13.4	1.47

**Fig. 1: Hydrograph**

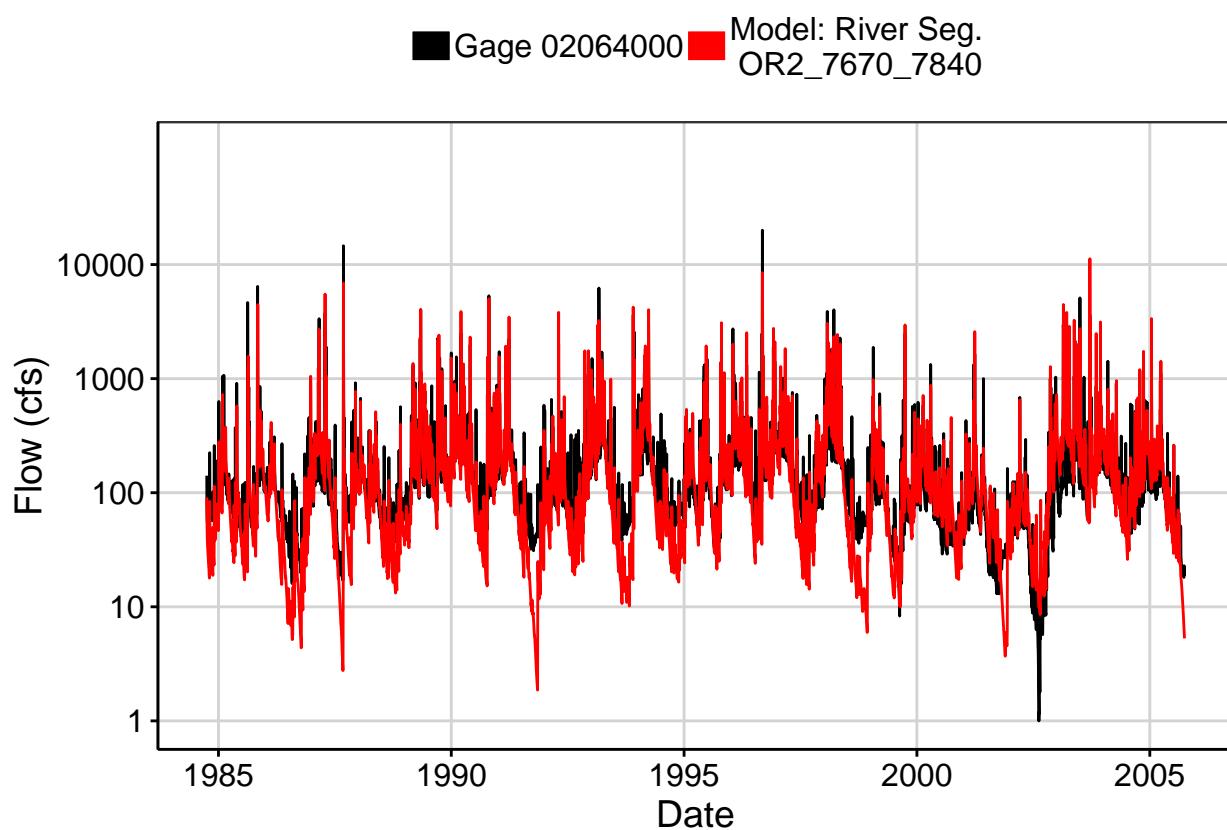


Fig. 2: Zoomed Hydrograph

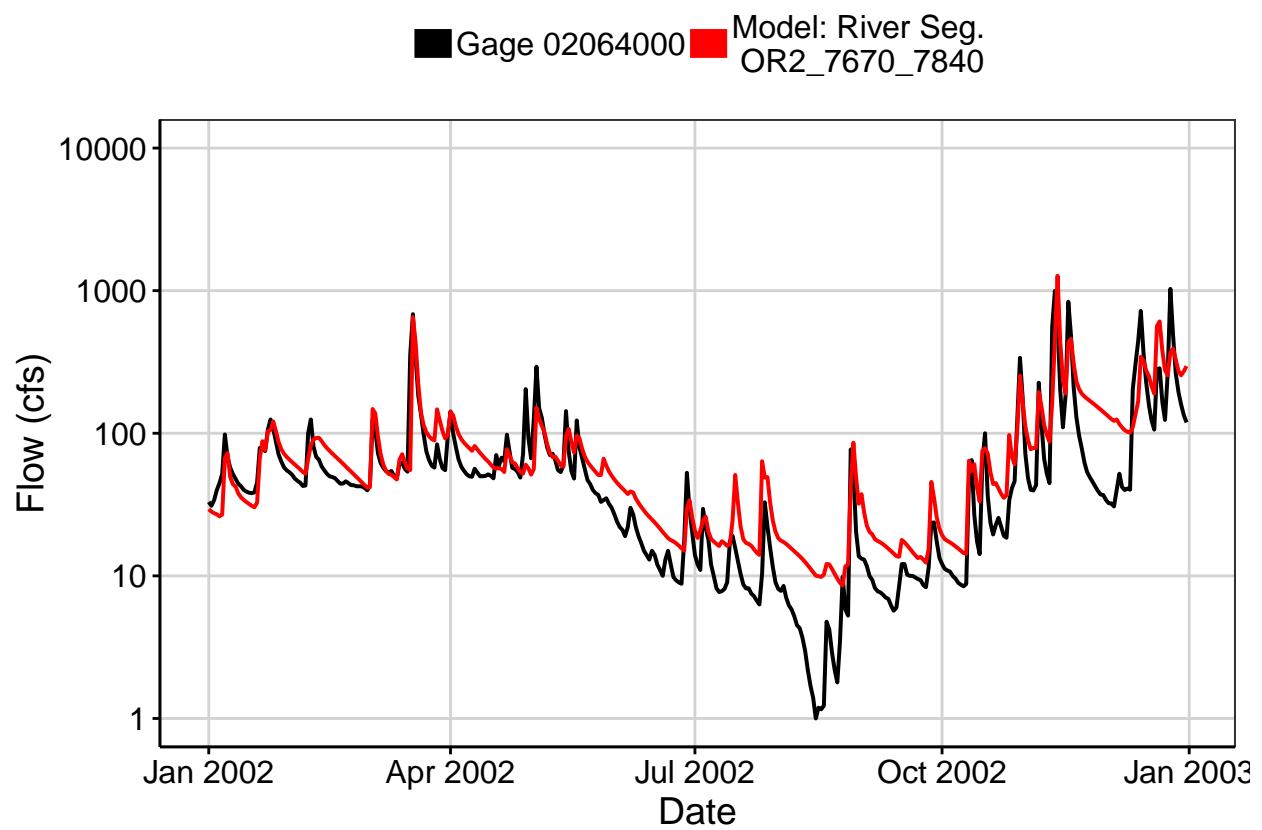


Fig. 3: Flow Exceedance

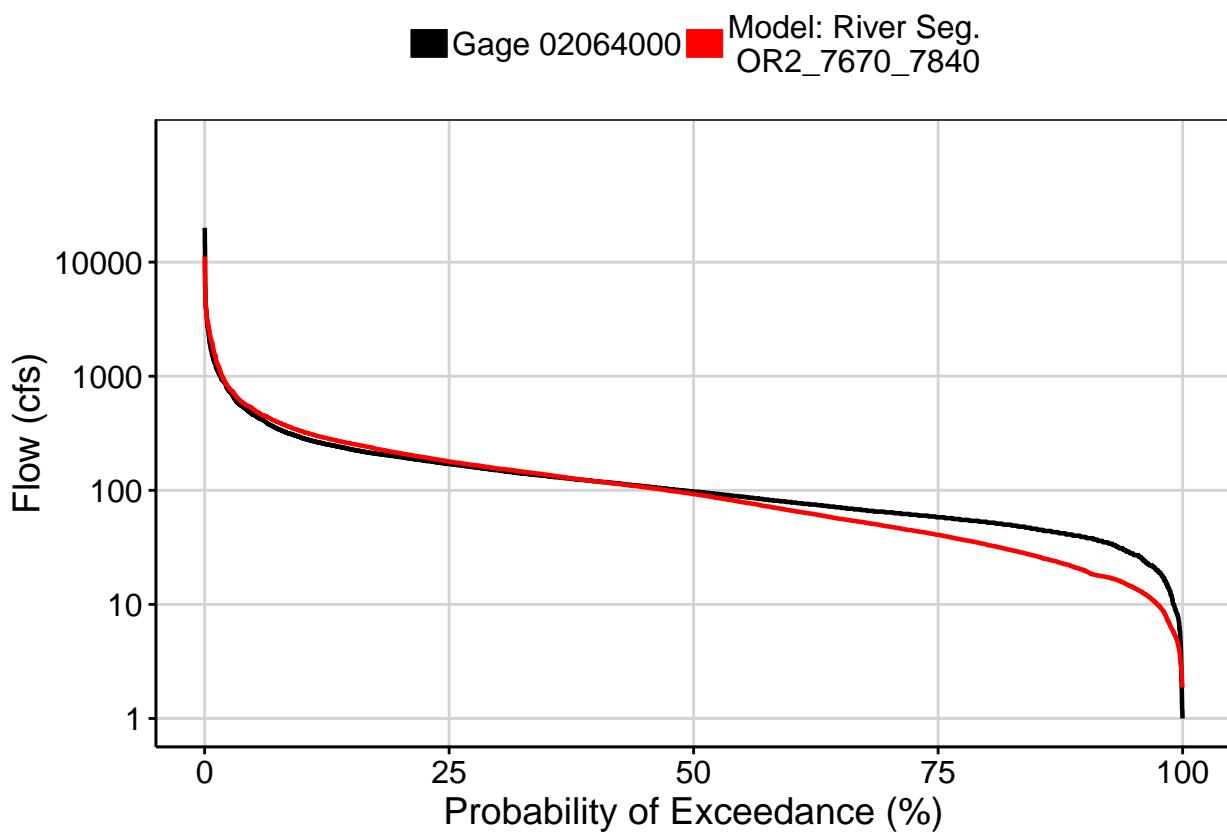


Fig. 4: Baseflow

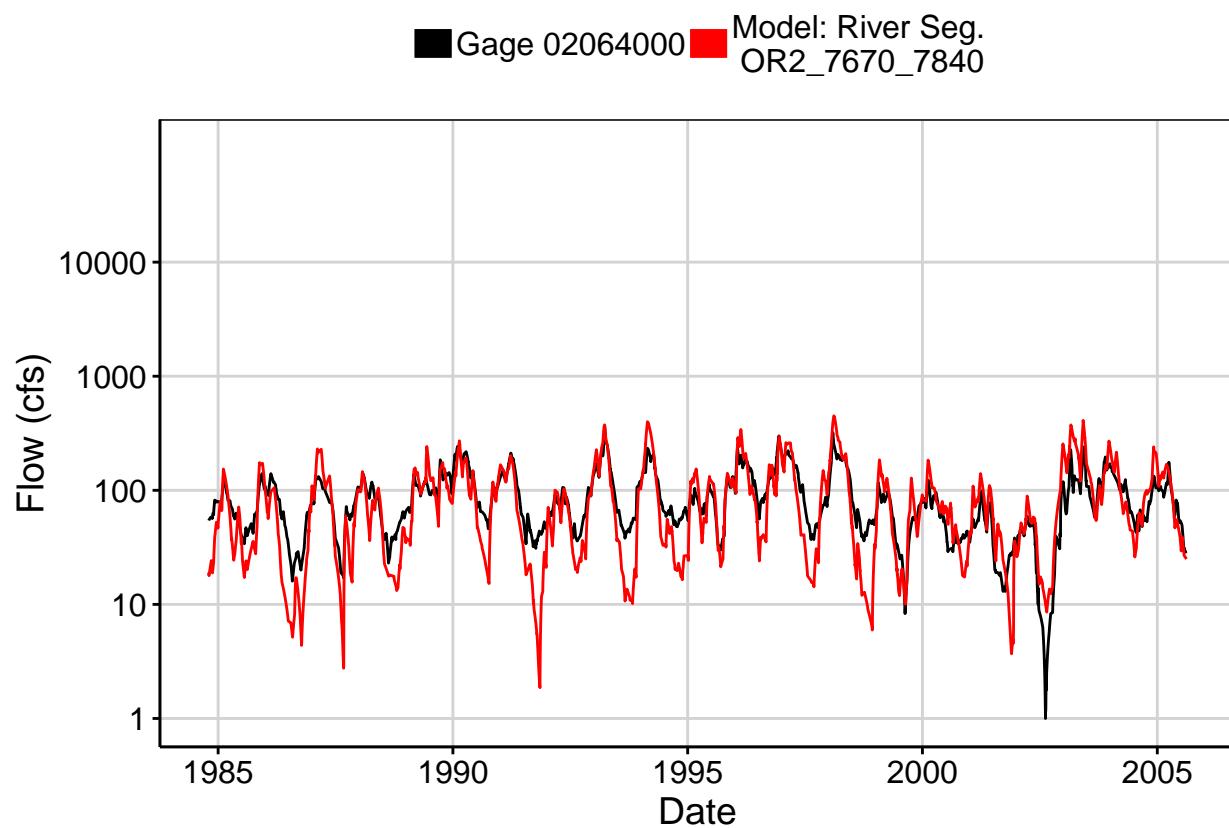


Fig. 5: Combined Baseflow

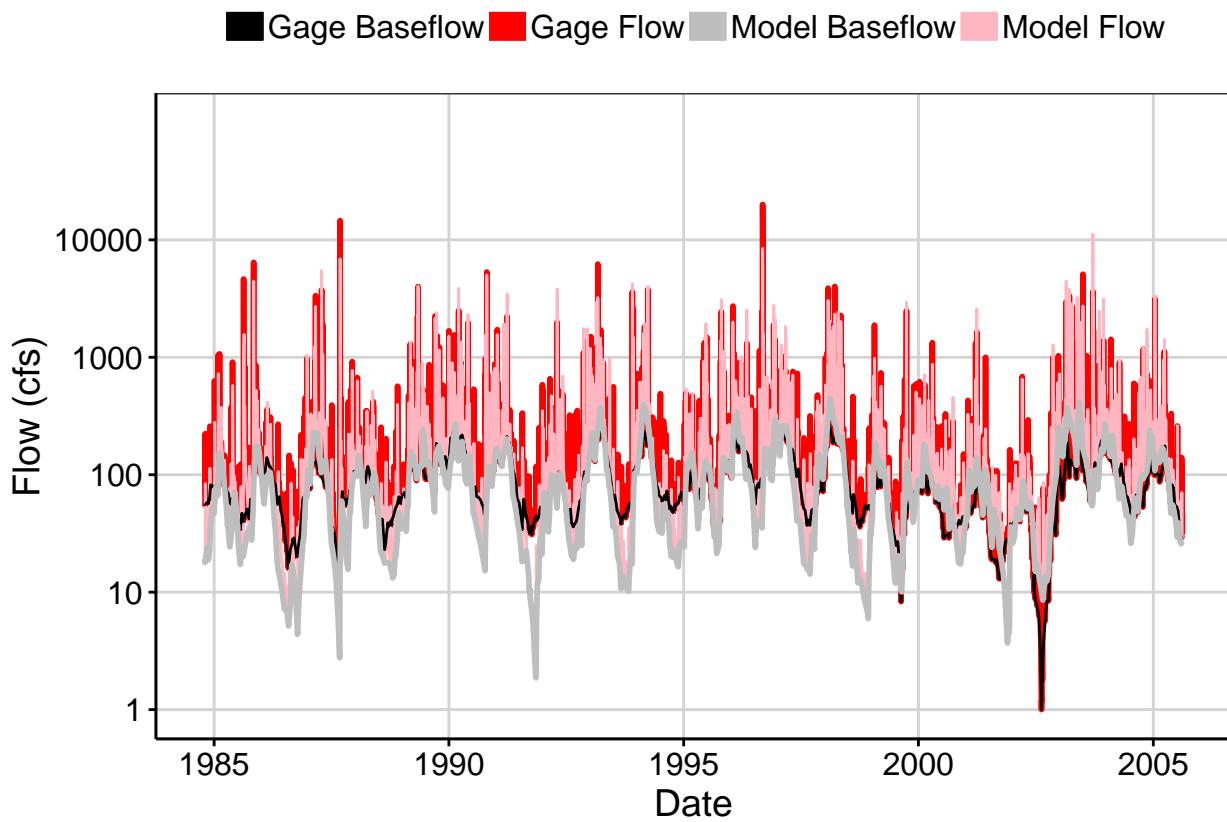


Fig. 6: Largest Error Segment

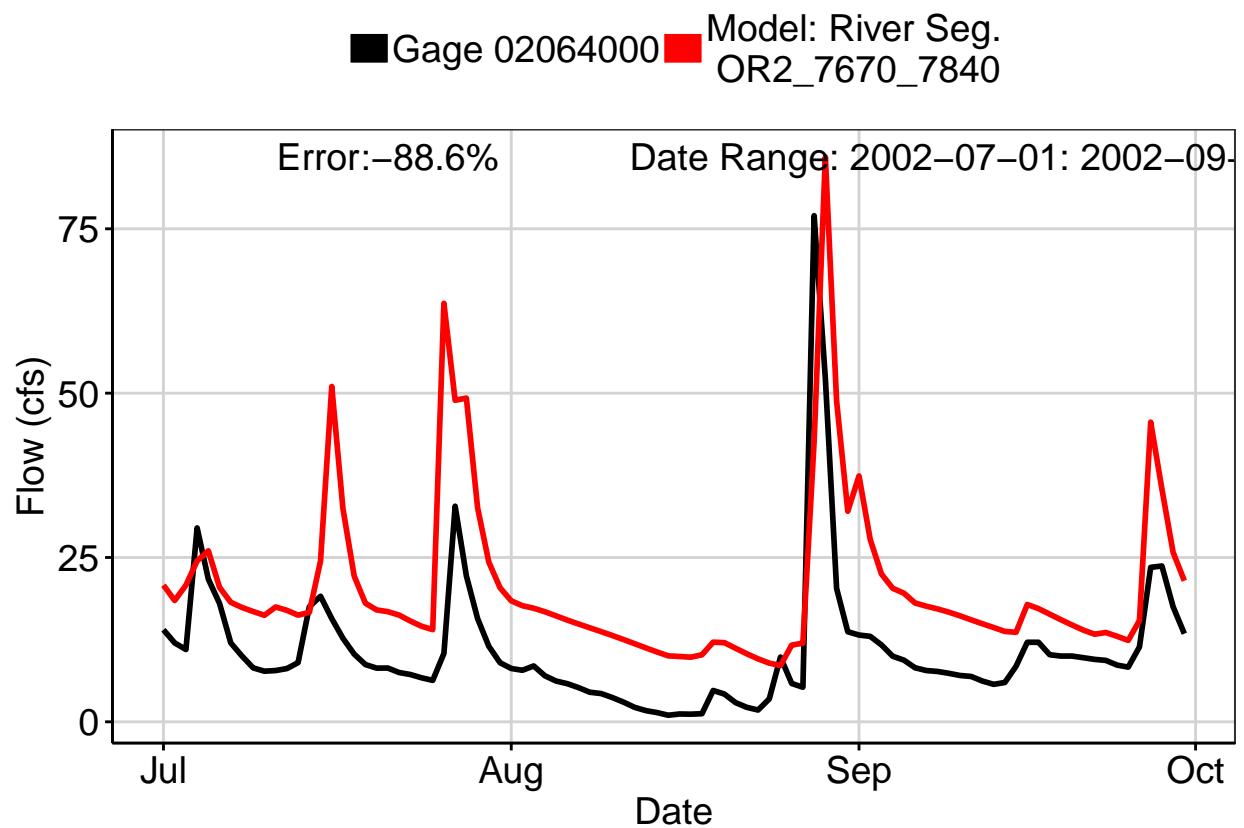


Fig. 7: Second Largest Error Segment

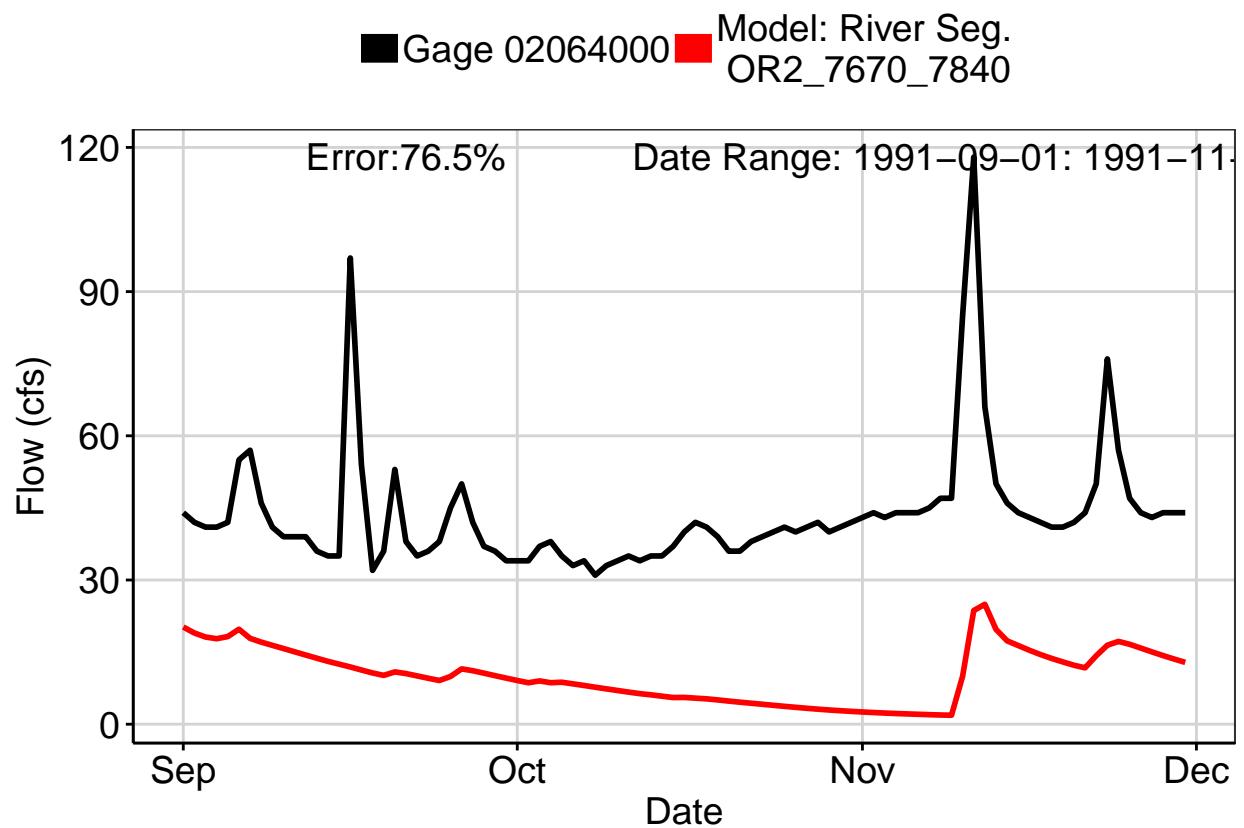


Fig. 8: Third Largest Error Segment

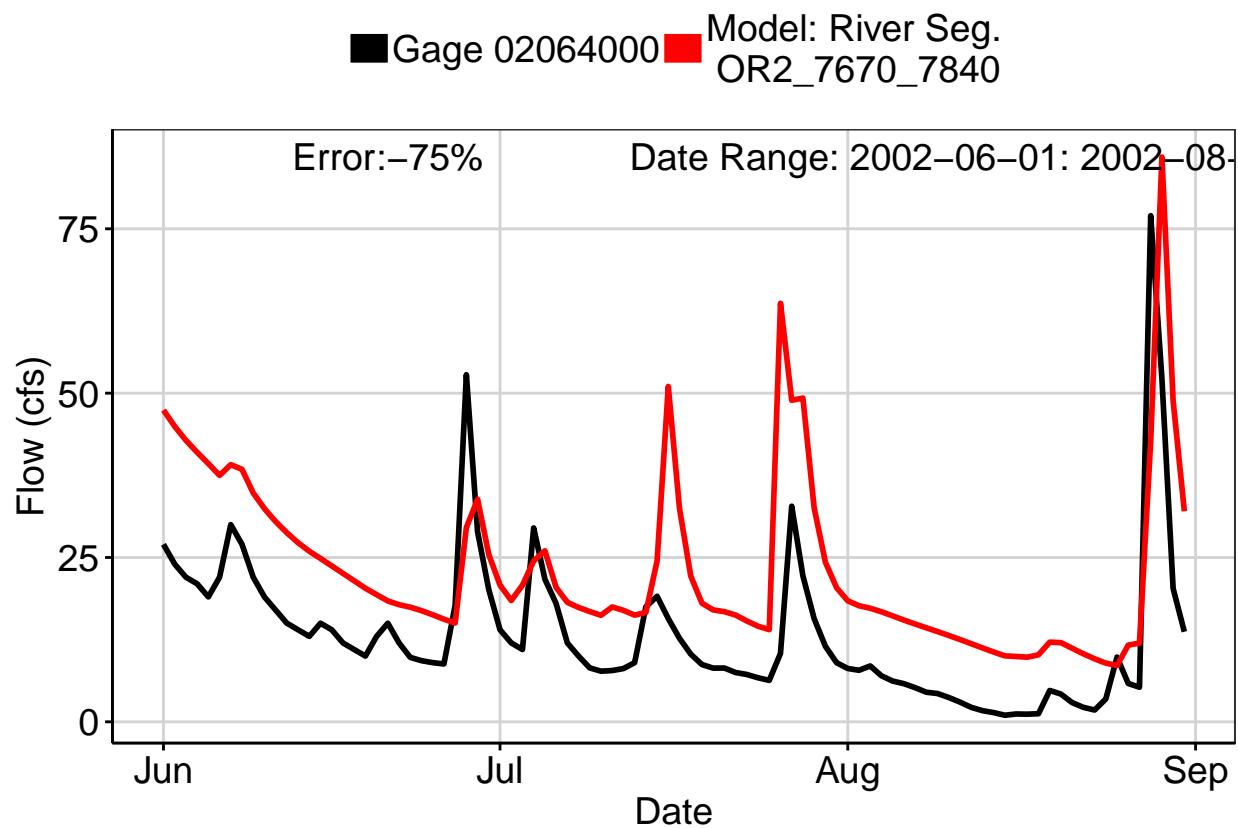
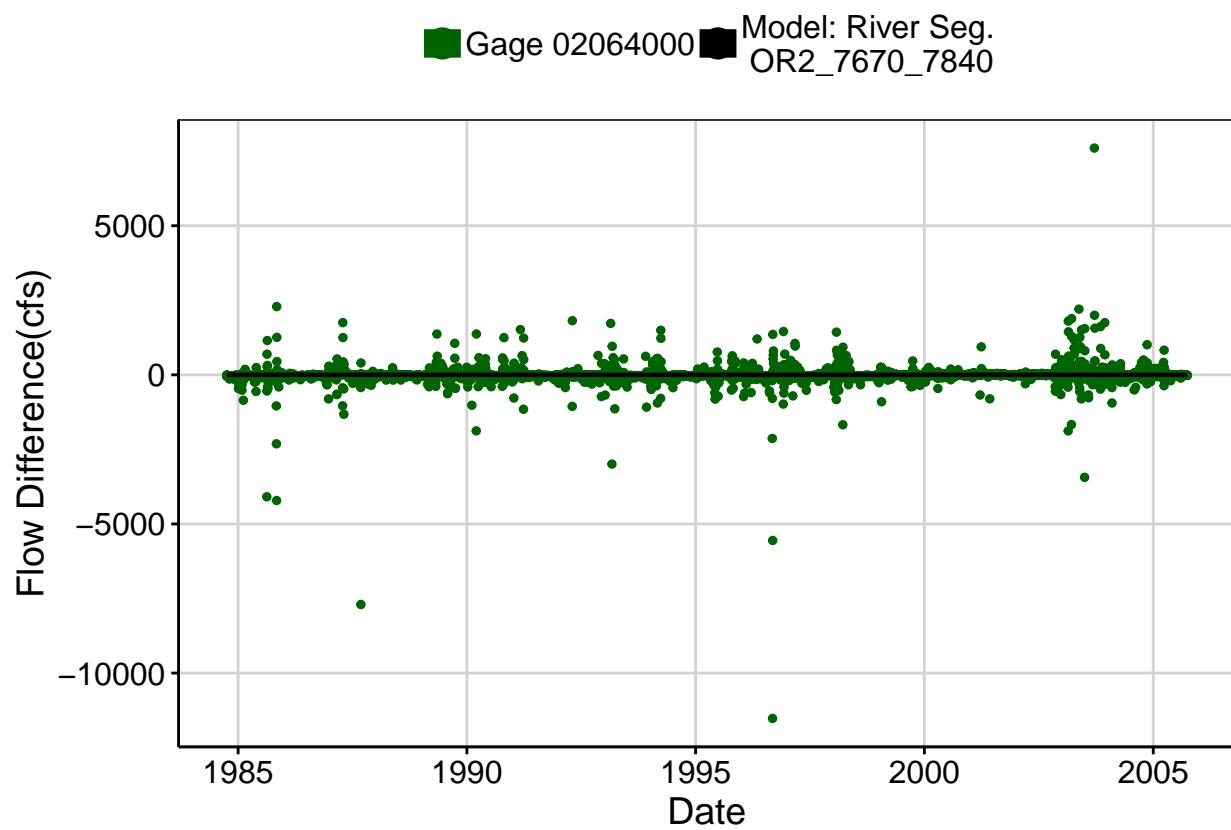
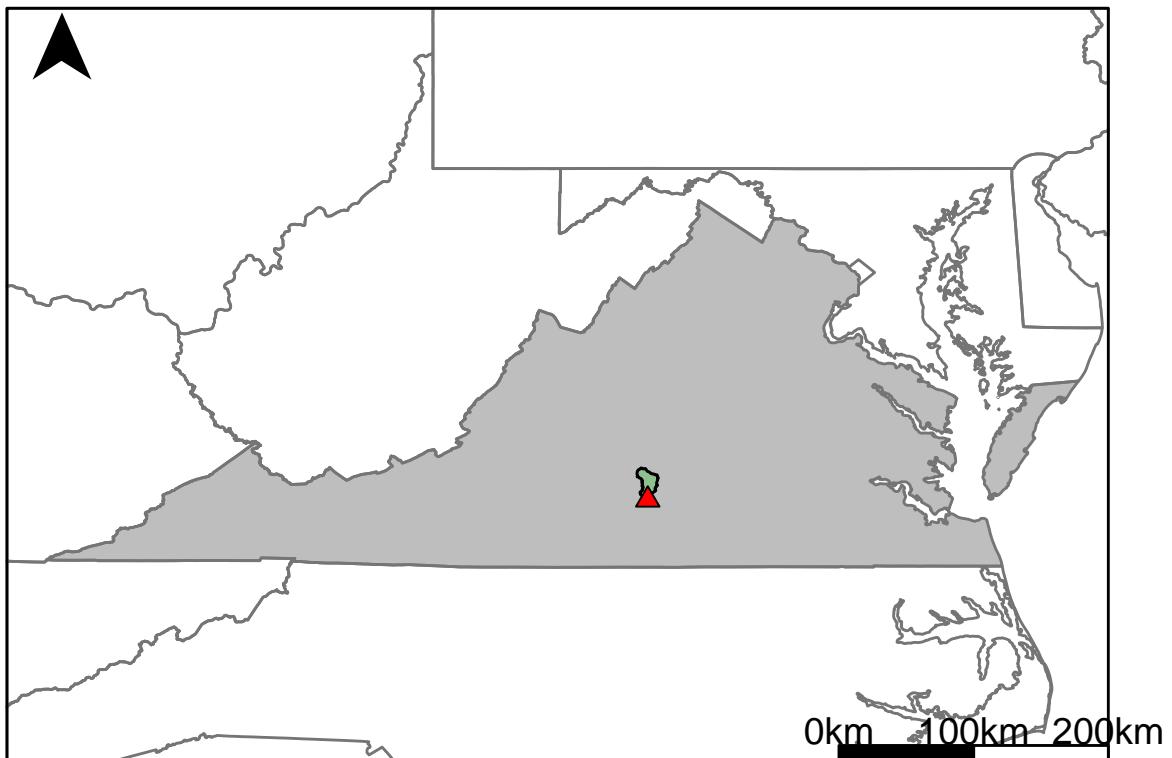


Fig. 9: Residuals Plot



## Appendix H.12: USGS Gage 02065500 vs. OR1\_7700\_7980



This river segment follows part of the flow of the Cub Creek, a tributary of the Roanoke River. The gage is located in Charlotte County, VA (Lat 37°04'45", Long 78°45'50") approximately 31 miles southeast of Lynchburg, VA. Drainage area is 97.6 sq. miles. This gage started taking data in 1946 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 2.88%, with 58.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	30	12.3	59
Feb. Low Flow	44	21.9	50.2
Mar. Low Flow	55.2	41.5	24.8
Apr. Low Flow	62	55.1	11.1
May Low Flow	73	82.9	-13.6
Jun. Low Flow	77	80.6	-4.68
Jul. Low Flow	69.9	61.2	12.4
Aug. Low Flow	53	39.2	26
Sep. Low Flow	40	27.5	31.2
Oct. Low Flow	27	17.2	36.3
Nov. Low Flow	23	14.4	37.4
Dec. Low Flow	26	11.8	54.6

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	104	101	2.88
Jan. Mean Flow	127	128	-0.79
Feb. Mean Flow	139	159	-14.4
Mar. Mean Flow	169	198	-17.2
Apr. Mean Flow	133	141	-6.02
May Mean Flow	108	107	0.93
Jun. Mean Flow	77.1	72.2	6.36
Jul. Mean Flow	58.7	44.3	24.5
Aug. Mean Flow	61.4	39.6	35.5
Sep. Mean Flow	101	88	12.9
Oct. Mean Flow	61.8	58.3	5.66
Nov. Mean Flow	105	90.4	13.9
Dec. Mean Flow	105	94	10.5

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	120	52.5	56.2
Feb. High Flow	243	262	-7.82
Mar. High Flow	277	210	24.2
Apr. High Flow	339	347	-2.36
May High Flow	486	266	45.3
Jun. High Flow	456	838	-83.8
Jul. High Flow	269	389	-44.6
Aug. High Flow	195	167	14.4
Sep. High Flow	123	94.9	22.8
Oct. High Flow	124	67.8	45.3
Nov. High Flow	147	49.8	66.1
Dec. High Flow	70	45.4	35.1

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	0	2.29	-Inf
Med. 1 Day Min	22	9.66	56.1
Min. 3 Day Min	0.01	2.38	-35400
Med. 3 Day Min	23.3	9.84	57.8
Min. 7 Day Min	0.02	2.54	-12600
Med. 7 Day Min	23.9	10.5	56.1
Min. 30 Day Min	1.82	3.11	-70.9
Med. 30 Day Min	28.6	12.2	57.3
Min. 90 Day Min	7.03	9.03	-28.4
Med. 90 Day Min	42.2	23.7	43.8
7Q10	2.51	3.43	-36.7
Year of 90-Day Min. Flow	2002	1986	100
Drought Year Mean	32.9	101	-207
Mean Baseflow	59.3	55.5	6.41

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	6920	5500	20.5
Med. 1 Day Max	1340	1430	-6.72
Max. 3 Day Max	4520	2870	36.5
Med. 3 Day Max	784	867	-10.6
Max. 7 Day Max	2120	1790	15.6
Med. 7 Day Max	523	473	9.56
Max. 30 Day Max	611	573	6.22
Med. 30 Day Max	243	262	-7.82
Max. 90 Day Max	341	433	-27
Med. 90 Day Max	173	177	-2.31

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	7.48	4.23	43.4
5% Non-Exceedance	21.2	9.74	54.1
50% Non-Exceedance	66	56.6	14.2
95% Non-Exceedance	261	299	-14.6
99% Non-Exceedance	793	829	-4.54
Sept. 10% Non-Exceedance	9.66	9.66	0

**Fig. 1: Hydrograph**

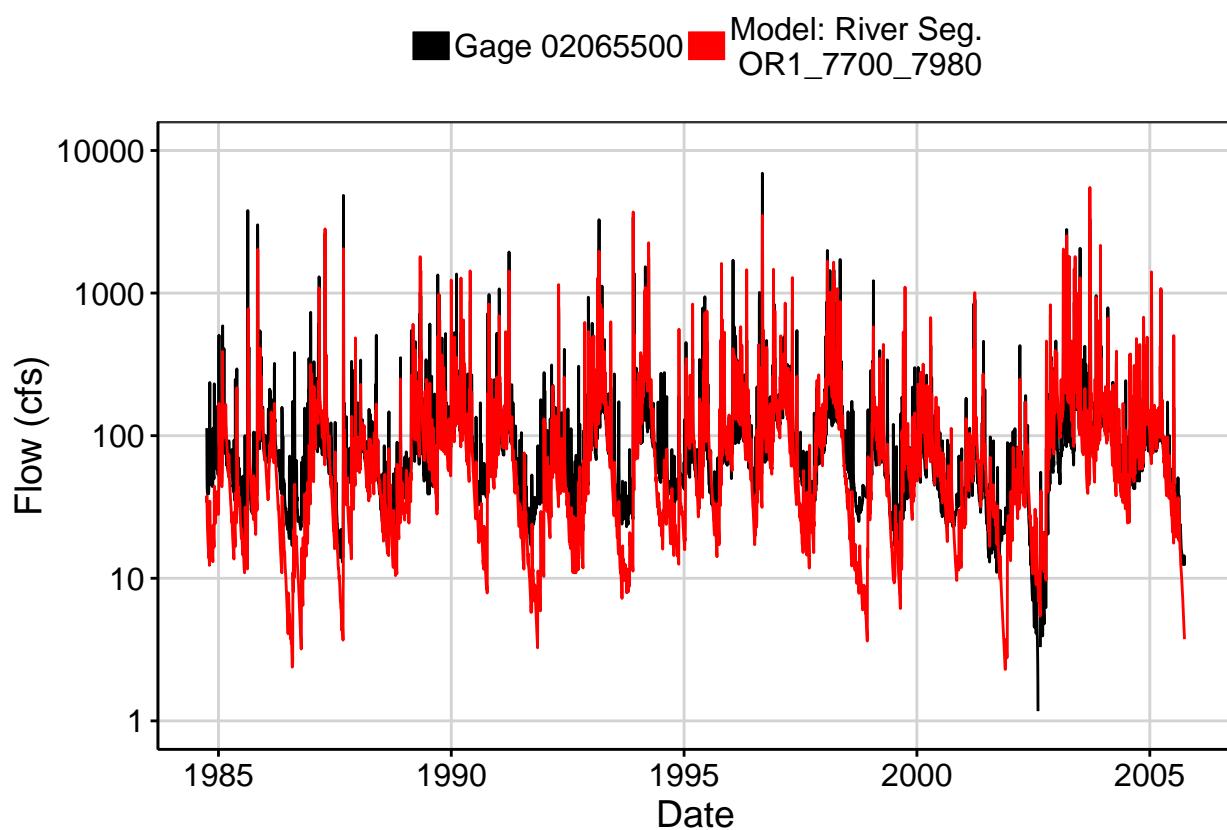


Fig. 2: Zoomed Hydrograph

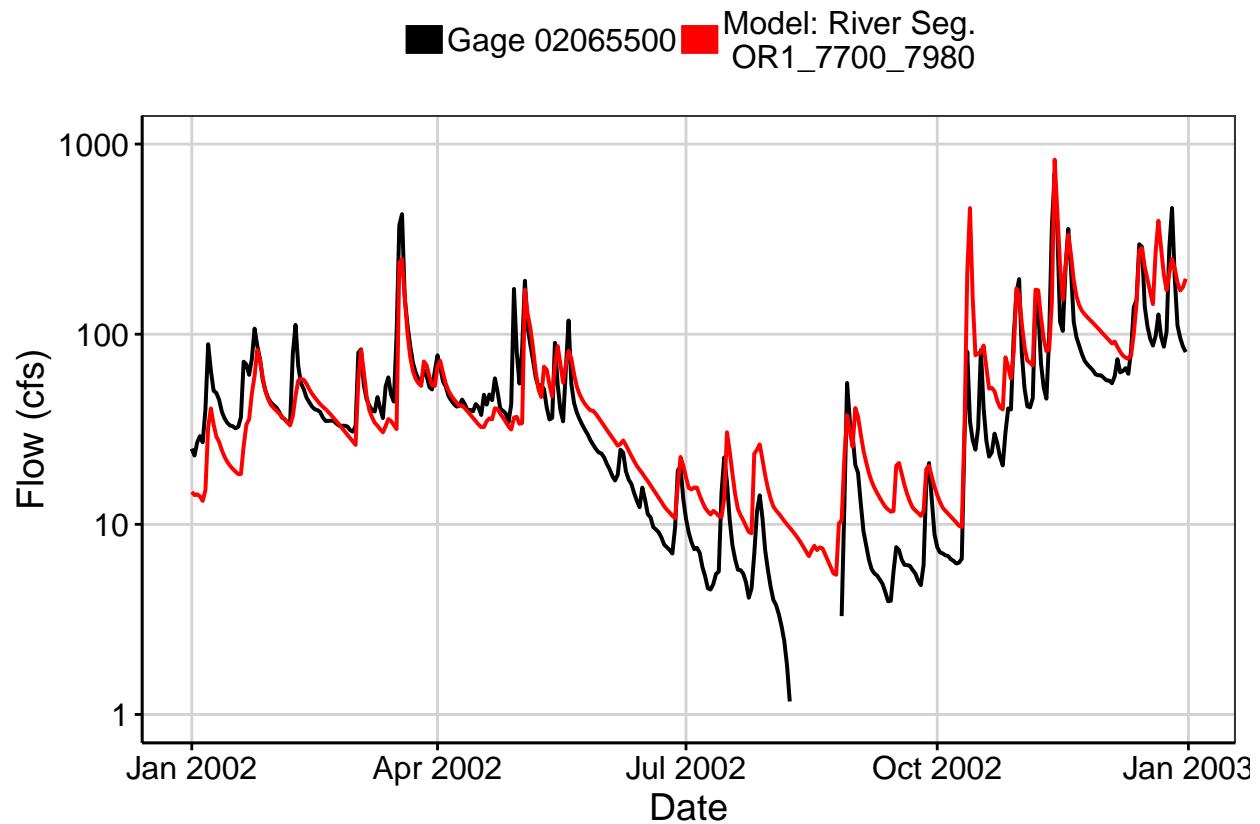


Fig. 3: Flow Exceedance

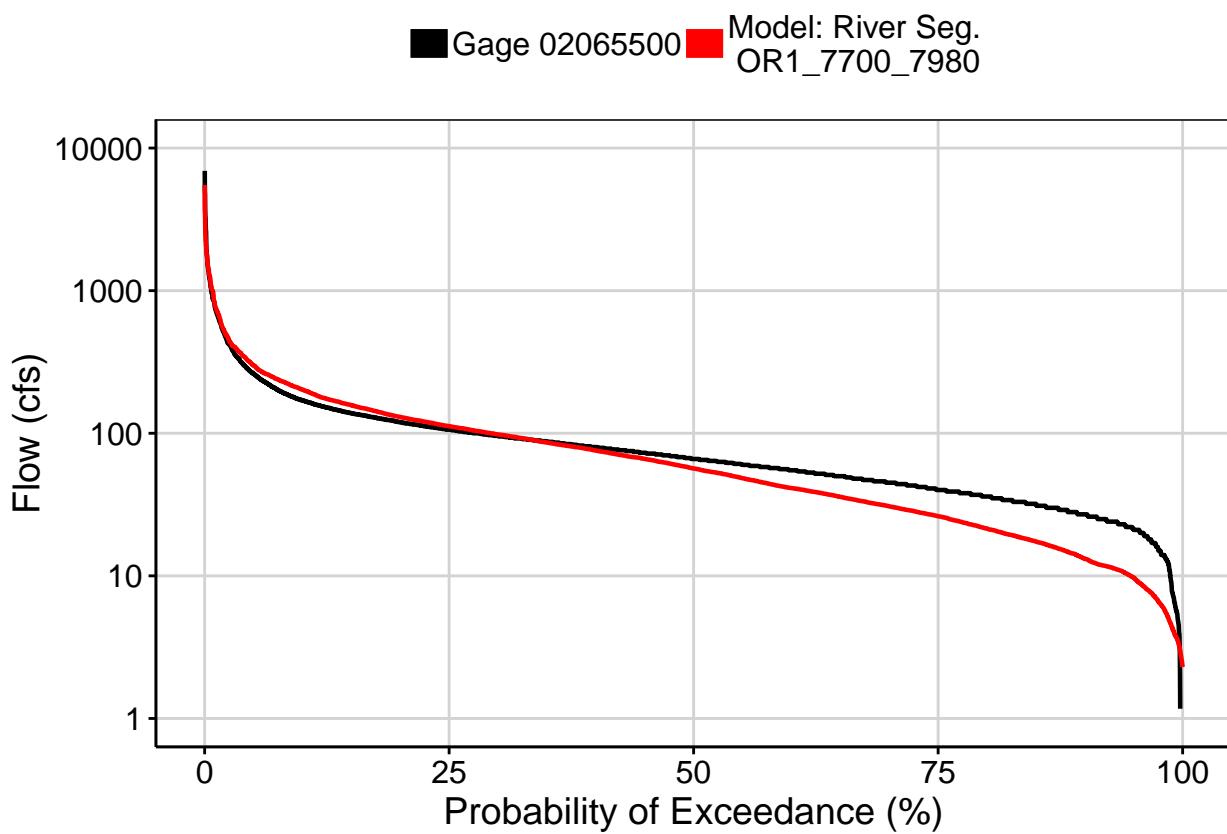


Fig. 4: Baseflow

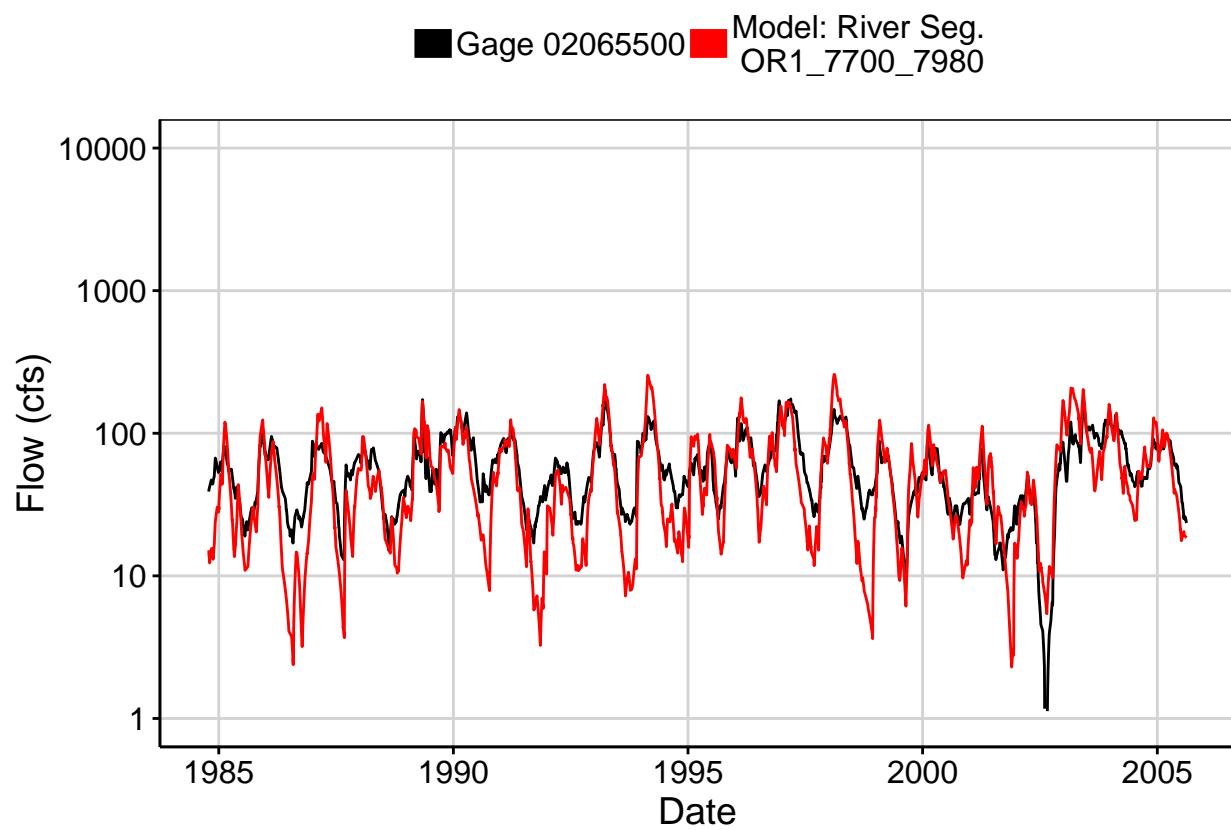


Fig. 5: Combined Baseflow

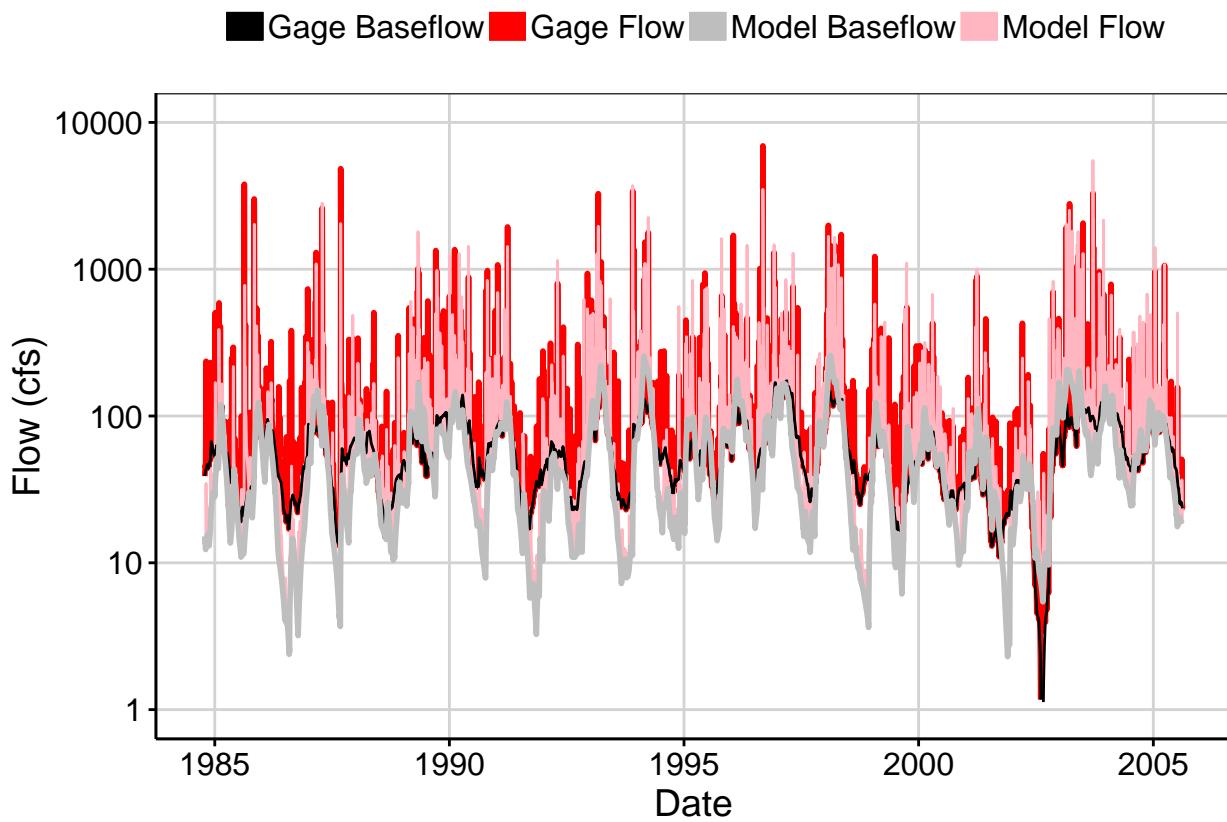


Fig. 6: Largest Error Segment

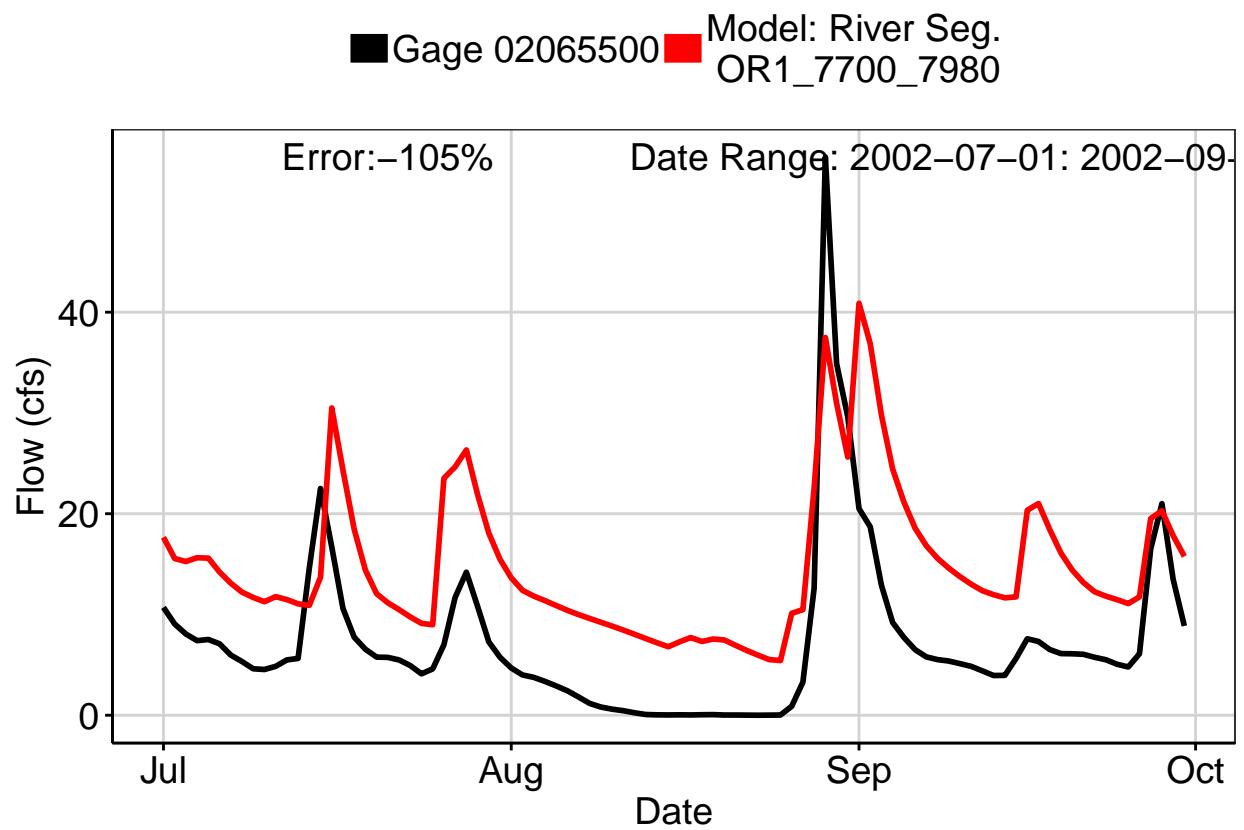


Fig. 7: Second Largest Error Segment

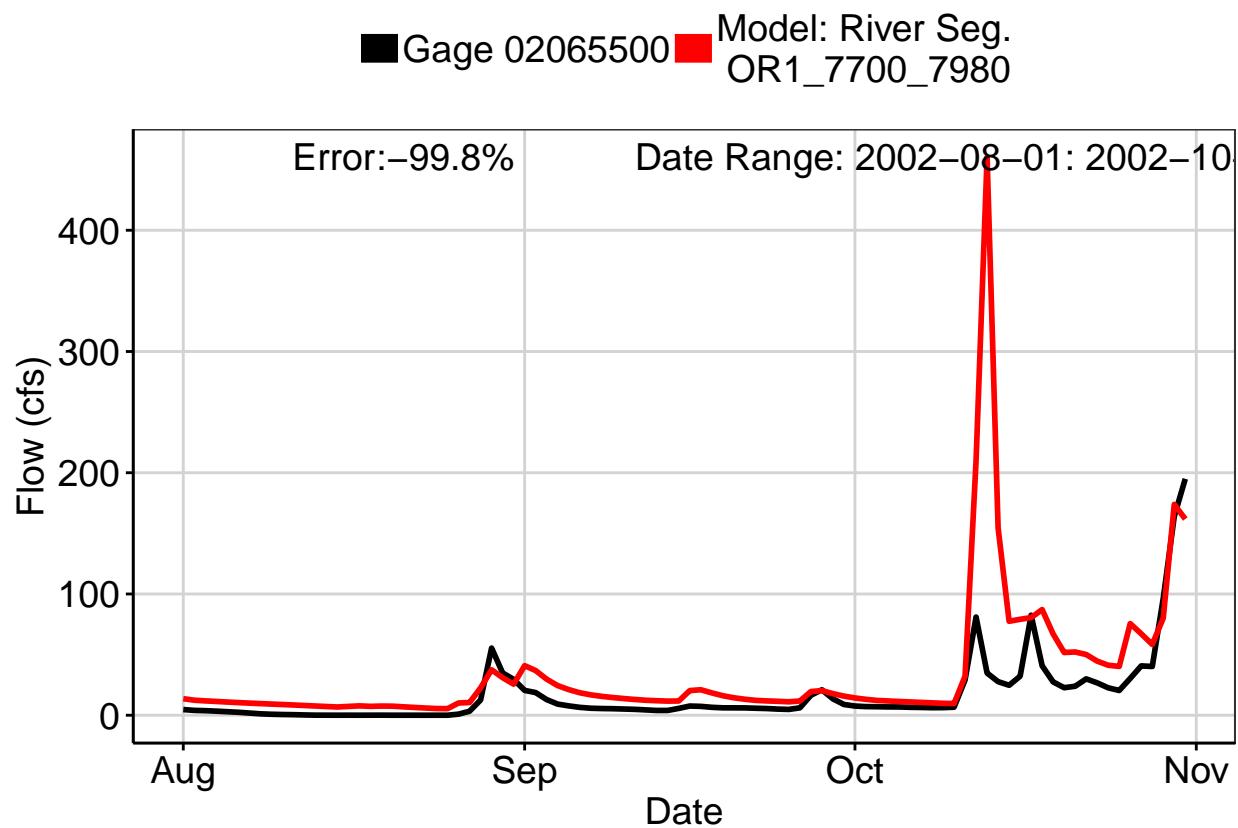


Fig. 8: Third Largest Error Segment

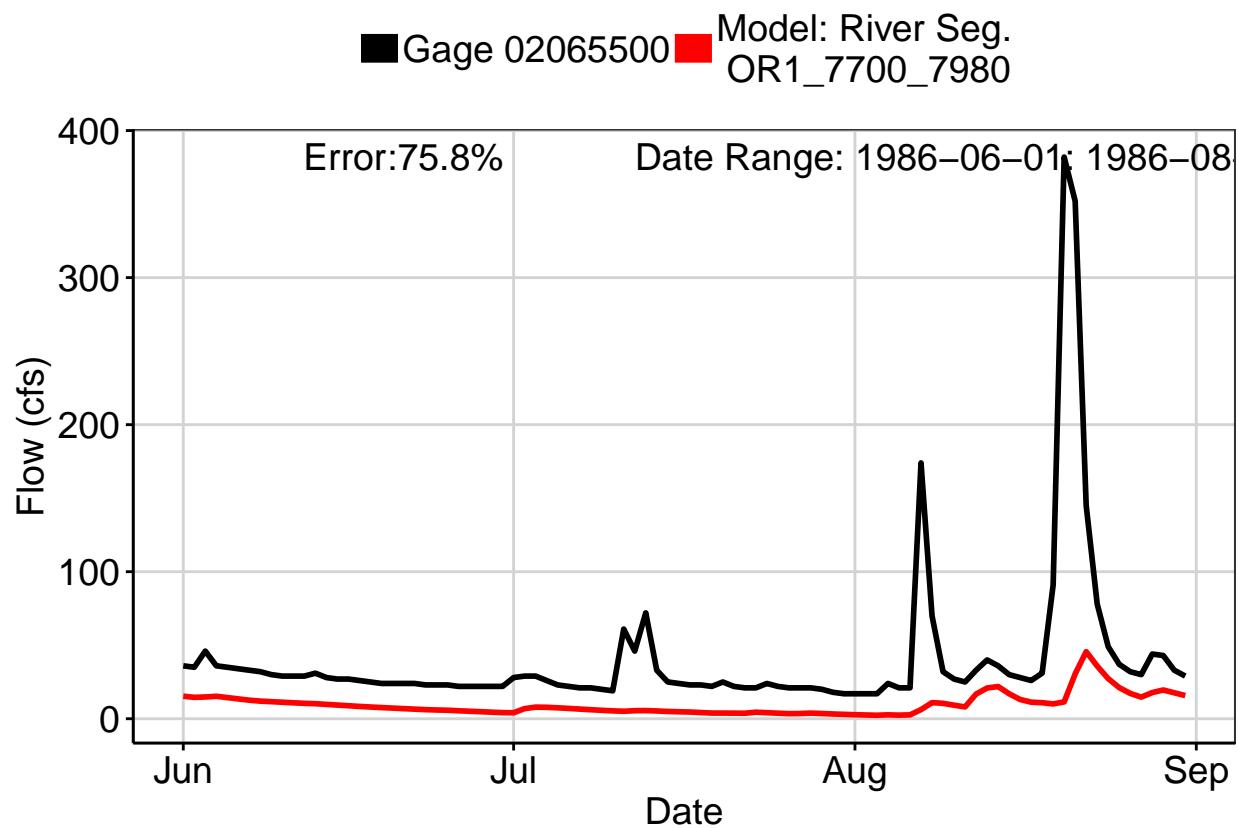
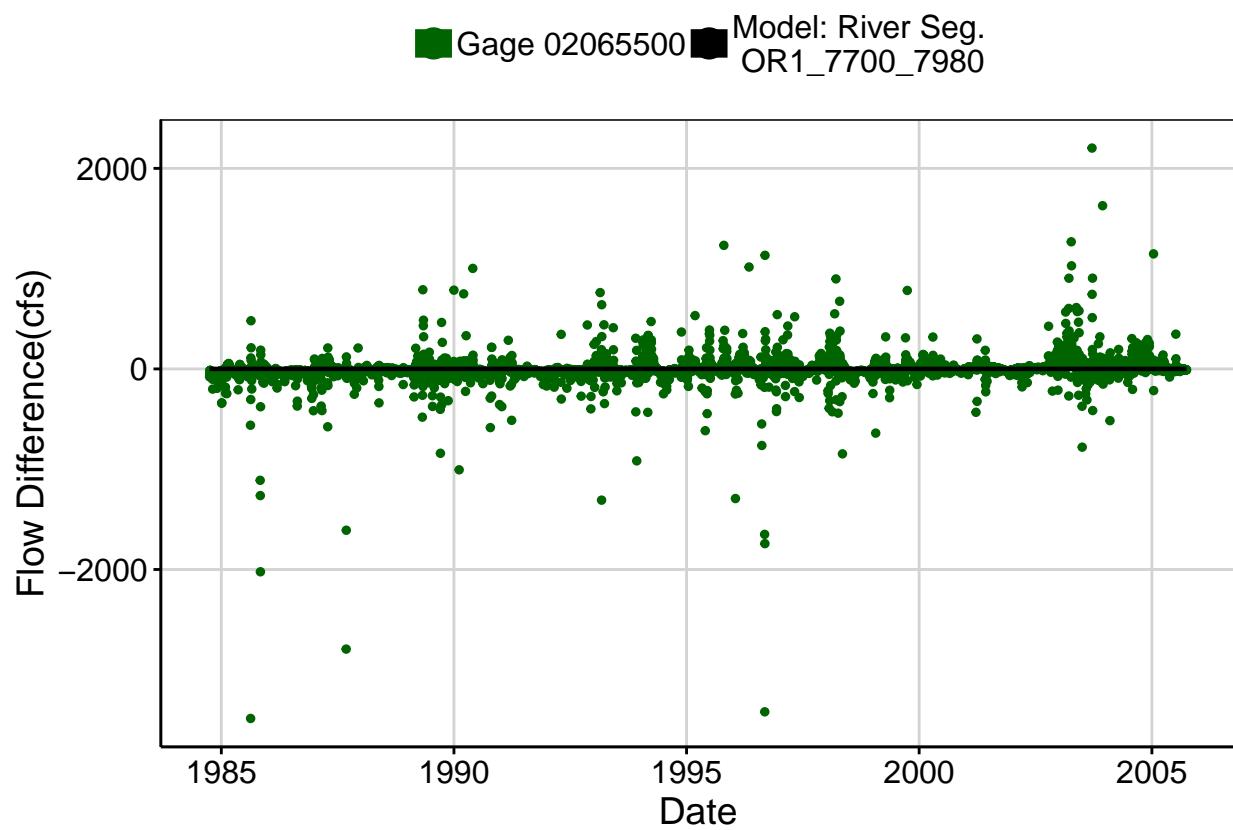
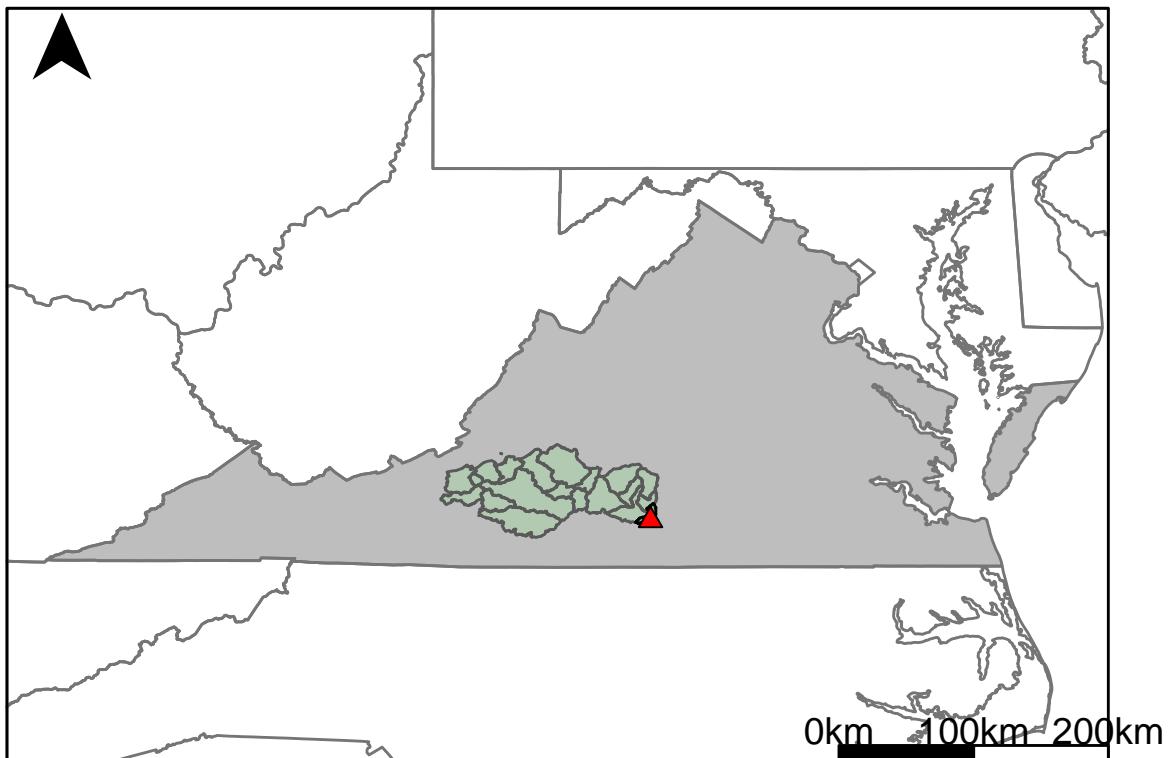


Fig. 9: Residuals Plot



## Appendix H.13: USGS Gage 02066000 vs. OR5\_8200\_8370



This river segment follows part of the flow of the Roanoke River. The gage is located in Halifax County, VA (Lat 36°54'54", Long 78°44'28") approximately 43 miles northeast of Danville, VA. Drainage area is 2966 sq. miles. This gage started taking data in 1901 and is still taking data. Flow in this area is regulated by Leesville Lake, approximately 68.7 miles upstream, and Smith Mountain Lake, approximately 86.7 miles upstream. Both of these lakes have dams associated with them but there are no diversions. The average daily discharge error between the model and gage data for the 20 year timespan was -0.32%, with 42.1% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	1040	613	41.1
Feb. Low Flow	1220	722	40.8
Mar. Low Flow	1230	1380	-12.2
Apr. Low Flow	1270	1890	-48.8
May Low Flow	1500	2590	-72.7
Jun. Low Flow	1680	2800	-66.7
Jul. Low Flow	1560	1740	-11.5
Aug. Low Flow	1930	1300	32.6
Sep. Low Flow	1350	1100	18.5
Oct. Low Flow	1140	738	35.3
Nov. Low Flow	1050	688	34.5
Dec. Low Flow	959	657	31.5

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	3090	3100	-0.32
Jan. Mean Flow	3570	3870	-8.4
Feb. Mean Flow	4070	4720	-16
Mar. Mean Flow	4860	5650	-16.3
Apr. Mean Flow	4610	4690	-1.74
May Mean Flow	3450	3210	6.96
Jun. Mean Flow	2790	2620	6.09
Jul. Mean Flow	2030	1610	20.7
Aug. Mean Flow	1880	1410	25
Sep. Mean Flow	2680	2440	8.96
Oct. Mean Flow	2010	1980	1.49
Nov. Mean Flow	2510	2360	5.98
Dec. Mean Flow	2740	2770	-1.09

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	2170	1360	37.3
Feb. High Flow	6200	3520	43.2
Mar. High Flow	4320	4370	-1.16
Apr. High Flow	9350	8710	6.84
May High Flow	10400	6450	38
Jun. High Flow	13400	13300	0.75
Jul. High Flow	11500	11900	-3.48
Aug. High Flow	5830	5290	9.26
Sep. High Flow	4470	3570	20.1
Oct. High Flow	3300	1980	40
Nov. High Flow	2860	1440	49.7
Dec. High Flow	2670	1220	54.3

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	350	109	68.9
Med. 1 Day Min	918	389	57.6
Min. 3 Day Min	393	110	72
Med. 3 Day Min	945	405	57.1
Min. 7 Day Min	406	113	72.2
Med. 7 Day Min	972	423	56.5
Min. 30 Day Min	458	145	68.3
Med. 30 Day Min	1060	616	41.9
Min. 90 Day Min	522	272	47.9
Med. 90 Day Min	1400	848	39.4
7Q10	605	170	71.9
Year of 90-Day Min. Flow	2002	2002	0
Drought Year Mean	852	3100	-264
Mean Baseflow	1640	1830	-11.6

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	78700	74600	5.21
Med. 1 Day Max	31500	35200	-11.7
Max. 3 Day Max	63200	61900	2.06
Med. 3 Day Max	26600	23000	13.5
Max. 7 Day Max	37000	36600	1.08
Med. 7 Day Max	18500	16600	10.3
Max. 30 Day Max	18300	16300	10.9
Med. 30 Day Max	7600	8090	-6.45
Max. 90 Day Max	10600	12000	-13.2
Med. 90 Day Max	5320	5750	-8.08

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	489	177	63.8
5% Non-Exceedance	781	397	49.2
50% Non-Exceedance	1860	1830	1.61
95% Non-Exceedance	8880	9560	-7.66
99% Non-Exceedance	23100	20900	9.52
Sept. 10% Non-Exceedance	413	413	0

**Fig. 1: Hydrograph**

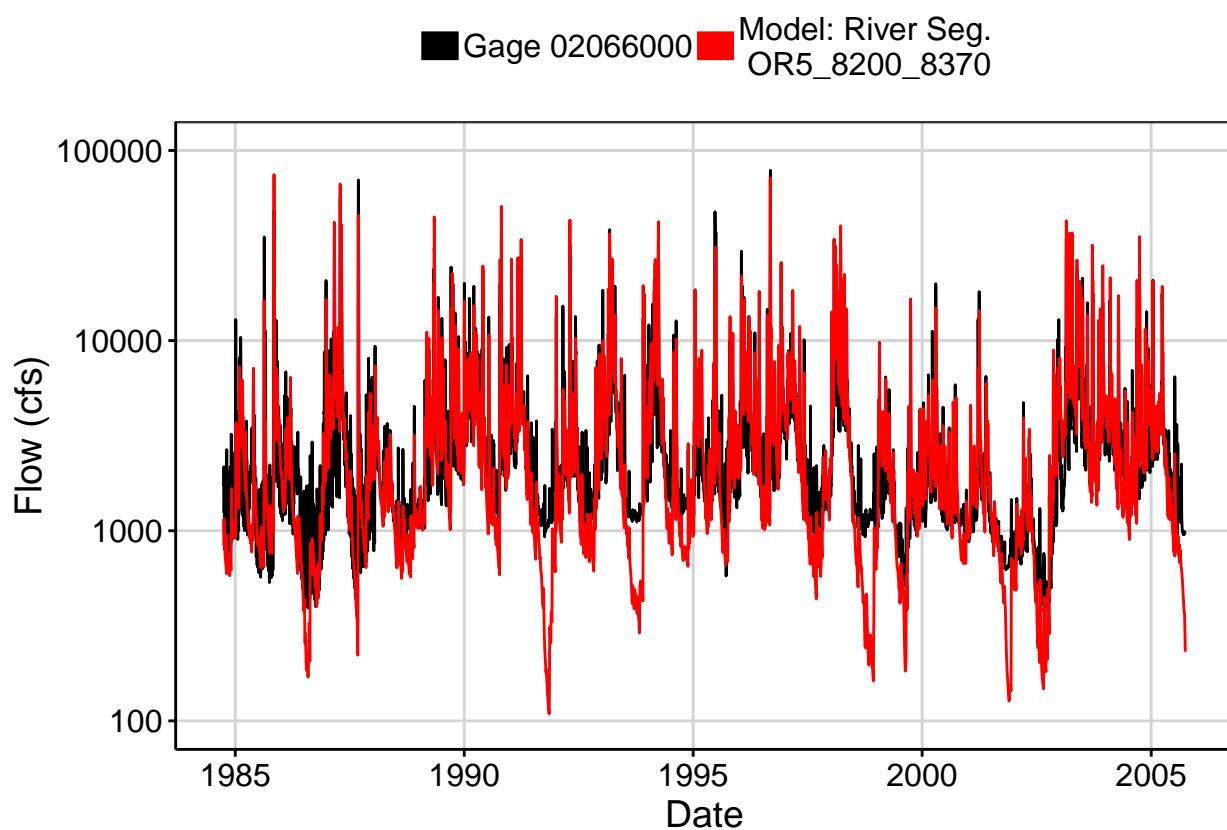


Fig. 2: Zoomed Hydrograph

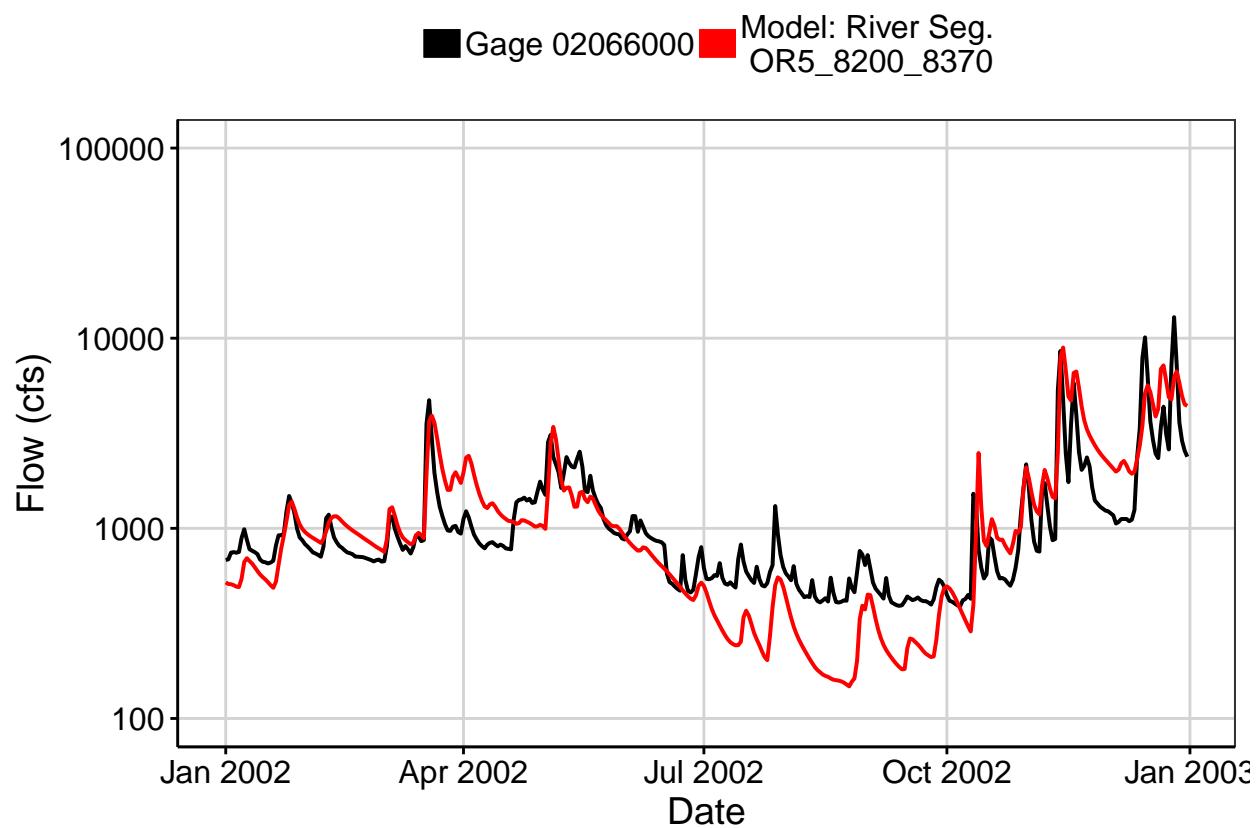


Fig. 3: Flow Exceedance

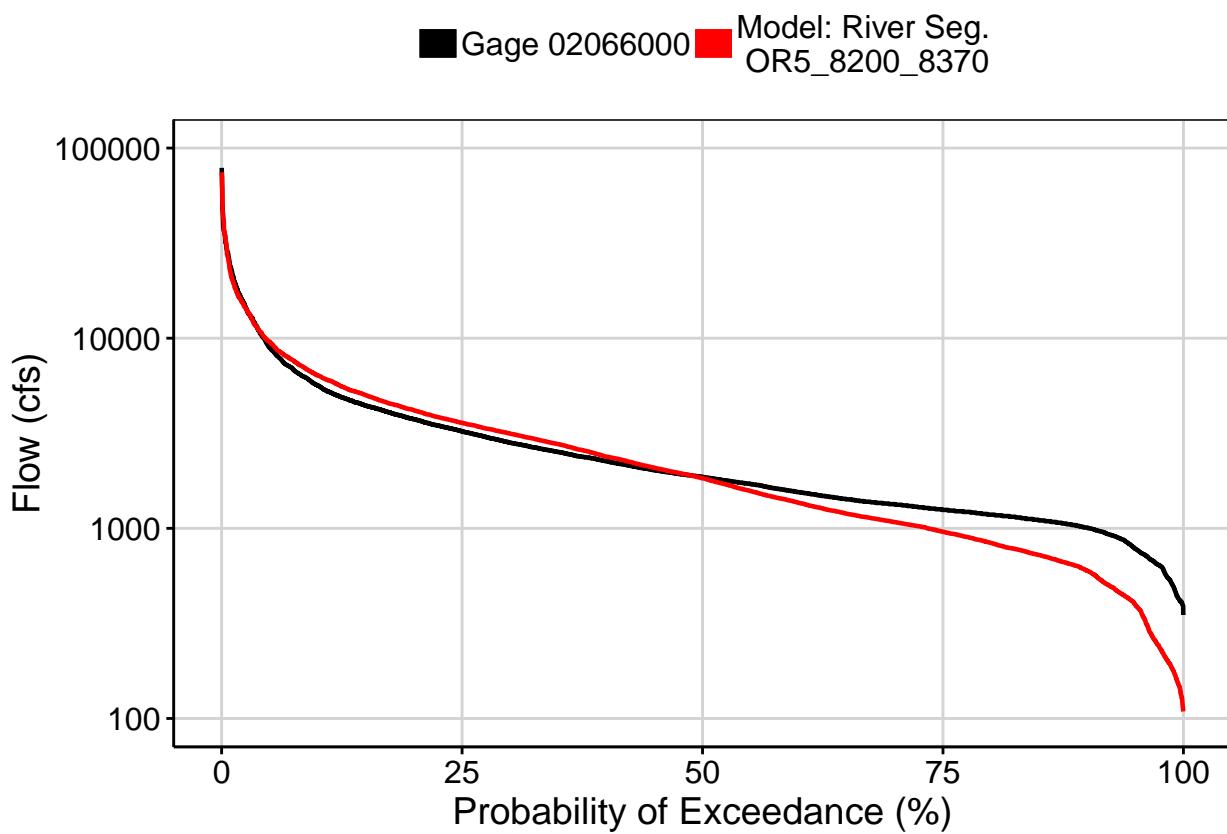


Fig. 4: Baseflow

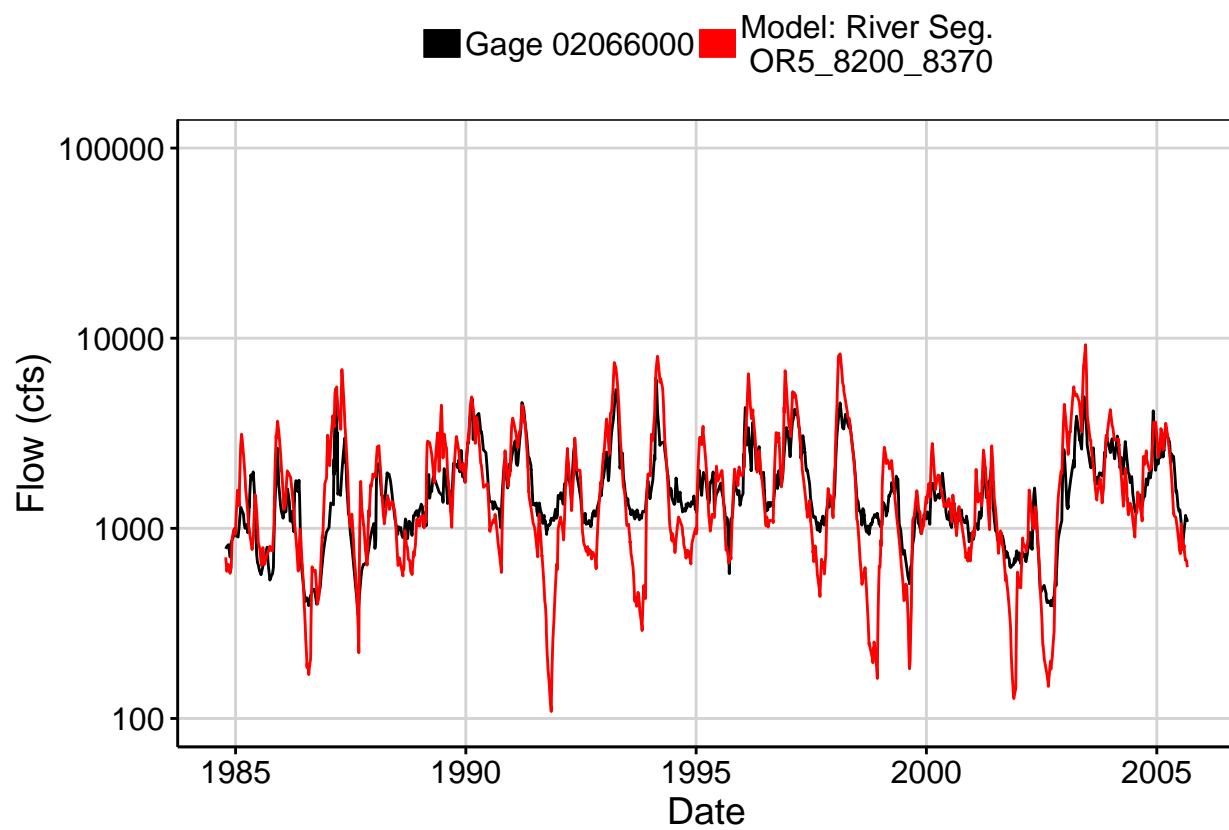


Fig. 5: Combined Baseflow

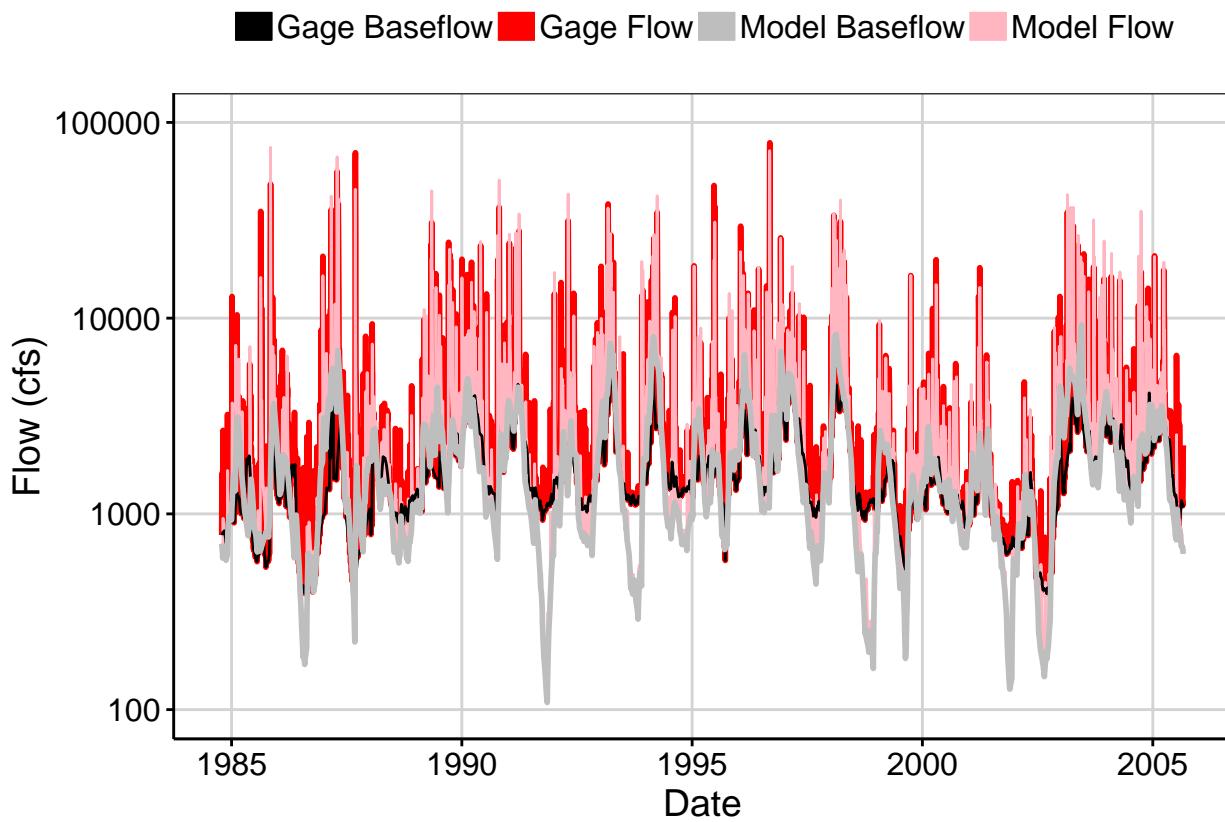


Fig. 6: Largest Error Segment

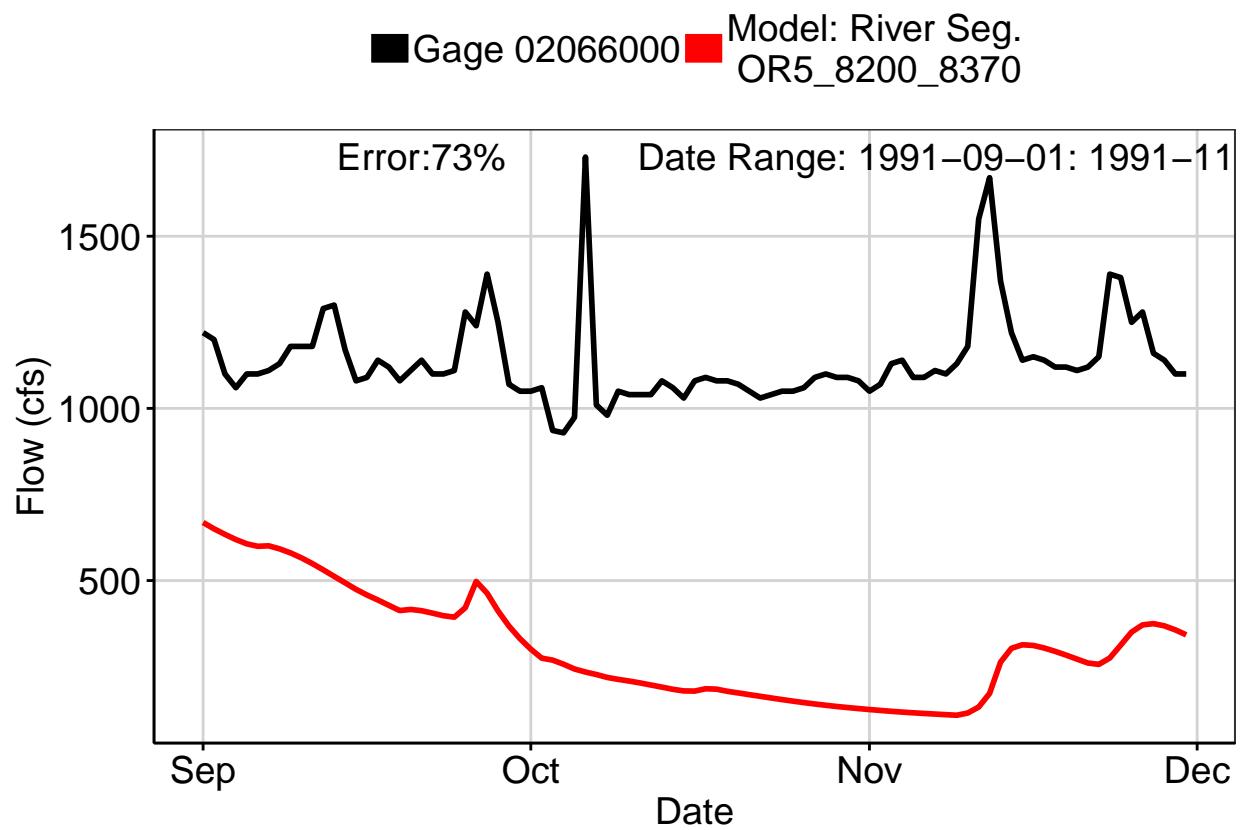


Fig. 7: Second Largest Error Segment

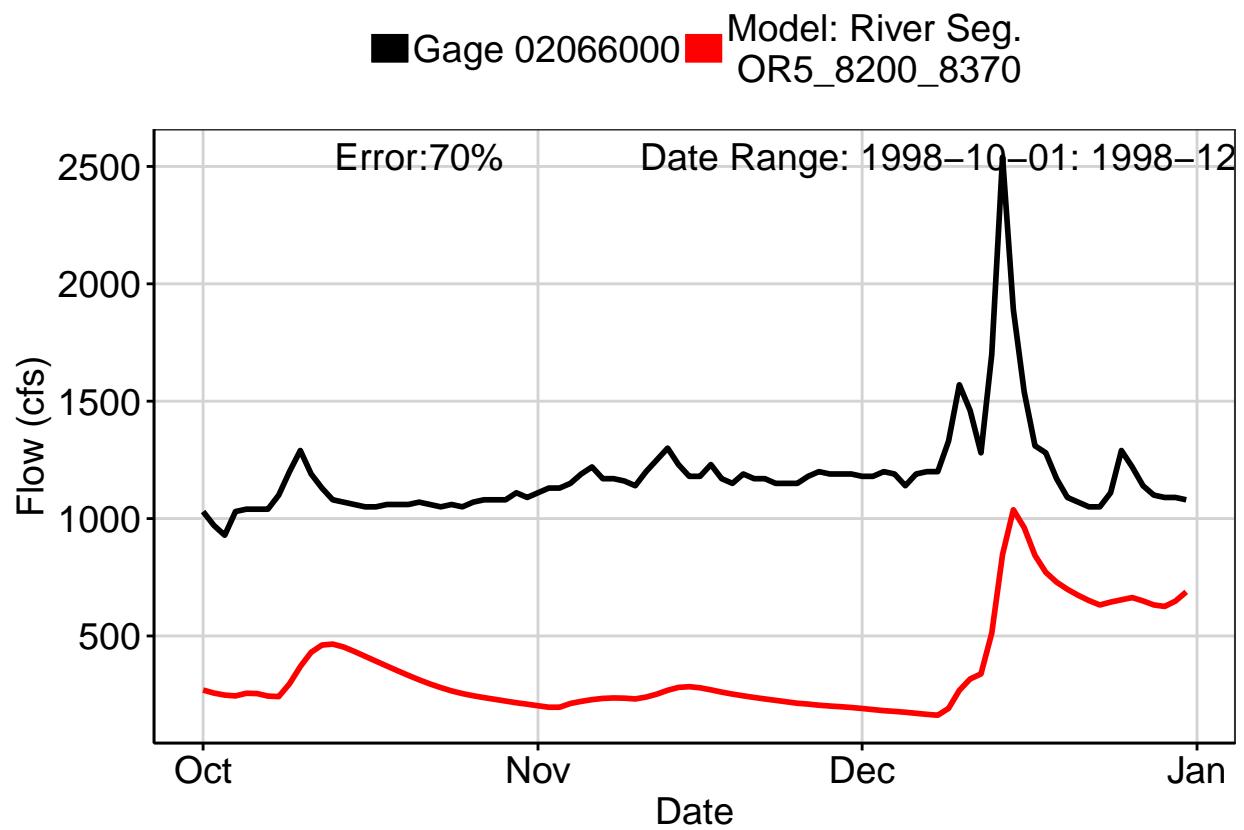


Fig. 8: Third Largest Error Segment

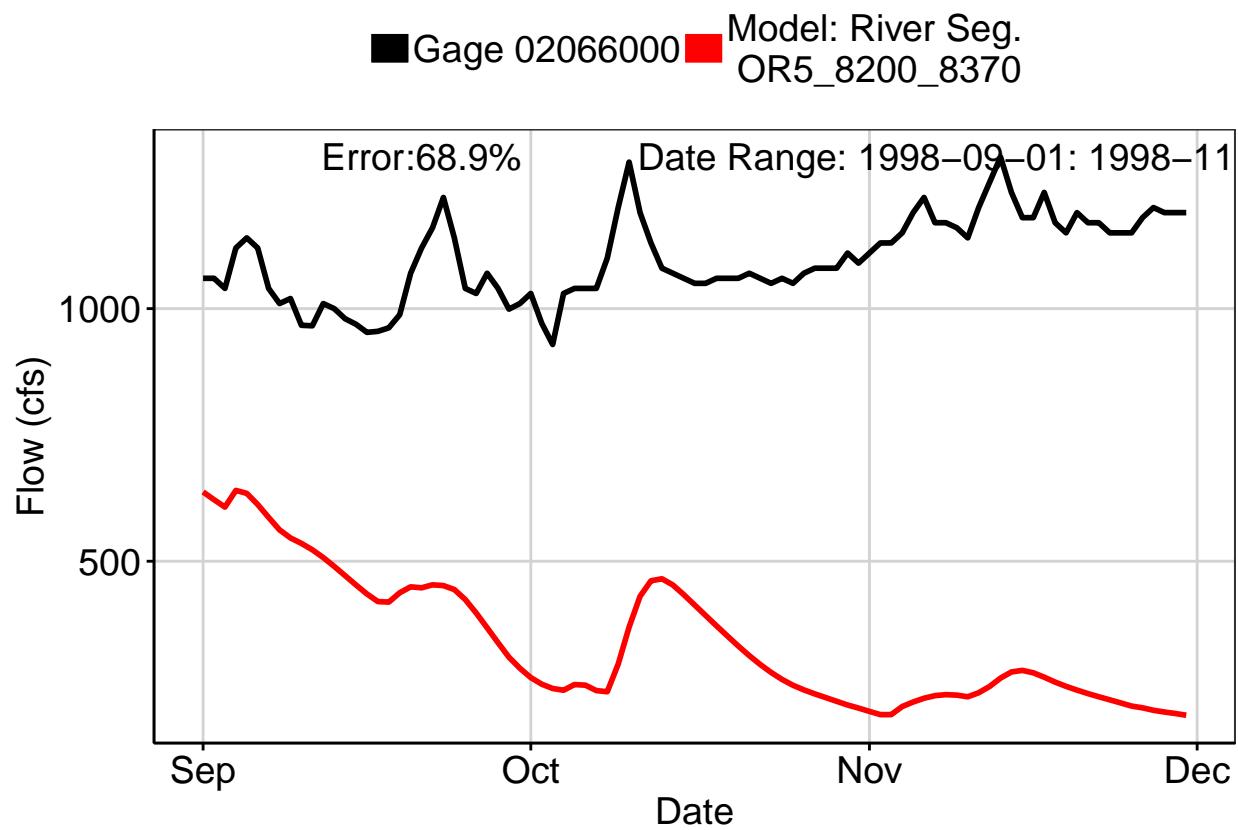
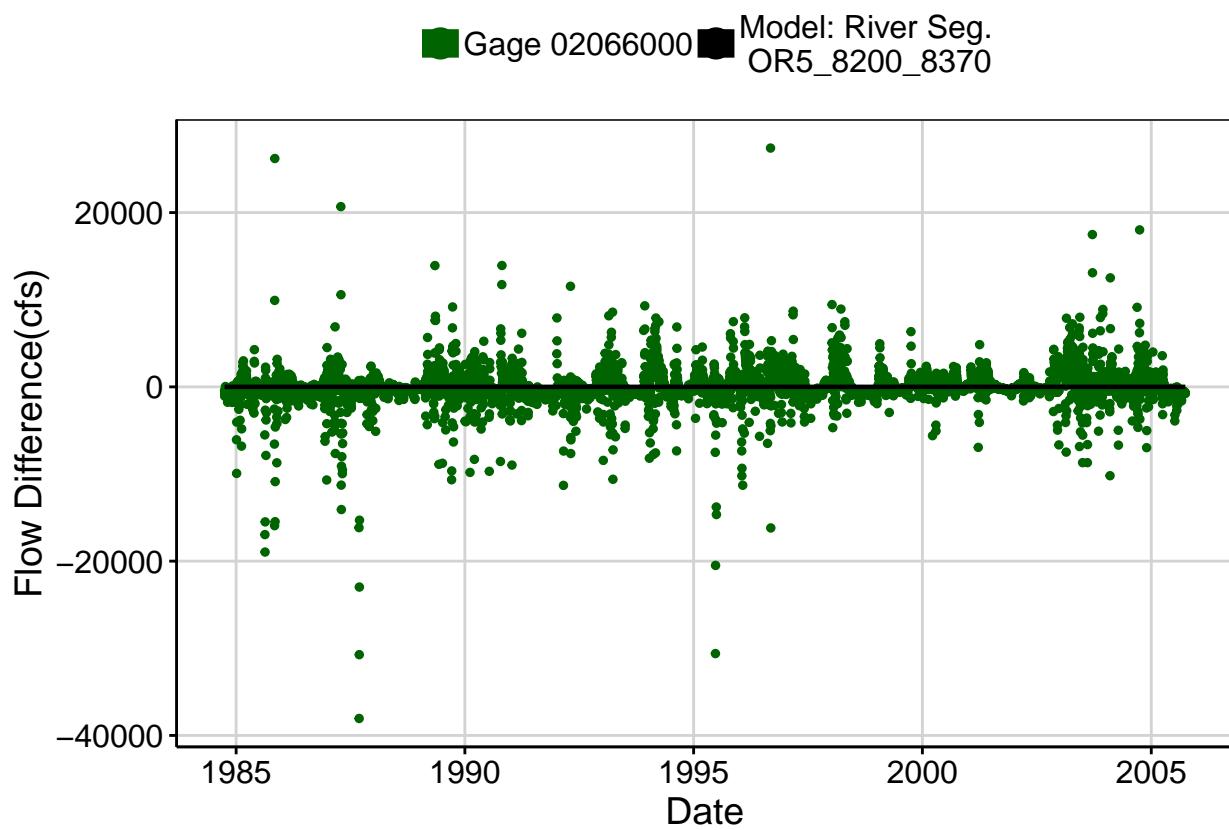
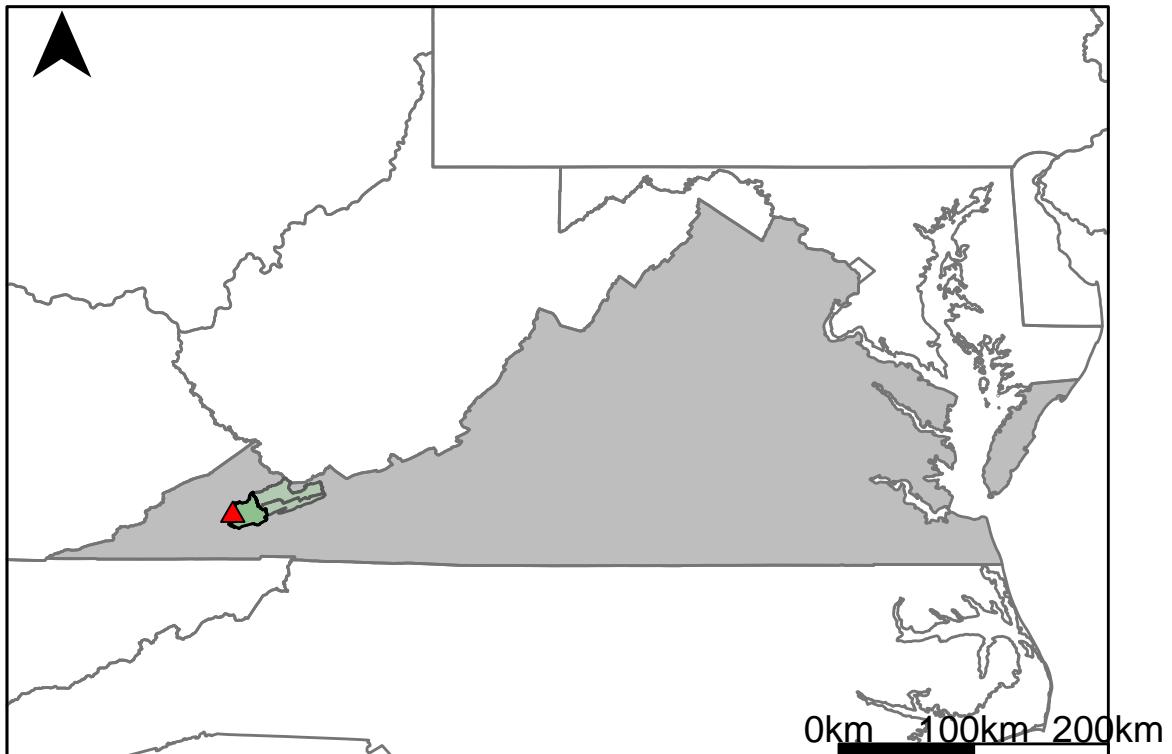


Fig. 9: Residuals Plot



# Appendix I: Tennessee River Gages

## Appendix I.1: USGS Gage 03524000 vs. TU4\_8680\_8810



This river segment follows part of the flow of the Clinch River, a tributary of the Tennessee River. The gage is located in Russell County, VA (Lat 36°56'41", Long 82°09'18") approximately 24 miles north of Bristol, VA. Drainage area is 533 sq. miles. This gage started taking data in 1920 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was -0.28%, with 39.2% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	91	86.8	4.62
Feb. Low Flow	94.1	178	-89.2
Mar. Low Flow	201	250	-24.4
Apr. Low Flow	270	396	-46.7
May Low Flow	481	491	-2.08
Jun. Low Flow	488	586	-20.1
Jul. Low Flow	441	398	9.75
Aug. Low Flow	307	245	20.2
Sep. Low Flow	189	193	-2.12
Oct. Low Flow	153	116	24.2
Nov. Low Flow	114	122	-7.02
Dec. Low Flow	93	83.5	10.2

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	701	703	-0.28
Jan. Mean Flow	1010	1010	0
Feb. Mean Flow	1360	1430	-5.15
Mar. Mean Flow	1340	1310	2.24
Apr. Mean Flow	1110	965	13.1
May Mean Flow	826	715	13.4
Jun. Mean Flow	567	512	9.7
Jul. Mean Flow	352	354	-0.57
Aug. Mean Flow	294	326	-10.9
Sep. Mean Flow	215	301	-40
Oct. Mean Flow	222	334	-50.5
Nov. Mean Flow	435	479	-10.1
Dec. Mean Flow	738	754	-2.17

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	215	354	-64.7
Feb. High Flow	1260	923	26.7
Mar. High Flow	2500	1300	48
Apr. High Flow	3210	3520	-9.66
May High Flow	5120	3250	36.5
Jun. High Flow	3530	3990	-13
Jul. High Flow	1940	1800	7.22
Aug. High Flow	2750	1660	39.6
Sep. High Flow	1050	938	10.7
Oct. High Flow	787	493	37.4
Nov. High Flow	533	479	10.1
Dec. High Flow	346	354	-2.31

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	39	8.21	78.9
Med. 1 Day Min	70	35.7	49
Min. 3 Day Min	44	8.65	80.3
Med. 3 Day Min	70.3	38.6	45.1
Min. 7 Day Min	49	10	79.6
Med. 7 Day Min	72.9	45.6	37.4
Min. 30 Day Min	62.7	27.6	56
Med. 30 Day Min	90.8	74.4	18.1
Min. 90 Day Min	83.4	69.6	16.5
Med. 90 Day Min	172	191	-11
7Q10	55.4	18.4	66.8
Year of 90-Day Min. Flow	1988	1988	0
Drought Year Mean	287	703	-145
Mean Baseflow	333	375	-12.6

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	20100	19100	4.98
Med. 1 Day Max	8530	8170	4.22
Max. 3 Day Max	11400	13200	-15.8
Med. 3 Day Max	6190	5140	17
Max. 7 Day Max	6930	7210	-4.04
Med. 7 Day Max	4030	3390	15.9
Max. 30 Day Max	3410	4050	-18.8
Med. 30 Day Max	2050	1920	6.34
Max. 90 Day Max	2210	2720	-23.1
Med. 90 Day Max	1430	1410	1.4

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	60.7	34	44
5% Non-Exceedance	83	74	10.8
50% Non-Exceedance	371	423	-14
95% Non-Exceedance	2270	2070	8.81
99% Non-Exceedance	5020	4980	0.8
Sept. 10% Non-Exceedance	56.1	55.9	0.36

**Fig. 1: Hydrograph**

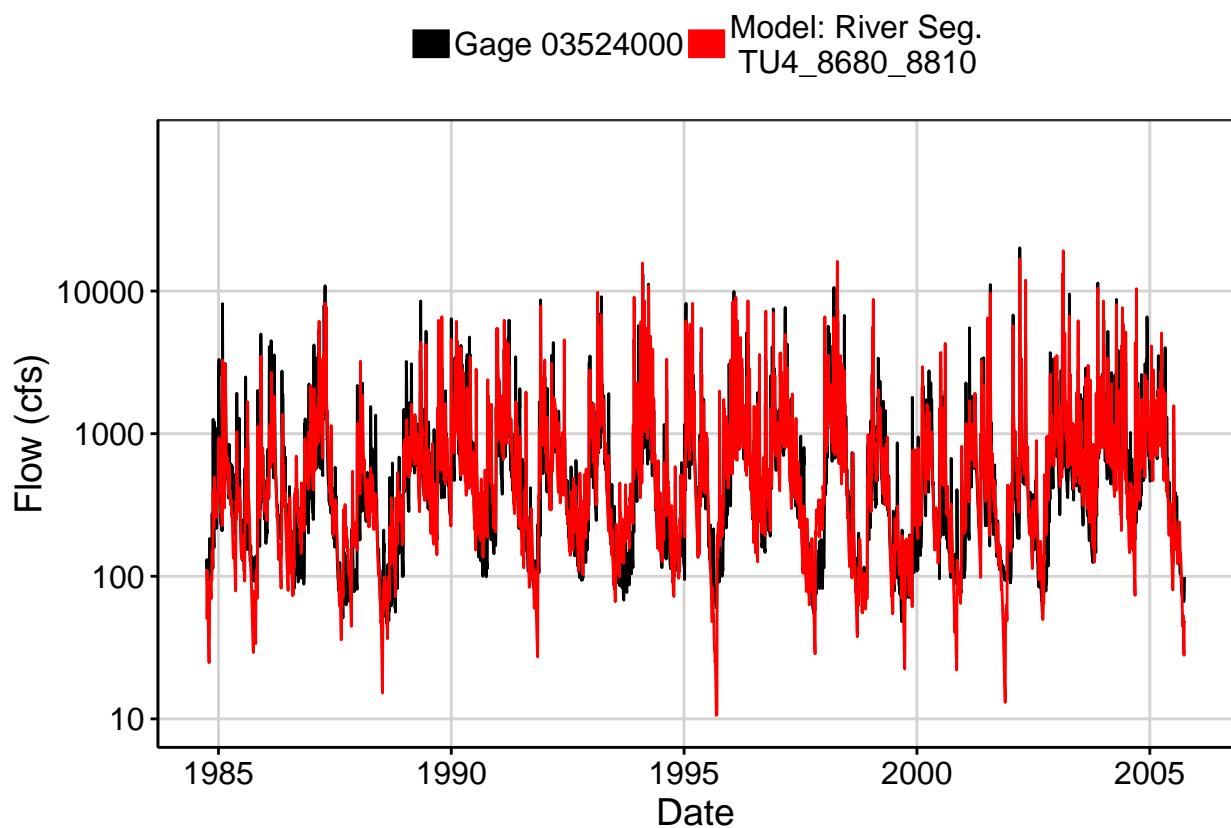


Fig. 2: Zoomed Hydrograph

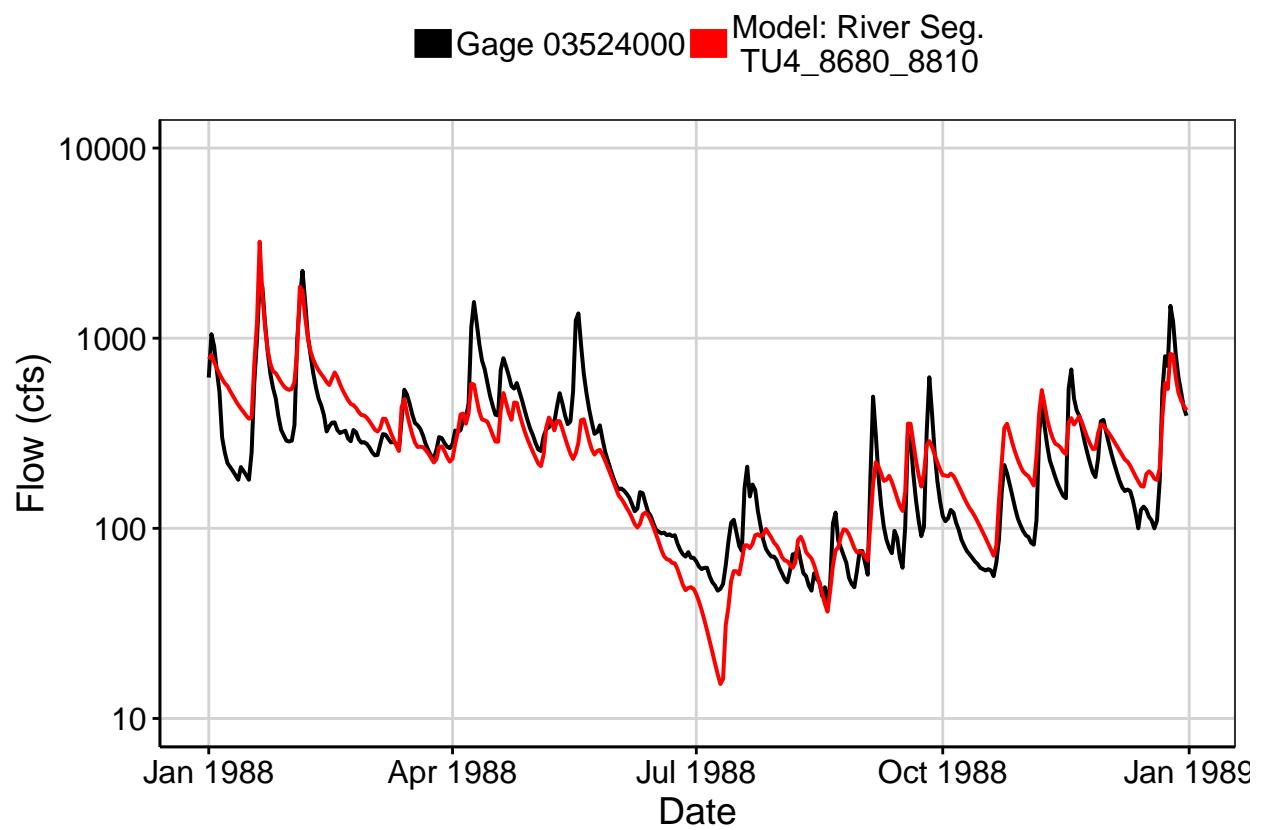


Fig. 3: Flow Exceedance

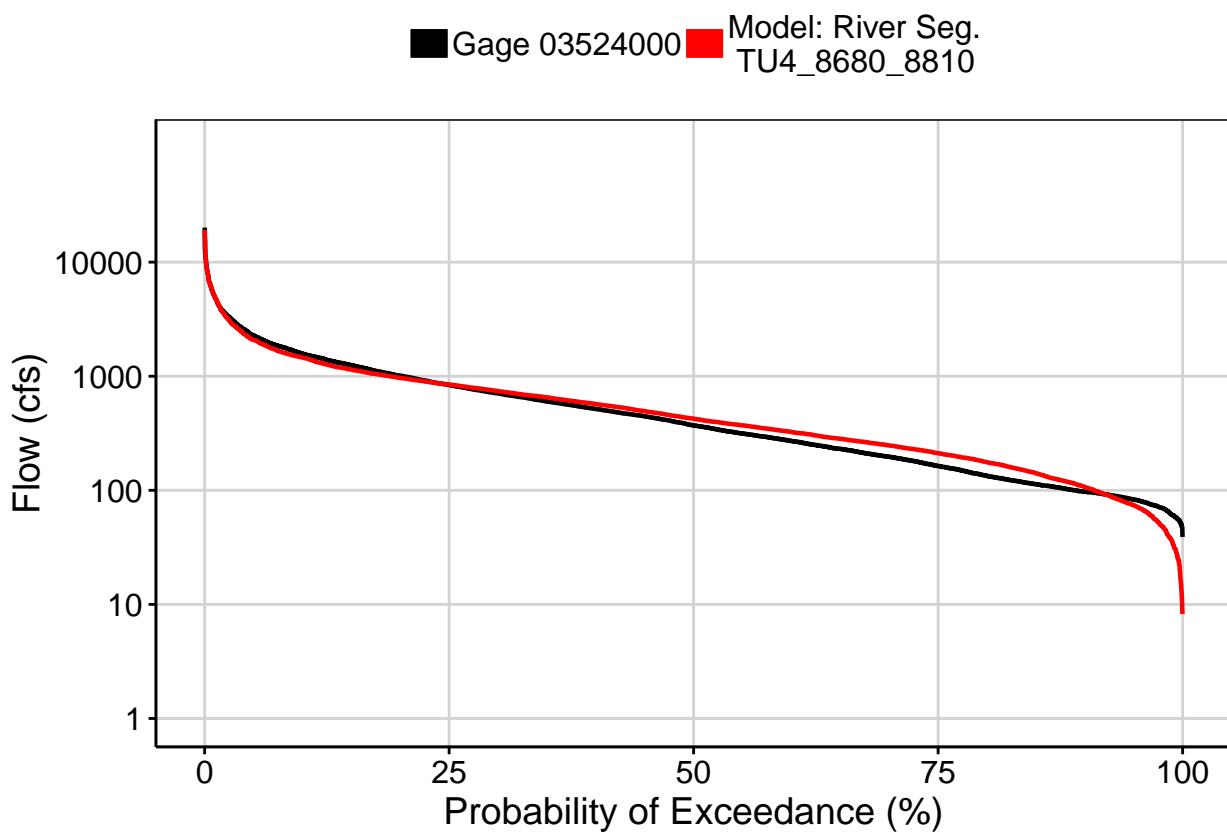


Fig. 4: Baseflow

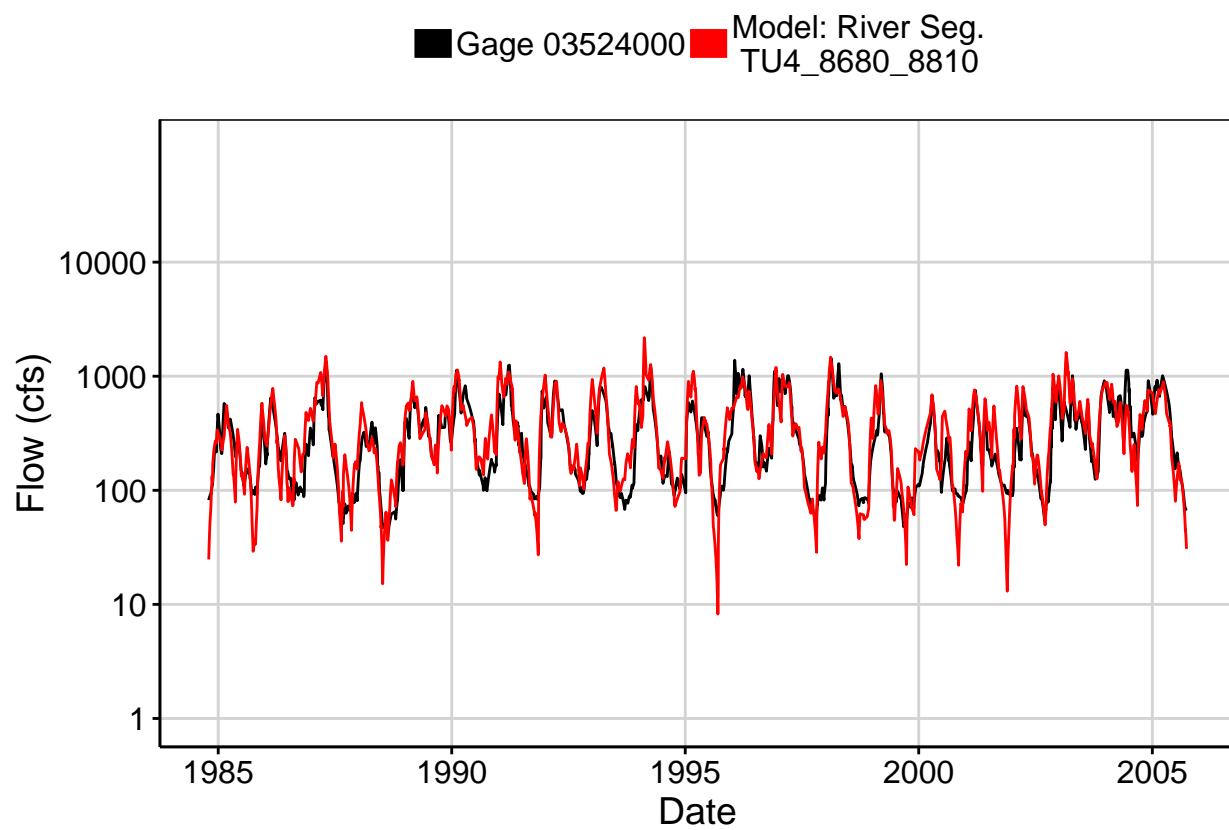


Fig. 5: Combined Baseflow

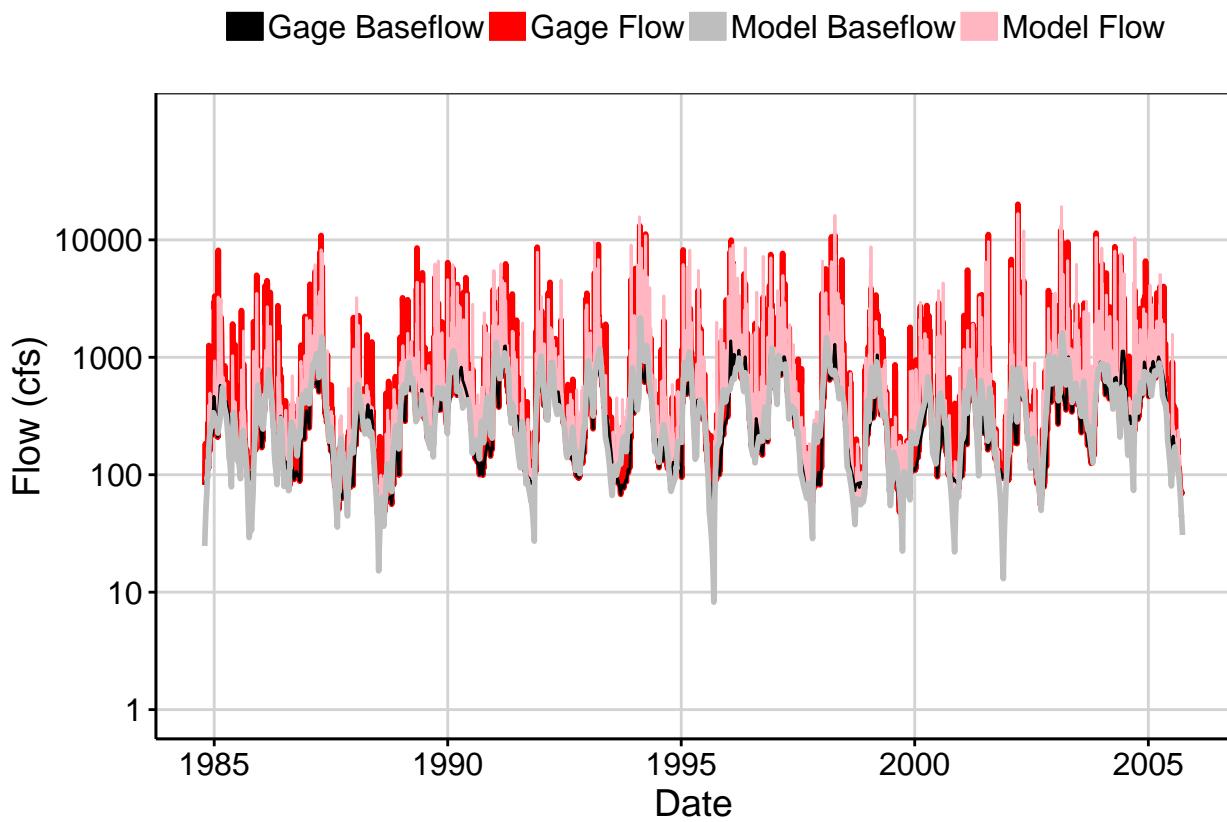


Fig. 6: Largest Error Segment

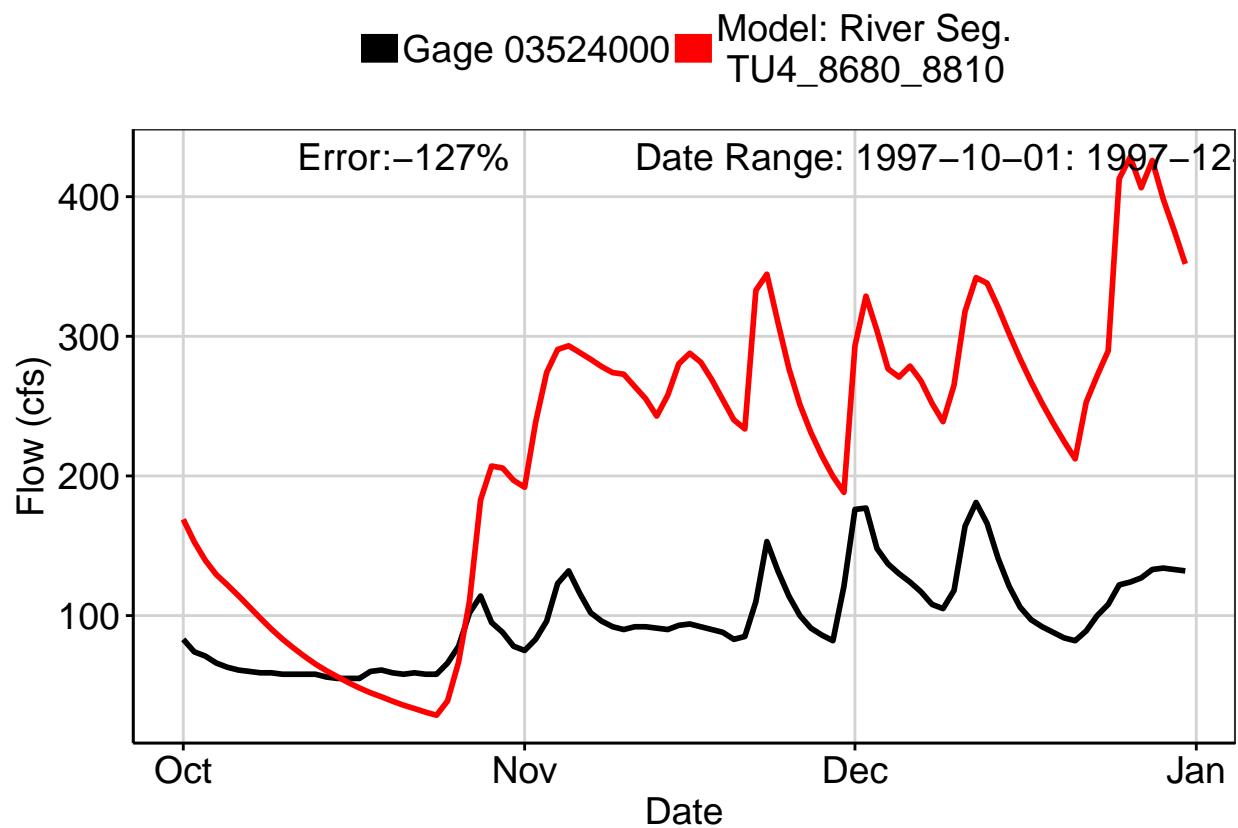


Fig. 7: Second Largest Error Segment

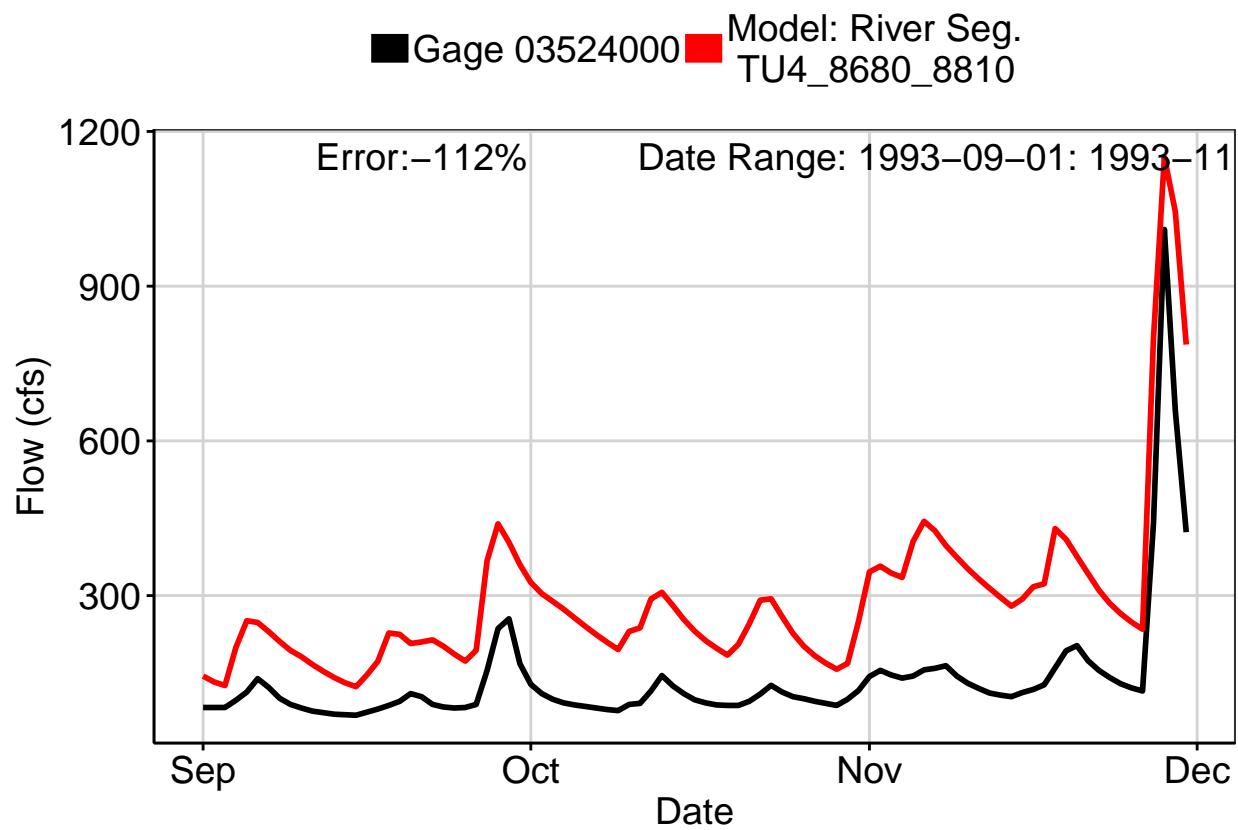


Fig. 8: Third Largest Error Segment

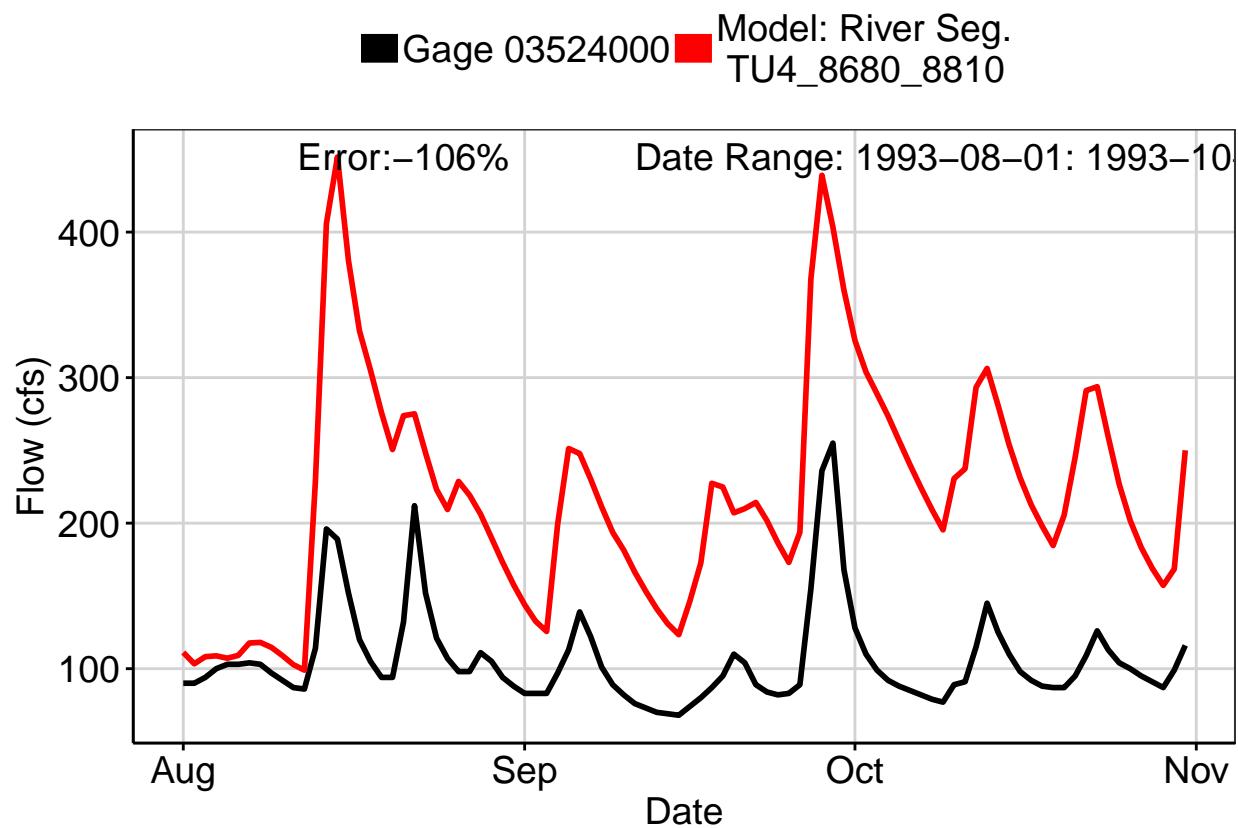
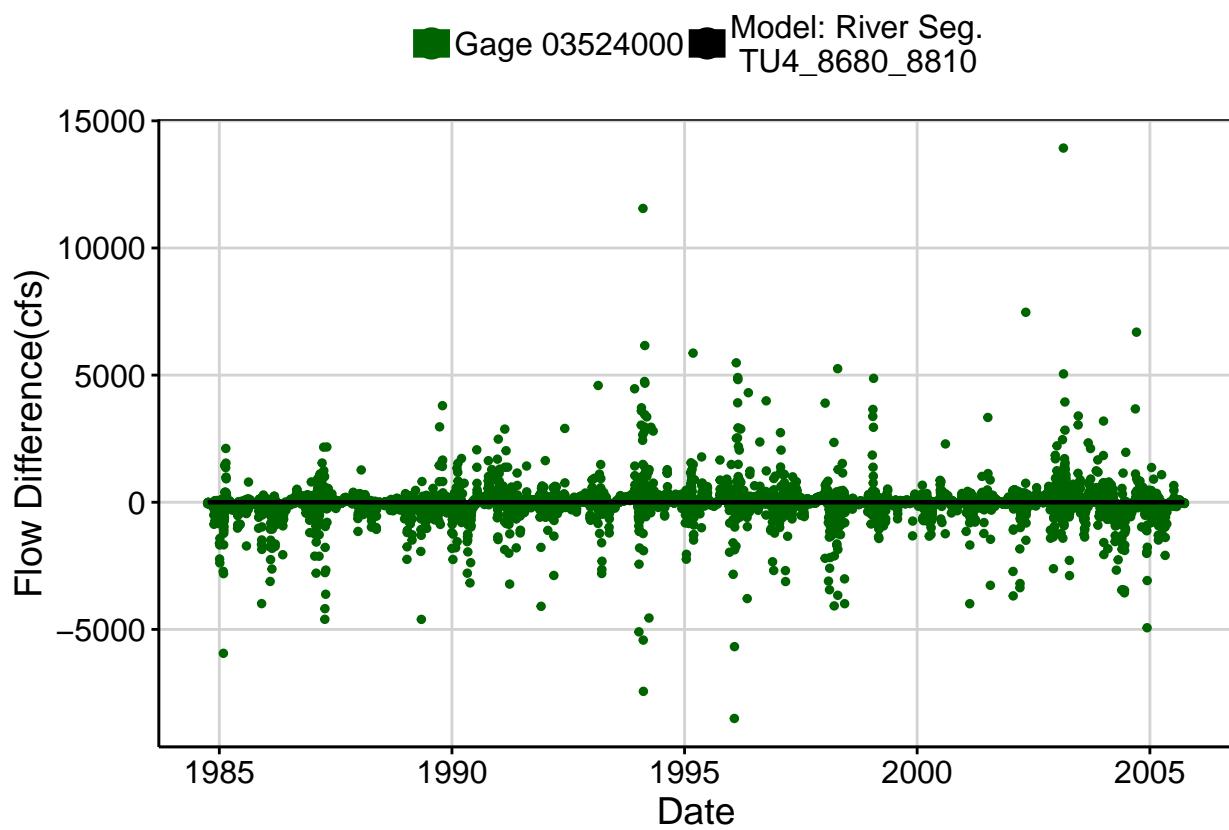
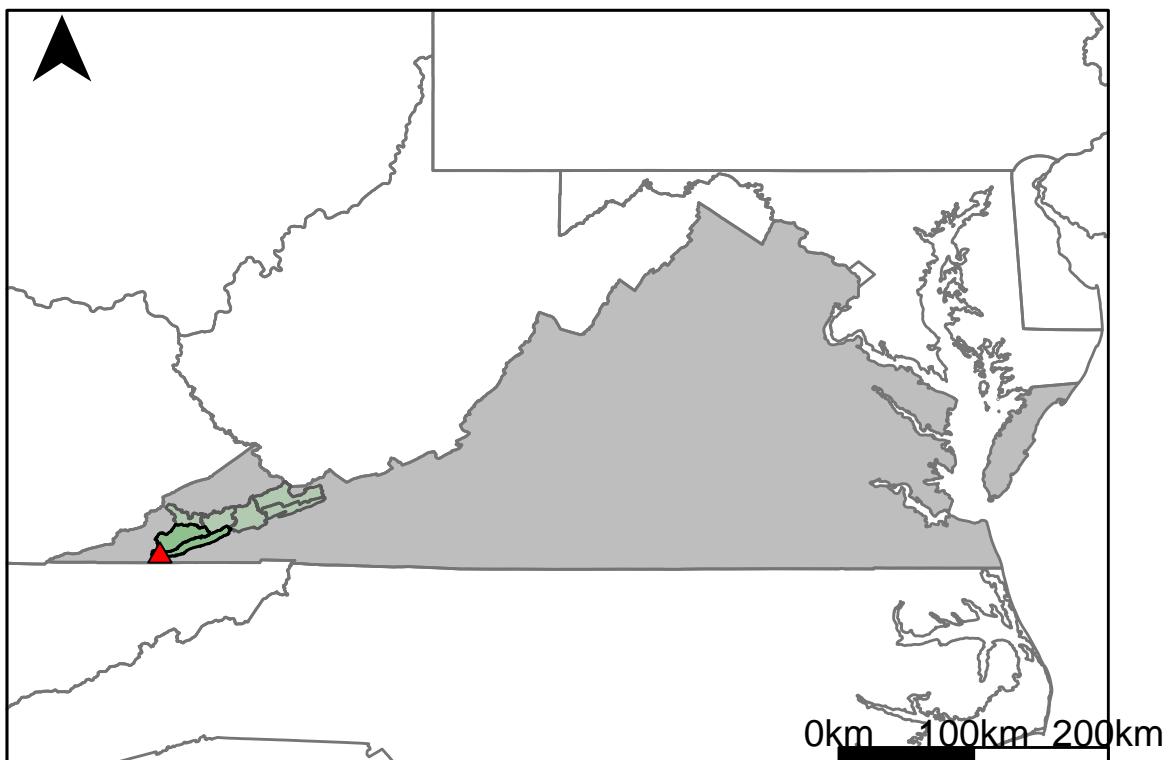


Fig. 9: Residuals Plot



## Appendix I.2: USGS Gage 03527000 vs. TU5\_9000\_9280+TU2\_8970\_9280



This river segment follows part of the flow of the Clinch River, a tributary of the Tennessee River. The gage is located in Scott County, VA (Lat 3638'55", Long 8245'02") approximately 21 miles southwest of Norton, VA. Drainage area is 1123 sq. miles. This gage started taking data in 1920, but there is a gap from 1976-10-13 to 1978-10-02 and another between 1981-09-30 to 2001-09-17. For this reason, analysis was done from 2001-10-01 to 2005-09-30. There are no known anthropogenic alterations that would affect flow in this area. The average daily discharge error between the model and gage data for the 20 year timespan was 28.5%, with 30.6% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	199	179	10.1
Feb. Low Flow	368	310	15.8
Mar. Low Flow	888	509	42.7
Apr. Low Flow	648	778	-20.1
May Low Flow	1160	1060	8.62
Jun. Low Flow	846	1130	-33.6
Jul. Low Flow	1180	754	36.1
Aug. Low Flow	659	444	32.6
Sep. Low Flow	552	395	28.4
Oct. Low Flow	413	247	40.2
Nov. Low Flow	296	262	11.5
Dec. Low Flow	200	181	9.5

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	1790	1280	28.5
Jan. Mean Flow	2200	1860	15.5
Feb. Mean Flow	2890	2650	8.3
Mar. Mean Flow	2780	2400	13.7
Apr. Mean Flow	3270	1790	45.3
May Mean Flow	1800	1270	29.4
Jun. Mean Flow	1860	893	52
Jul. Mean Flow	999	611	38.8
Aug. Mean Flow	722	572	20.8
Sep. Mean Flow	543	515	5.16
Oct. Mean Flow	422	572	-35.5
Nov. Mean Flow	1690	867	48.7
Dec. Mean Flow	2430	1420	41.6

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	746	669	10.3
Feb. High Flow	6450	1960	69.6
Mar. High Flow	5180	2570	50.4
Apr. High Flow	9170	4900	46.6
May High Flow	6580	6420	2.43
Jun. High Flow	7040	6280	10.8
Jul. High Flow	11800	3100	73.7
Aug. High Flow	7580	3700	51.2
Sep. High Flow	3360	1670	50.3
Oct. High Flow	2960	1060	64.2
Nov. High Flow	1060	758	28.5
Dec. High Flow	1440	708	50.8

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	88	22.4	74.5
Med. 1 Day Min	133	88.8	33.2
Min. 3 Day Min	88.7	23.7	73.3
Med. 3 Day Min	137	98.3	28.2
Min. 7 Day Min	90.7	25.8	71.6
Med. 7 Day Min	142	105	26.1
Min. 30 Day Min	142	60.5	57.4
Med. 30 Day Min	235	168	28.5
Min. 90 Day Min	282	152	46.1
Med. 90 Day Min	694	328	52.7
7Q10	95	44.5	53.2
Year of 90-Day Min. Flow	2002	1988	100
Drought Year Mean	1170	1280	-9.4
Mean Baseflow	846	723	14.5

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	43600	31300	28.2
Med. 1 Day Max	22000	12100	45
Max. 3 Day Max	30700	20700	32.6
Med. 3 Day Max	15600	9010	42.2
Max. 7 Day Max	16200	12900	20.4
Med. 7 Day Max	9880	6230	36.9
Max. 30 Day Max	6180	7310	-18.3
Med. 30 Day Max	5270	3600	31.7
Max. 90 Day Max	3890	5230	-34.4
Med. 90 Day Max	3140	2550	18.8

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	125	80.3	35.8
5% Non-Exceedance	173	142	17.9
50% Non-Exceedance	1120	781	30.3
95% Non-Exceedance	5350	3740	30.1
99% Non-Exceedance	11800	8210	30.4
Sept. 10% Non-Exceedance	121	116	4.13

**Fig. 1: Hydrograph**

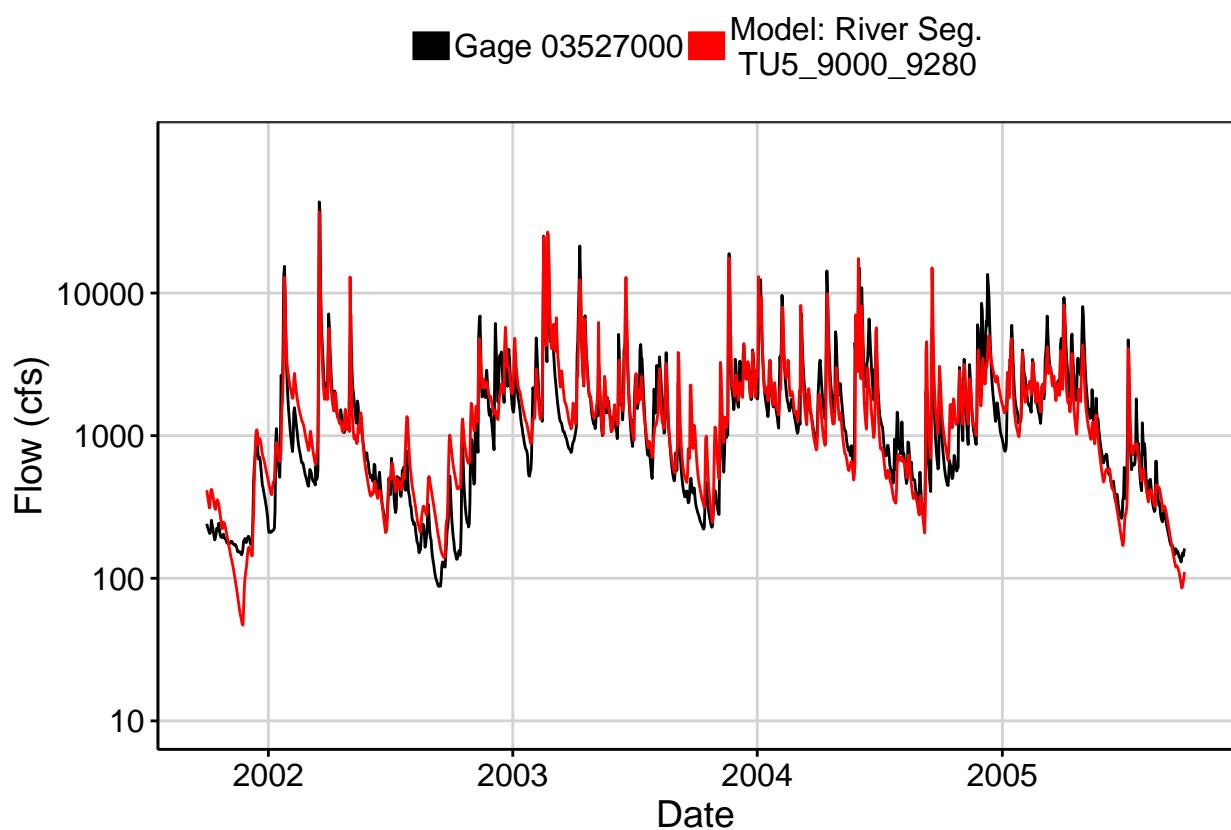


Fig. 2: Zoomed Hydrograph

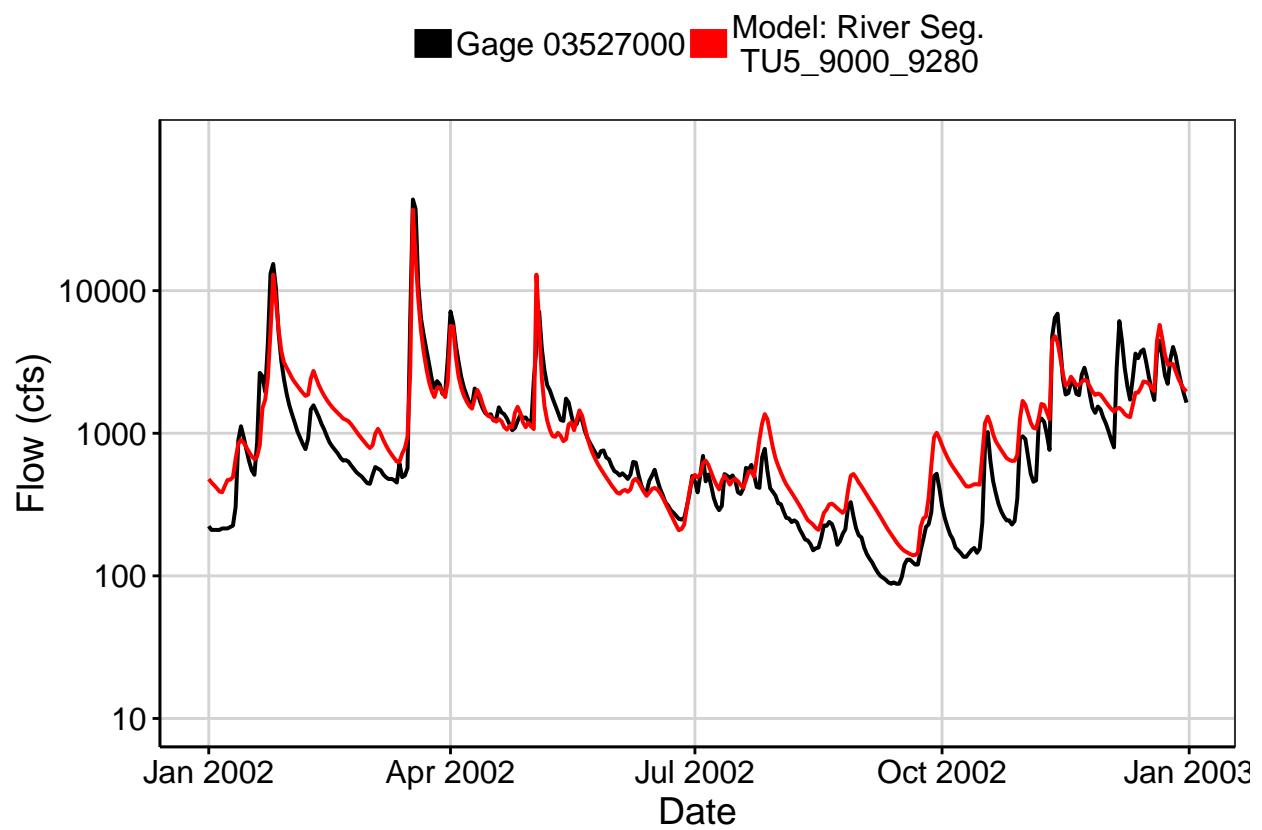


Fig. 3: Flow Exceedance

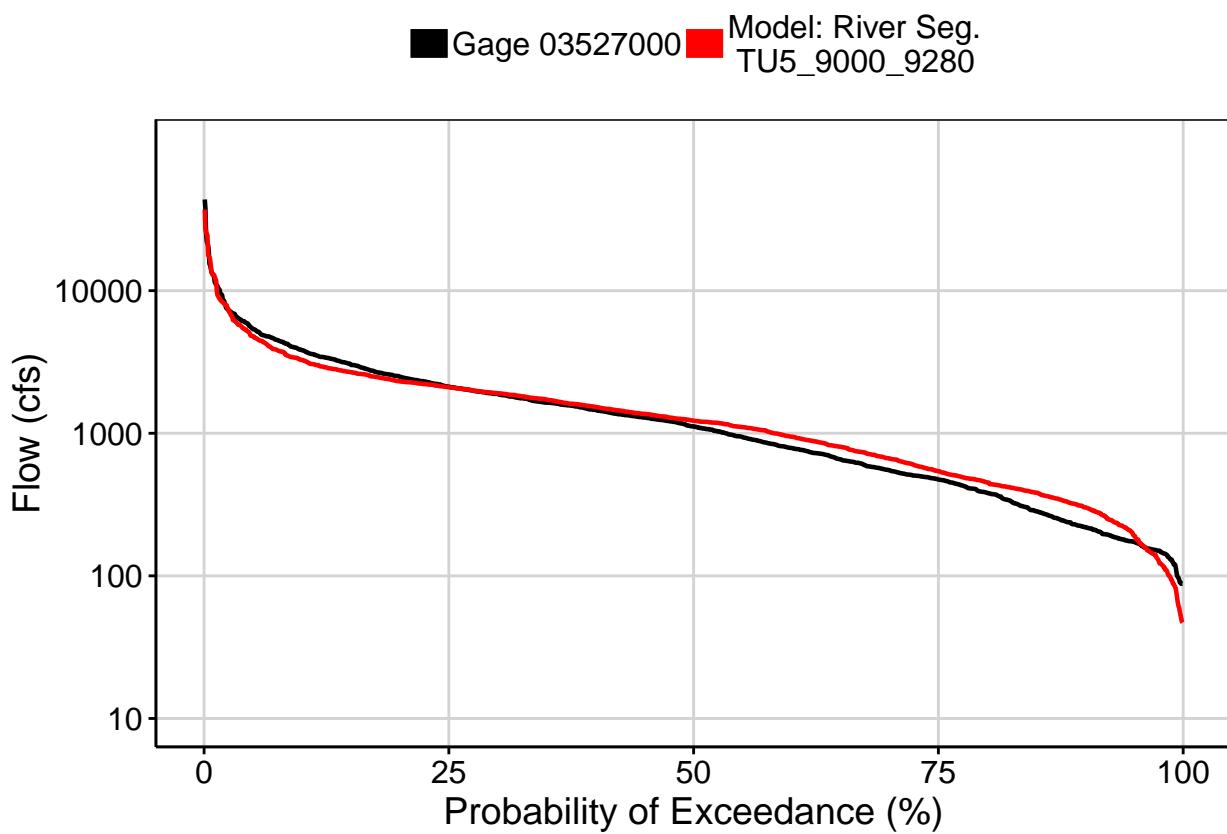


Fig. 4: Baseflow

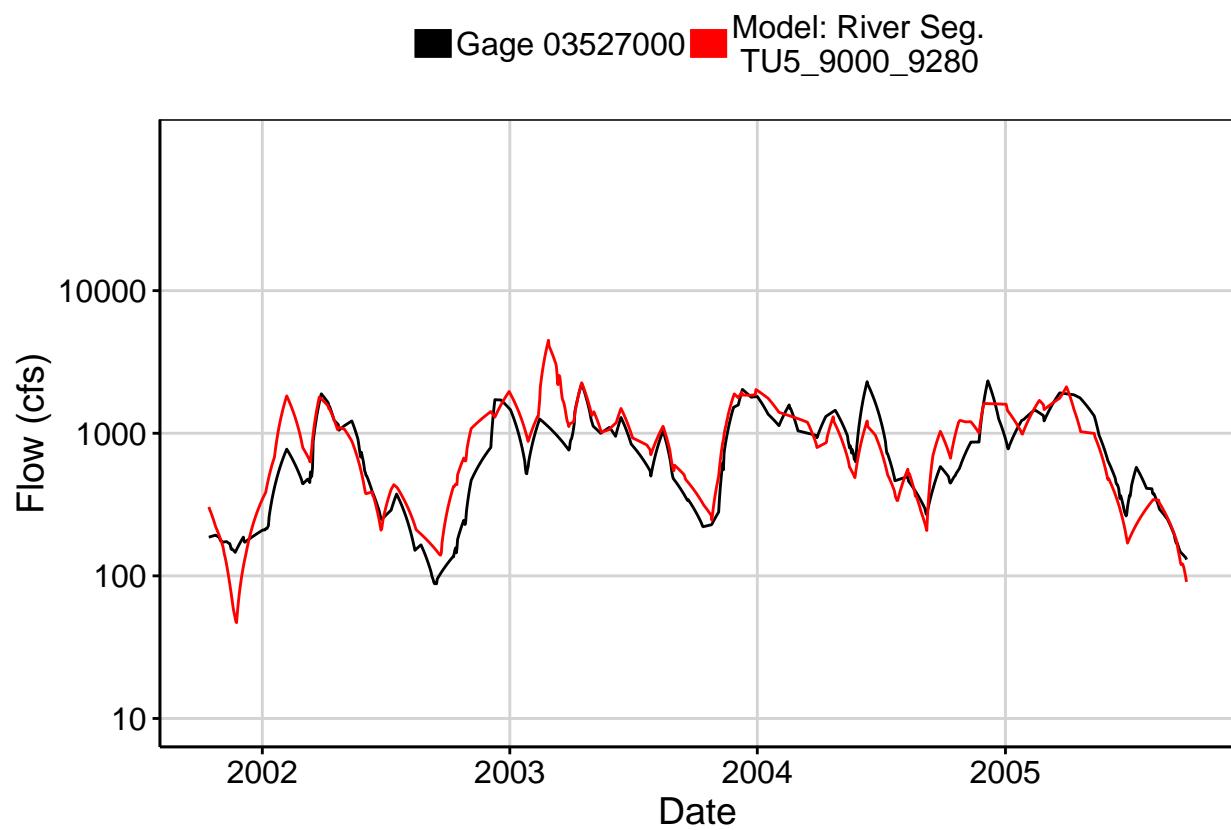


Fig. 5: Combined Baseflow

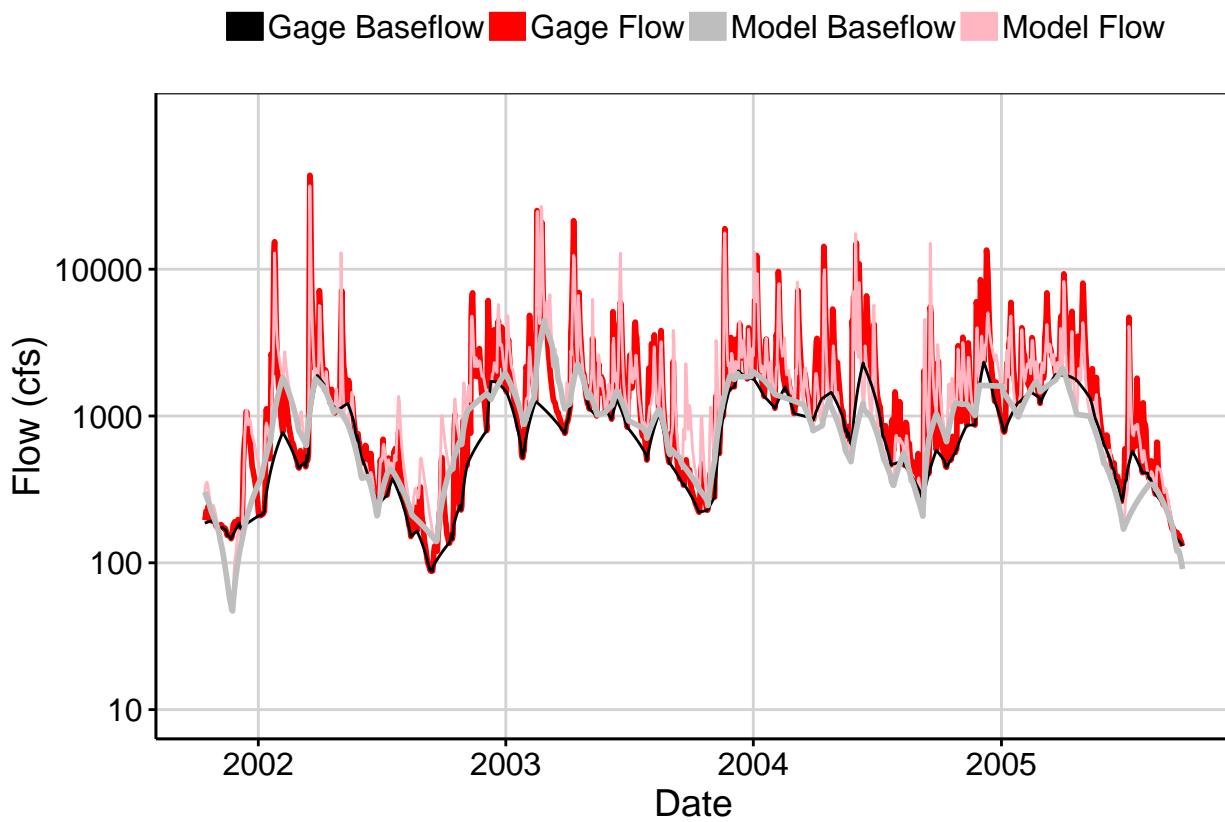


Fig. 6: Largest Error Segment

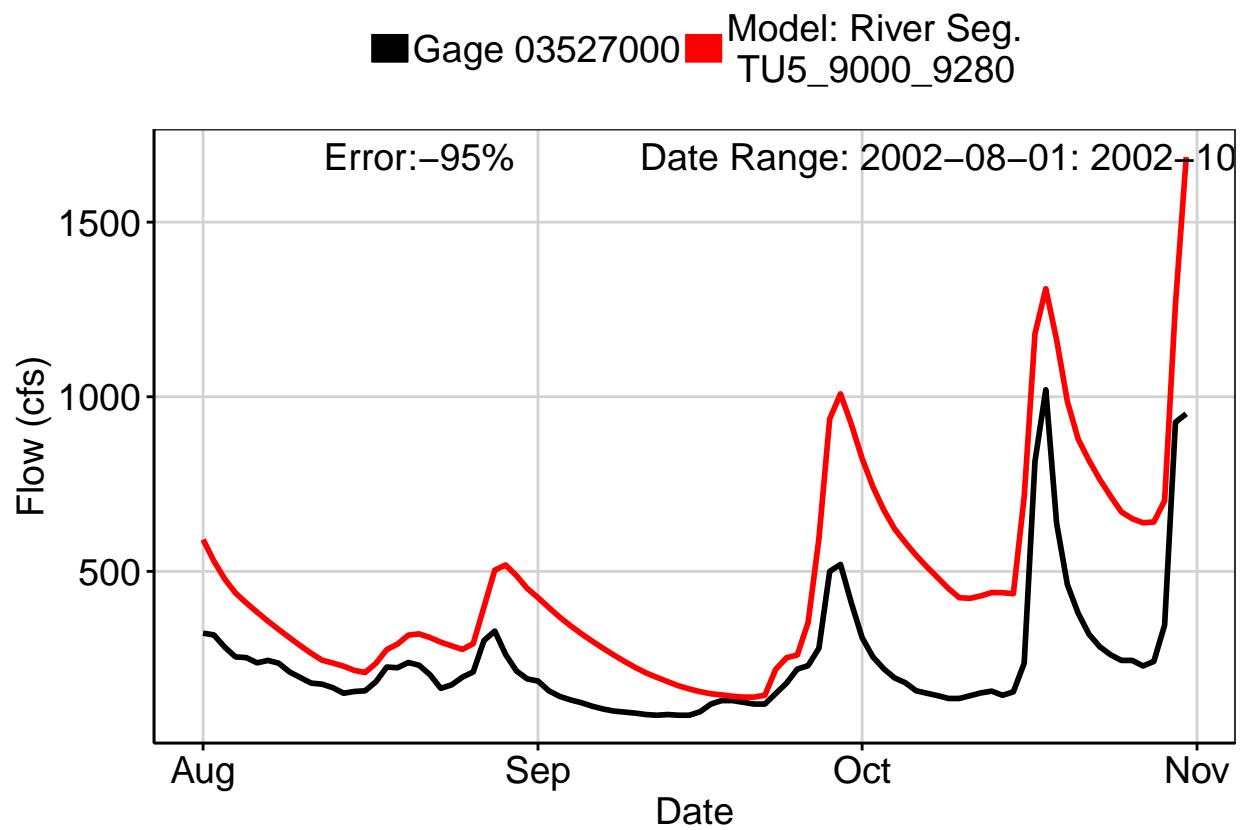


Fig. 7: Second Largest Error Segment

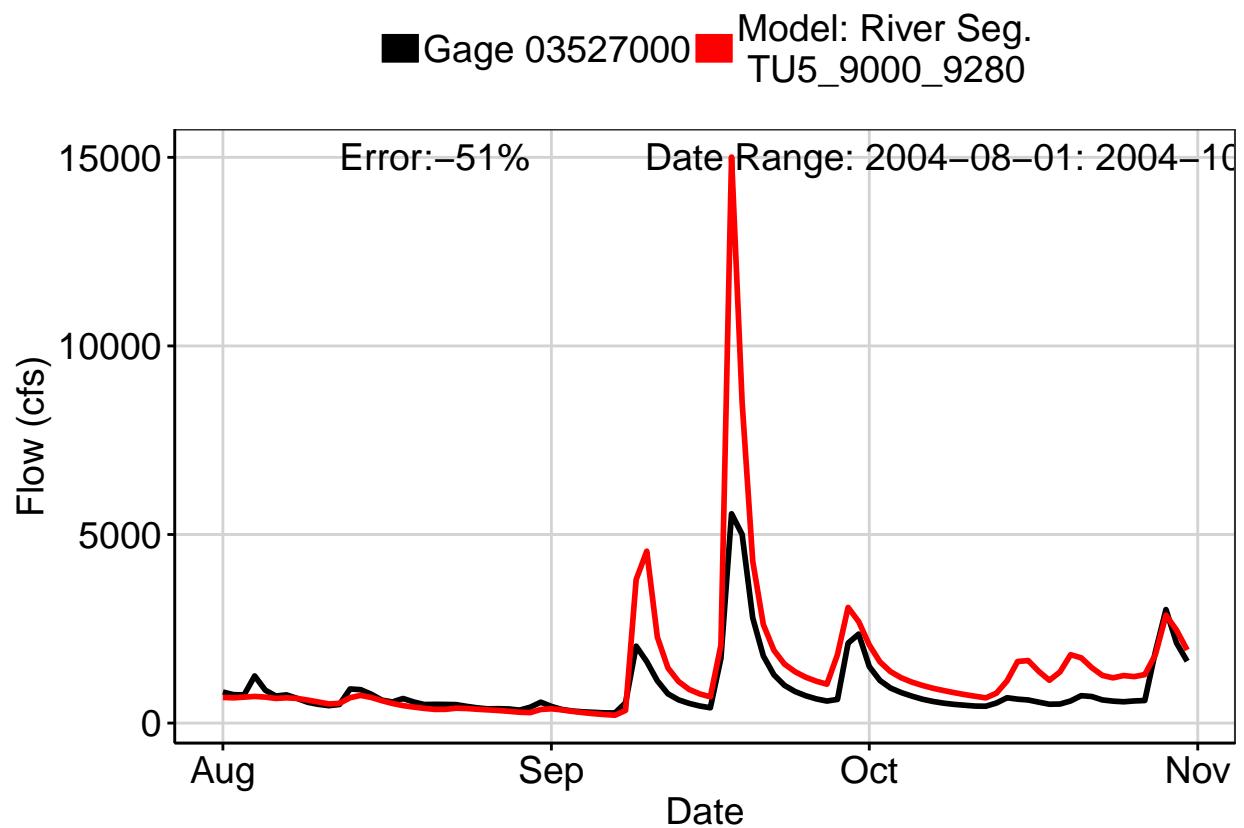


Fig. 8: Third Largest Error Segment

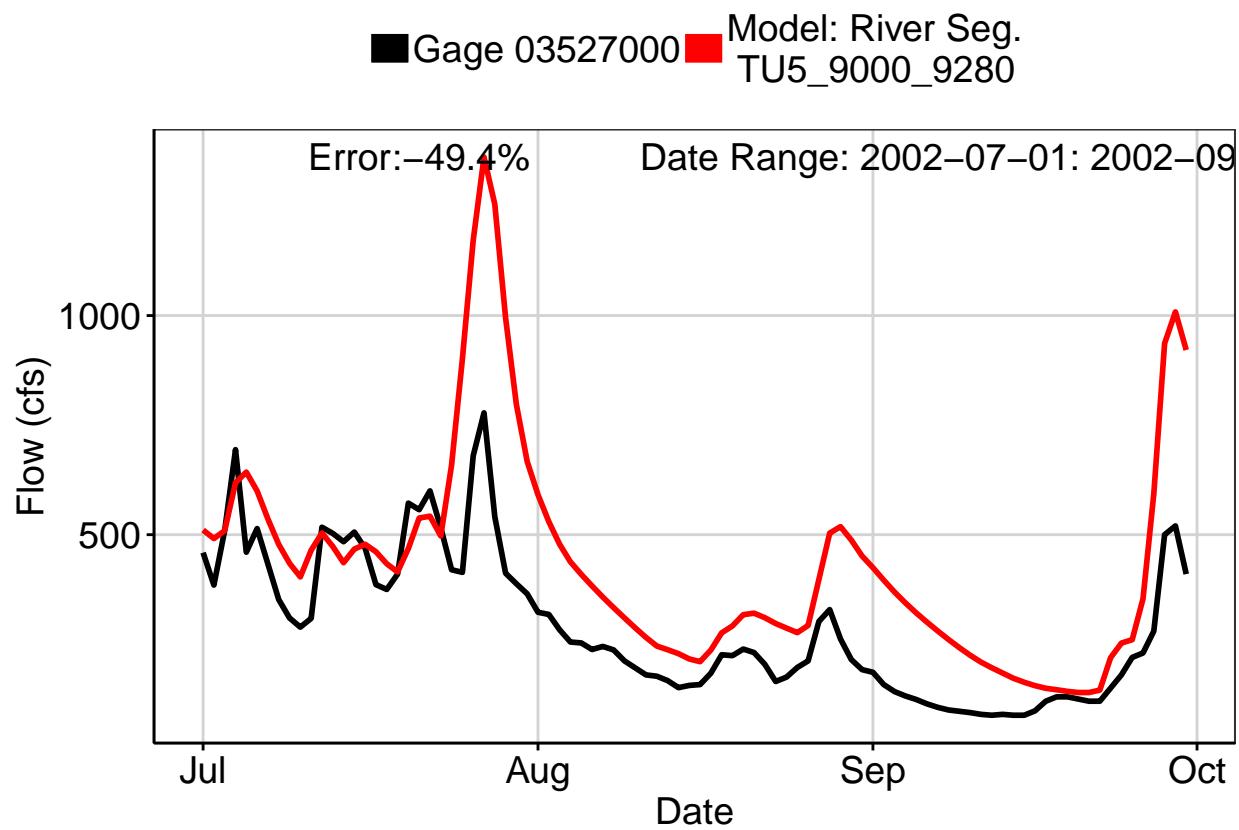
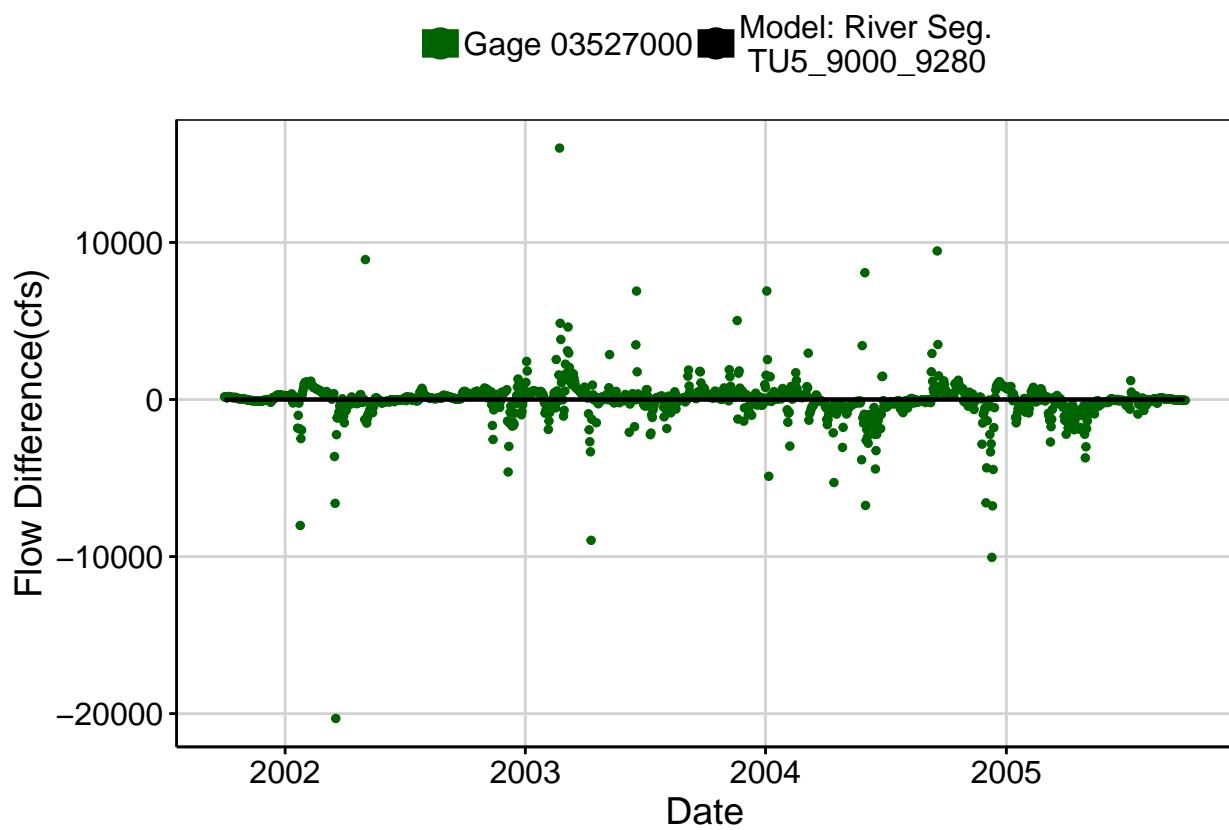
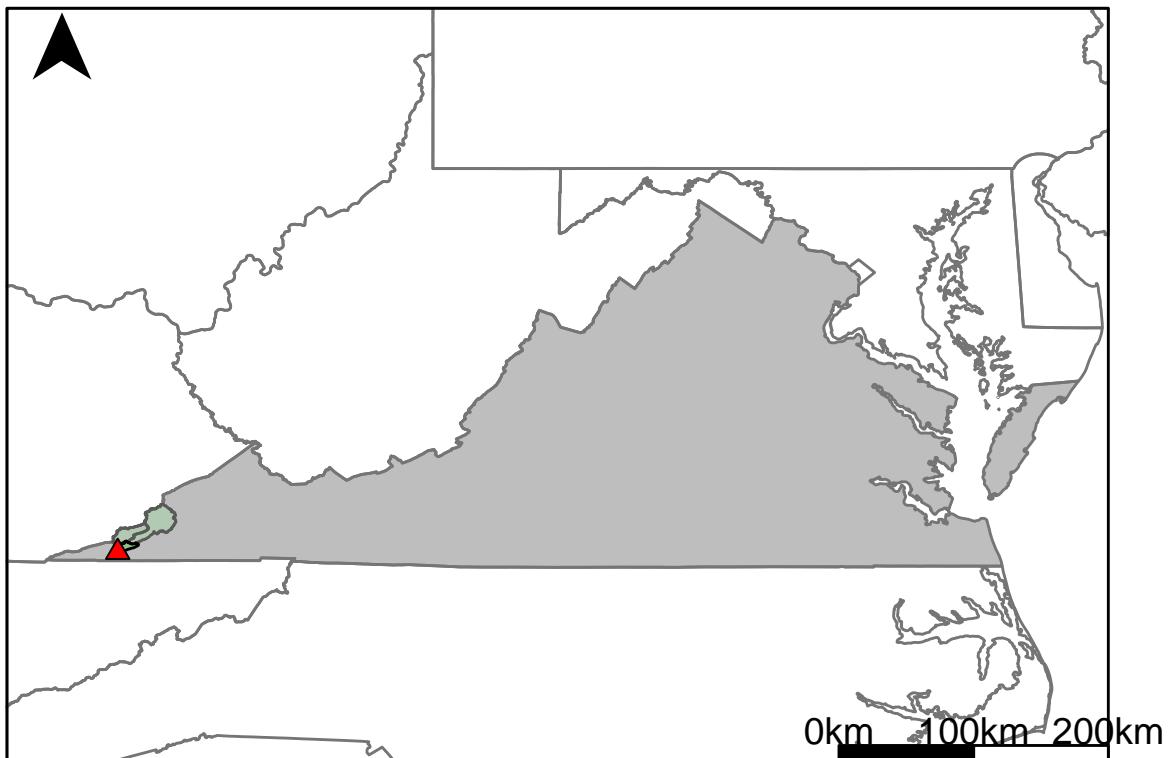


Fig. 9: Residuals Plot



## Appendix I.3: USGS Gage 03531500 vs. TU3\_9230\_9260



This river segment follows part of the flow of the Powell River, a tributary of the Tennessee River. The gage is located in Lee County, VA (Lat 36°39'43", Long 83°05'42") approximately 32 miles southwest of Norton, VA. Drainage area is 319 sq. miles. This gage started taking data in 1931 and is still taking data. There are no known anthropogenic alterations in this area that would affect the flow conditions. The average daily discharge error between the model and gage data for the 20 year timespan was 1.29%, with 45.8% of its rolling three month time spans above 20% error.

**Table 1: Monthly Low Flows**

	USGS Gage	Model	Pct. Error
Jan. Low Flow	59	76.7	-30
Feb. Low Flow	72	147	-104
Mar. Low Flow	169	196	-16
Apr. Low Flow	211	280	-32.7
May Low Flow	312	341	-9.29
Jun. Low Flow	327	299	8.56
Jul. Low Flow	303	213	29.7
Aug. Low Flow	208	155	25.5
Sep. Low Flow	124	119	4.03
Oct. Low Flow	88	85.2	3.18
Nov. Low Flow	66	83.6	-26.7
Dec. Low Flow	55	73.5	-33.6

**Table 2: Monthly Average Flows**

	USGS Gage	Model	Pct. Error
Overall Mean Flow	541	534	1.29
Jan. Mean Flow	804	753	6.34
Feb. Mean Flow	1090	1050	3.67
Mar. Mean Flow	993	917	7.65
Apr. Mean Flow	834	692	17
May Mean Flow	643	514	20.1
Jun. Mean Flow	428	343	19.9
Jul. Mean Flow	224	245	-9.38
Aug. Mean Flow	186	234	-25.8
Sep. Mean Flow	146	263	-80.1
Oct. Mean Flow	137	257	-87.6
Nov. Mean Flow	353	474	-34.3
Dec. Mean Flow	686	695	-1.31

**Table 3: Monthly High Flows**

	USGS Gage	Model	Pct. Error
Jan. High Flow	211	590	-180
Feb. High Flow	1930	1820	5.7
Mar. High Flow	2500	1920	23.2
Apr. High Flow	3170	2510	20.8
May High Flow	3760	3320	11.7
Jun. High Flow	3030	2770	8.58
Jul. High Flow	1920	1490	22.4
Aug. High Flow	2040	1440	29.4
Sep. High Flow	559	661	-18.2
Oct. High Flow	700	546	22
Nov. High Flow	499	977	-95.8
Dec. High Flow	422	530	-25.6

**Table 4: Period Low Flows**

	USGS Gage	Model	Pct. Error
Min. 1 Day Min	34	4.85	85.7
Med. 1 Day Min	44	43.9	0.23
Min. 3 Day Min	34.7	5.78	83.3
Med. 3 Day Min	46	45.9	0.22
Min. 7 Day Min	35.1	8.48	75.8
Med. 7 Day Min	46.4	51.2	-10.3
Min. 30 Day Min	39.6	26.6	32.8
Med. 30 Day Min	62.2	77.9	-25.2
Min. 90 Day Min	72.7	81.1	-11.6
Med. 90 Day Min	136	159	-16.9
7Q10	38.2	13.6	64.4
Year of 90-Day Min. Flow	1995	1999	100
Drought Year Mean	500	534	-6.8
Mean Baseflow	234	242	-3.42

**Table 5: Period High Flows**

	USGS Gage	Model	Pct. Error
Max. 1 Day Max	21400	15900	25.7
Med. 1 Day Max	6610	6540	1.06
Max. 3 Day Max	10900	8950	17.9
Med. 3 Day Max	4600	4270	7.17
Max. 7 Day Max	6310	5380	14.7
Med. 7 Day Max	3030	2810	7.26
Max. 30 Day Max	3010	2840	5.65
Med. 30 Day Max	1620	1400	13.6
Max. 90 Day Max	2180	2140	1.83
Med. 90 Day Max	1150	1020	11.3

**Table 6: Non-Exceedance Flows**

	USGS Gage	Model	Pct. Error
1% Non-Exceedance	42	30.5	27.4
5% Non-Exceedance	51	61	-19.6
50% Non-Exceedance	277	320	-15.5
95% Non-Exceedance	1830	1630	10.9
99% Non-Exceedance	4150	3840	7.47
Sept. 10% Non-Exceedance	44.5	44.2	0.67

**Fig. 1: Hydrograph**

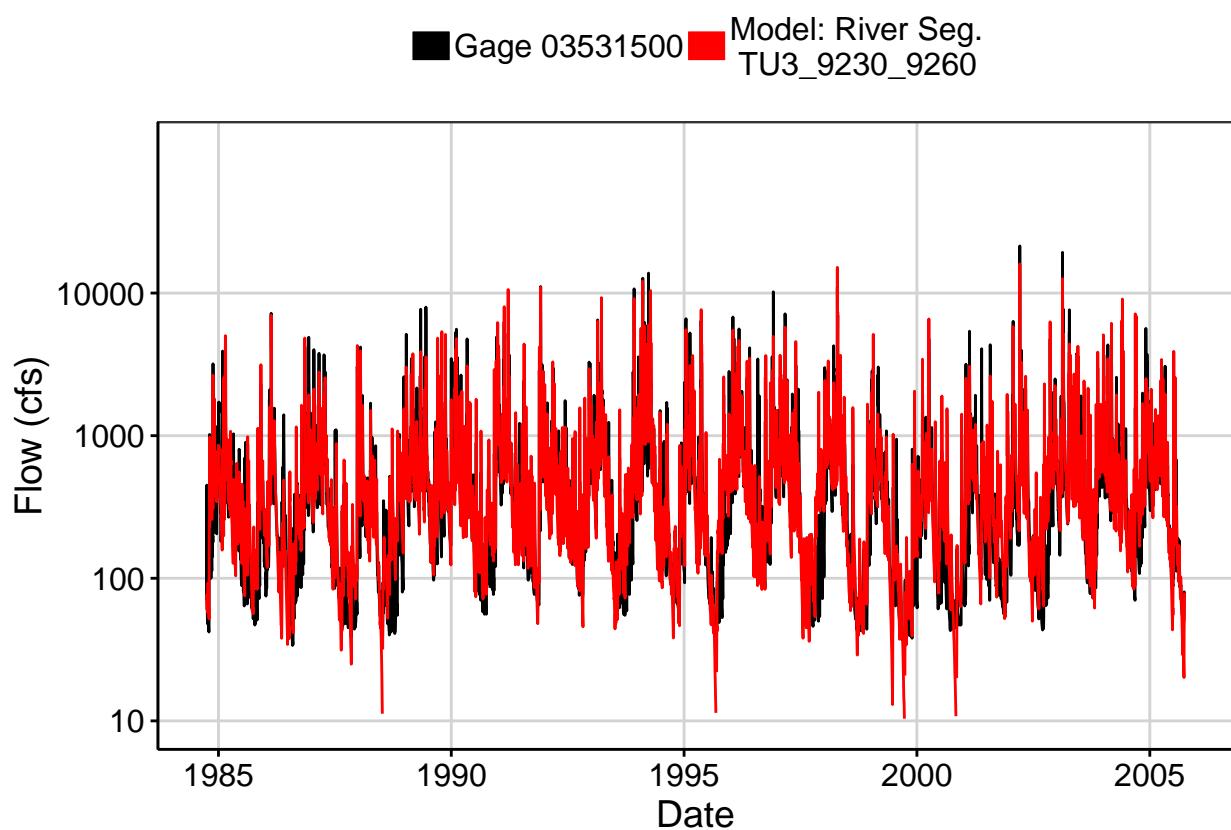


Fig. 2: Zoomed Hydrograph

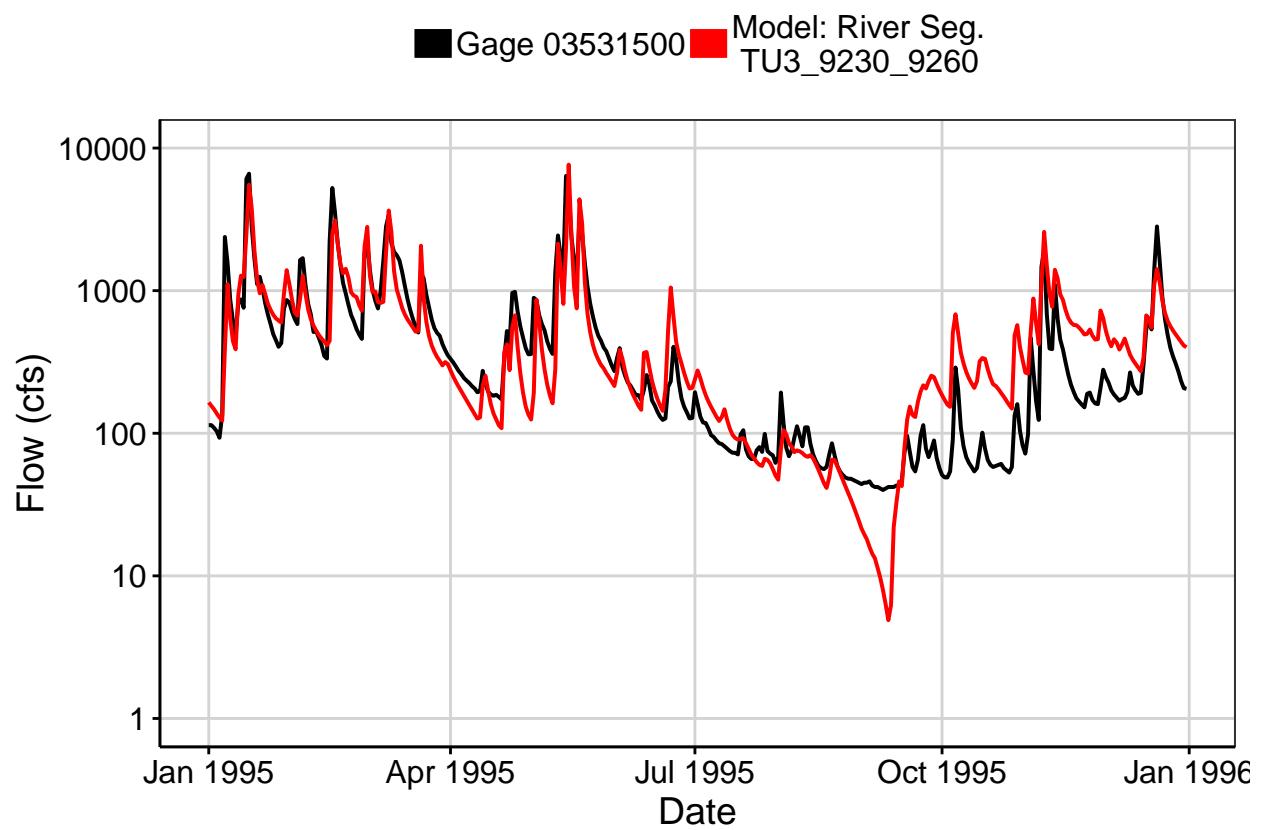


Fig. 3: Flow Exceedance

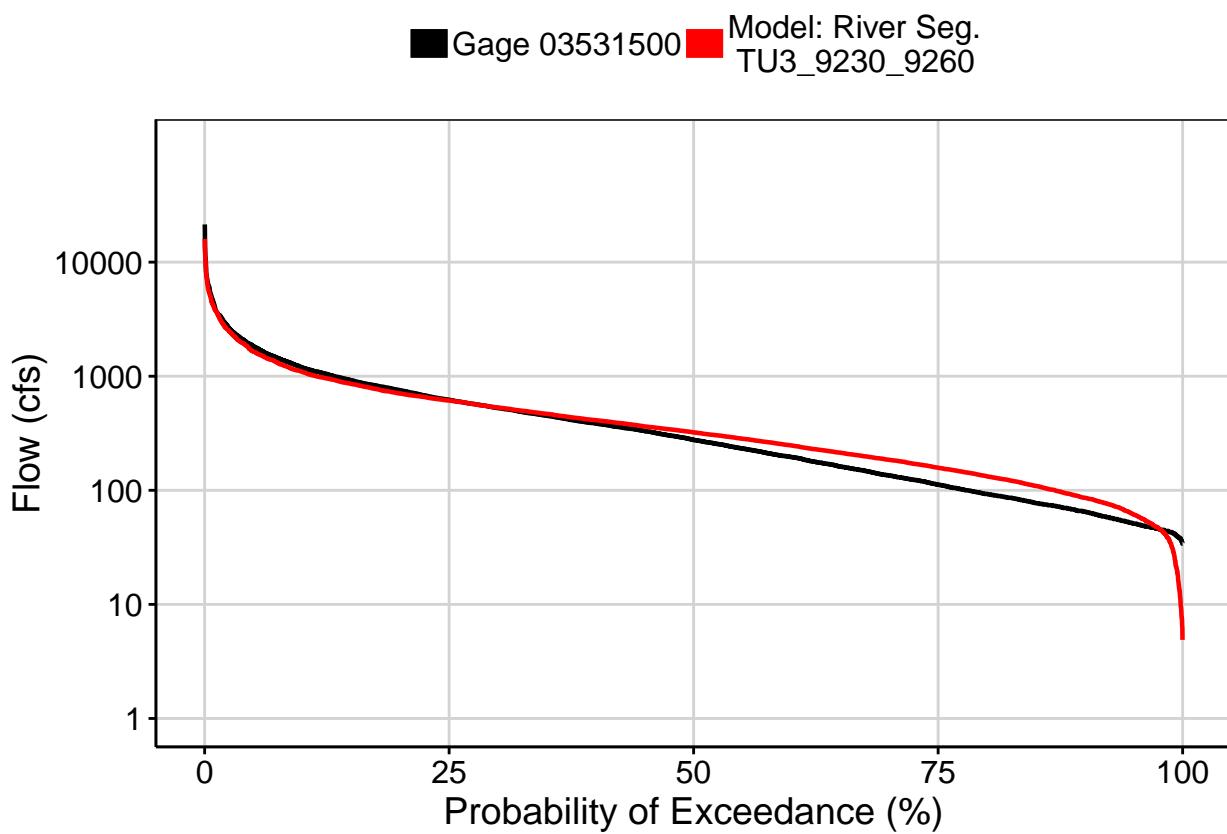
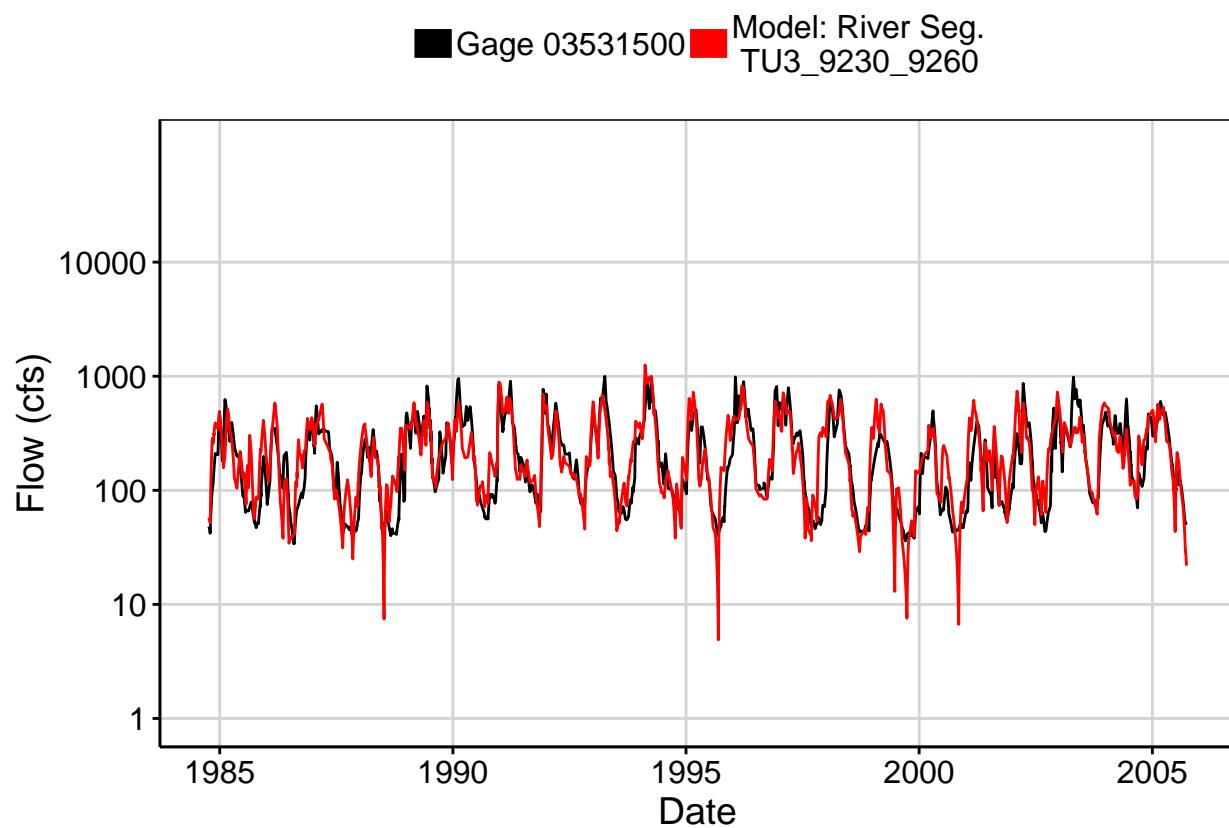


Fig. 4: Baseflow



**Fig. 5: Combined Baseflow**

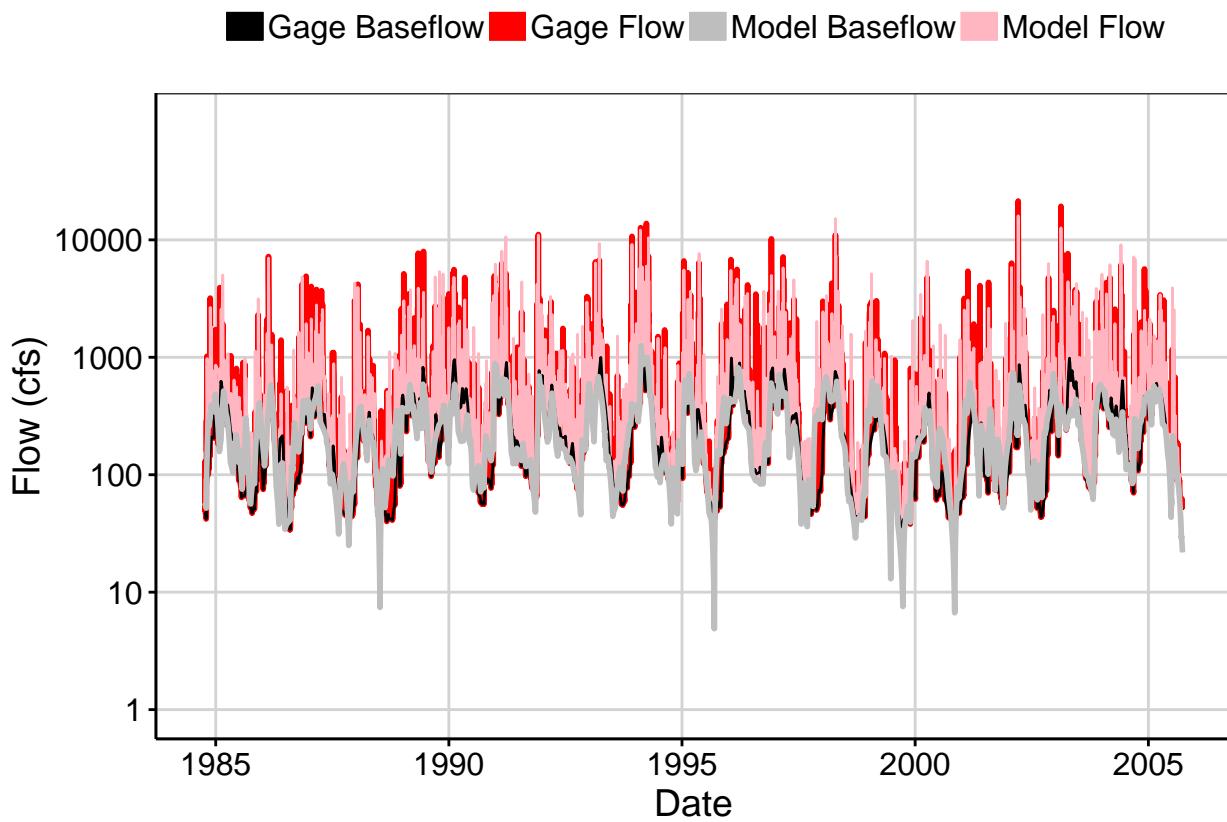


Fig. 6: Largest Error Segment

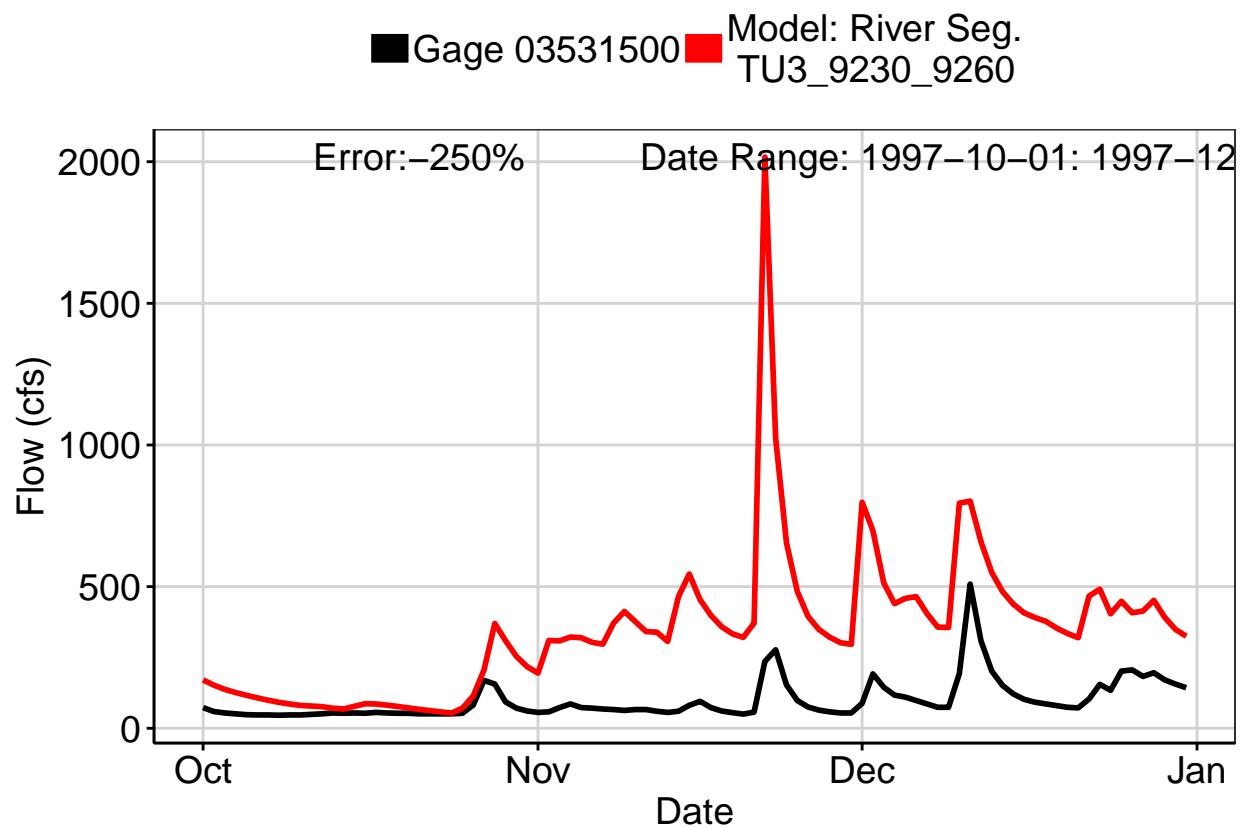


Fig. 7: Second Largest Error Segment

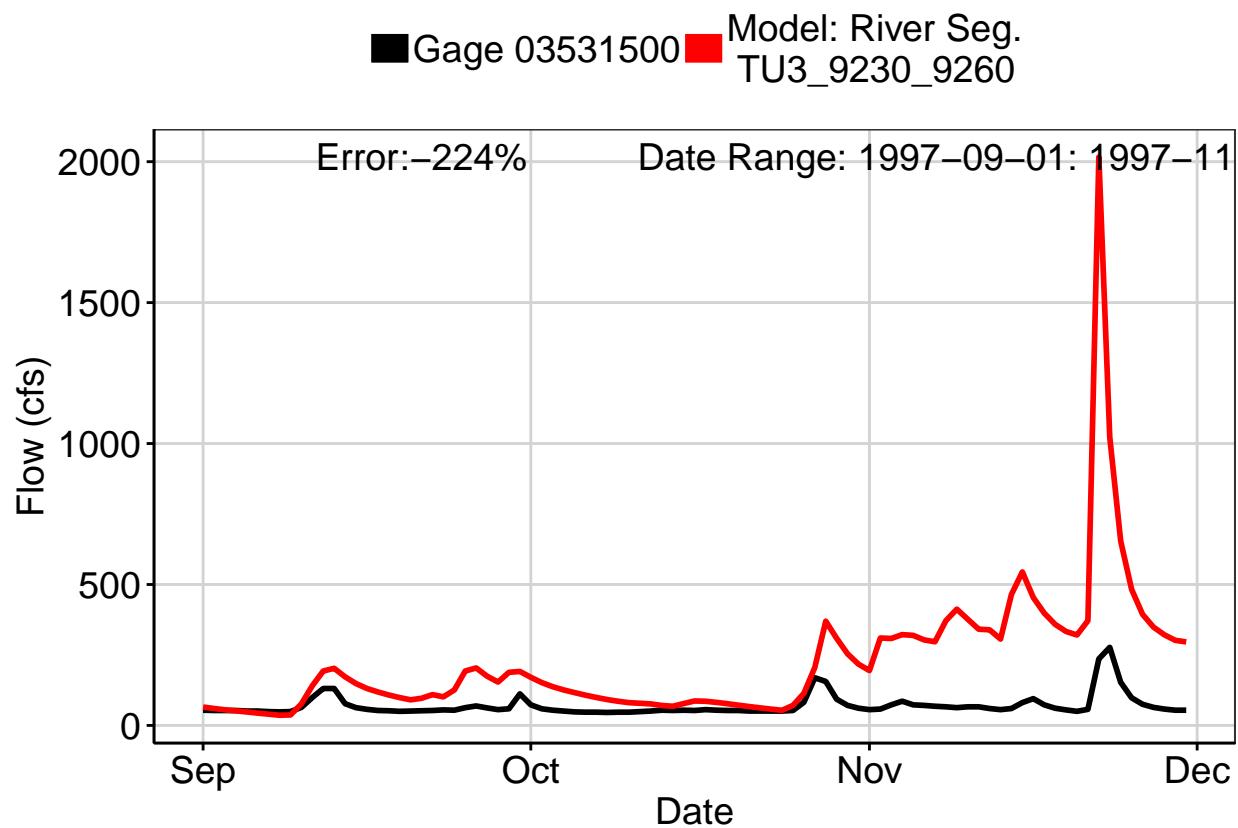


Fig. 8: Third Largest Error Segment

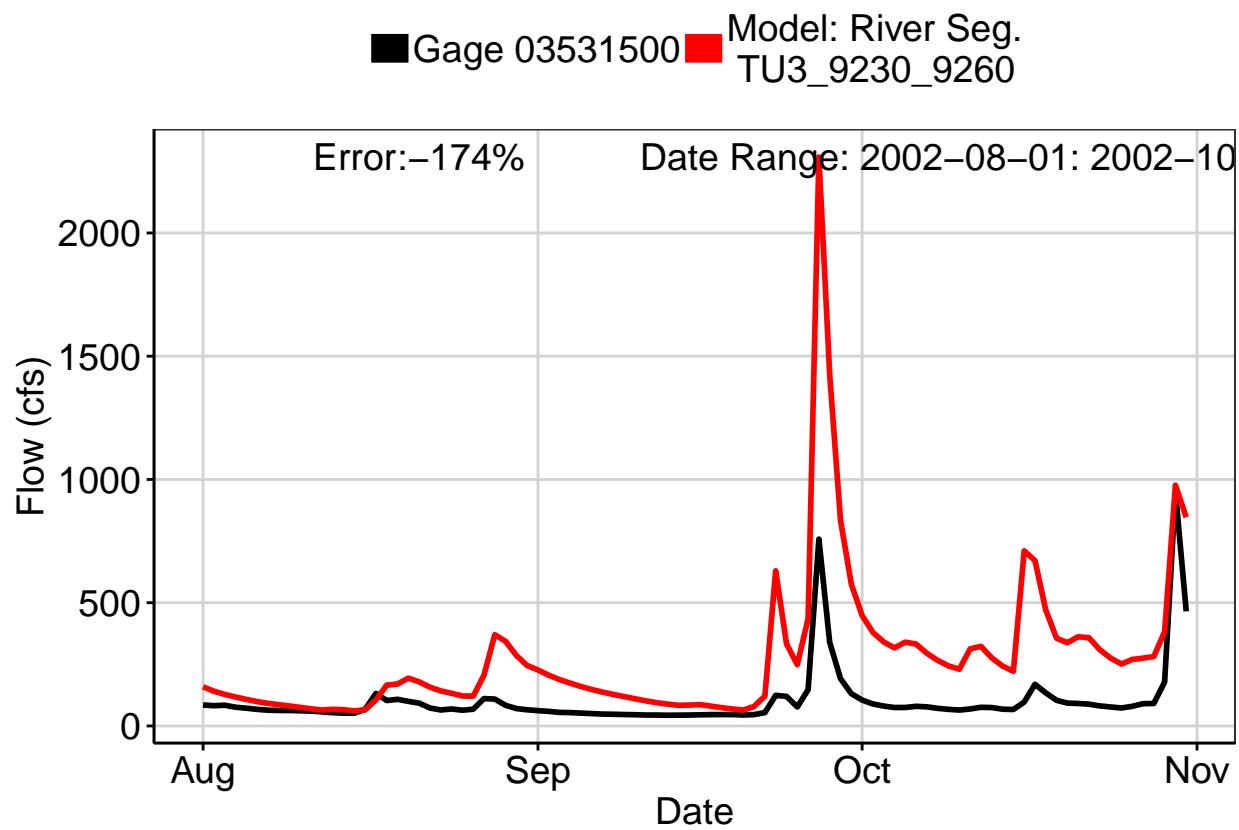


Fig. 9: Residuals Plot

