

# **Willamette River Basin Temperature TMDL Model: Model Scenarios**



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## Introduction

The State of Oregon Department of Environmental Quality (DEQ) is developing a TMDL for temperature in the Willamette River basin shown in Figure 1. The study area included the Willamette River and all major tributaries (except the Tualatin River where a TMDL process was already concluded). A large section of the Columbia River was also modeled to provide adequate boundary representation of tidal flows in the lower Willamette River. The Willamette River below the Oregon City Falls in the Portland metropolitan area has a typical diurnal tidal range of 1 m. The development of a dynamic model of temperature and hydrodynamics of the entire river basin incorporating shading were primary requirements of this modeling study. The model would be used by DEQ to set temperature limits on point source dischargers and to evaluate the impact of management strategies on river temperatures to improve fish habitat. Some of these strategies included modifications of the dam at the Willamette River Falls south of Portland and channel reconfigurations.

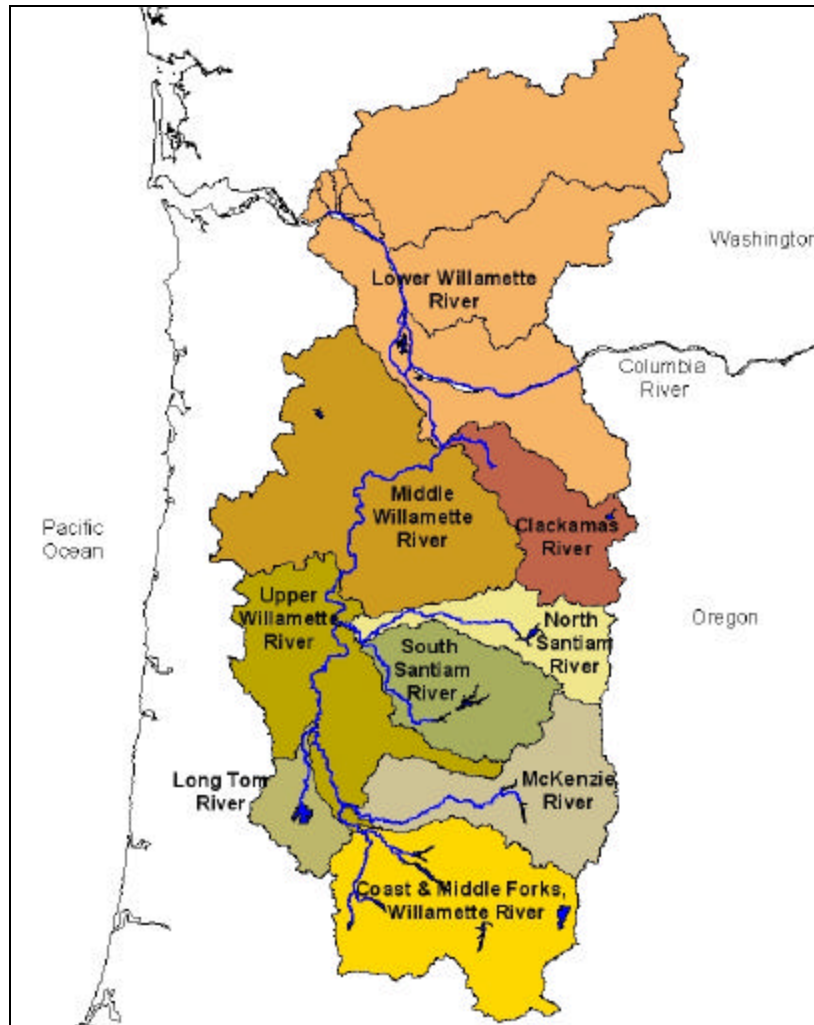


Figure 1: TMDL study area - the Willamette River basin with drainage basins delineated.

CE-QUAL-W2 Version 3.1 (Cole and Wells, 2002), a two dimensional (longitudinal-vertical), laterally averaged, hydrodynamic and water quality model developed by the U.S. Army Corps of Engineers

(USACOE) Waterways Experiments Station, was chosen as the appropriate model tool for this system for the following reasons:

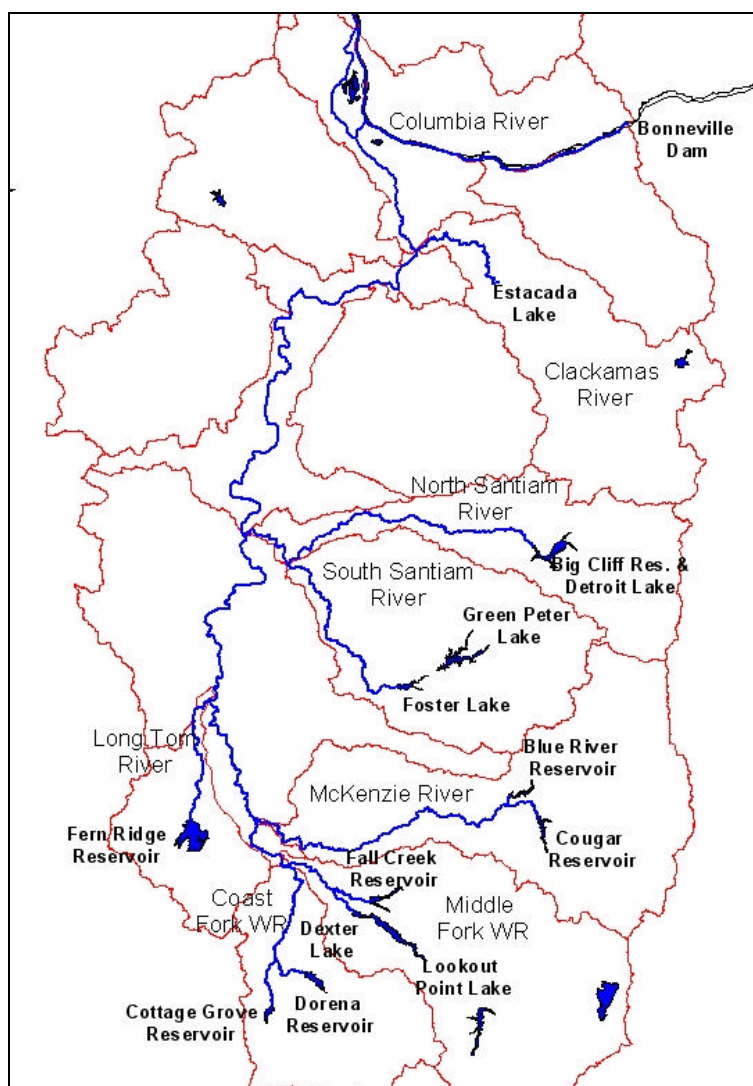
- Dynamic temperature predictive capability
- Dynamic shading prediction based on detailed topographic and vegetative shading information
- Ability of the model to be used for water quality after the temperature study where parameters of interest are algae, periphyton, pH, dissolved oxygen
- Ability to model complex hydraulic flow paths with multiple interconnected branches using hydraulic elements (weirs, pumps, spillways) between branches
- Ability to evaluate the stratification potential of deep pools in the Willamette River where water quality and temperature data have shown significant stratification
- Ability to model estuary hydrodynamics
- Ability to model an entire river basin including upstream deep-density stratified reservoirs
- Public domain executable and source code for quality-assurance and testing

The river basin model was originally divided into several reaches. Individual models were developed for each reach. These reaches were (see also Figure 2):

- **Columbia River** - from Beaver Army Terminal (Columbia River Mile 53.8) to Bonneville Dam (RM 144.5) (Willamette River enters the Columbia River at Columbia River Miles 87 and 101);
- **Tidal Willamette River** – Lower Willamette River from mouth to Willamette Falls (RM 26.5), including the Willamette Channel and the Multnomah Channel;
- **Non-tidal Willamette River** – Willamette Falls (RM 26.5) to confluence of Coast and Middle Forks (RM 187); this section was divided further into the following reaches: Middle Willamette from the Willamette Falls (RM 26.5) to the city of Salem (RM 85); Upper Willamette from the City of Salem (RM 85) to the confluence of Coast and Middle Forks (RM 187)
- **Clackamas River** up to River Mill Dam/Estacada Lake (RM 26);
- **Santiam River** (all 12 miles), North Santiam River up to Detroit Dam (RM 49), South Santiam River up to Foster Dam (RM 38);
- **Long Tom River** to Fern Ridge Dam (RM 26);
- **McKenzie River** to RM 56, and South Fork McKenzie River to Cougar Dam (RM 4);
- **Middle Fork Willamette** to Dexter Dam (RM 17), Fall Creek to Fall Creek Dam (RM 7);
- **Coast Fork Willamette** to Cottage Grove Dam (RM 30), Row River to Dorena Dam (RM 7.5);
- **Columbia Slough** in the tidal portion of the Willamette River (about 9 miles in length)

Once the models were set-up for each section of the Willamette basin, the model was calibrated to field data and management strategies were evaluated. These are the subjects of two other reports: Annear et al. (2004) and Berger et al. (2004).

This report outlines the results of implementing model scenarios for each of the model sections or elements for specific time periods. The model scenario simulation periods used to investigate management scenarios required boundary condition data that extended past the model calibration periods. The model simulation period for year 2001 was from June 1 to October 31 and for year 2002 from April 1 to October 31.



**Figure 2: Willamette River and modeled tributaries.**

There were twenty one model scenarios run as shown in Table 1, based on a technical memo developed by the Oregon Department of Environmental Quality (ODEQ, 2003).

**Table 1: Willamette River TMDLs Mainstem Model simulations (ODEQ, 2003)**

<b>Sim No.</b>	<b>Current or System Potential</b>	<b>Year</b>	<b>Description</b>
1	Calibration	2001	2001 calibration conditions
2	Calibration	2002	2002 calibration conditions
3	System Potential 1	2001	no point sources
4	System Potential 1	2001	point sources, current
5	System Potential 1	2001	point sources, design
6	System Potential 2	2001	no point sources
7	System Potential 2	2001	point sources, current
8	System Potential 2	2001	point sources, design
9	System Potential 1	2002	no point sources
10	System Potential 1	2002	point sources, current

<b>Sim No.</b>	<b>Current or System Potential</b>	<b>Year</b>	<b>Description</b>
11	System Potential 1	2002	point sources, design
12	System Potential 2	2002	no point sources
13	System Potential 2	2002	point sources, current
14	System Potential 2	2002	point sources, design
15	Calibration	2001	with 20% boundary flow rate reduction
16	Calibration	2001	with 20% boundary flow rate increase
17	Calibration	2001	with upstream boundary flow rates set to NFMS biological opinion flow rates
18	Calibration	2001	with 5°C boundary temperature reduction
19	Calibration	2001	with 5°C boundary temperature increase
20	Calibration	2001	with no vegetative shade
21	Calibration	2001	with System Potential vegetative shade

Model output results are presented in three output formats; time series plots of flow and temperature at specific site locations, longitudinal temperature plots for a specific data, contour plots of temperature difference over time and space comparing results between two model scenarios. The model output results are described in more detail:

1. Time series output at each location in Table 2
  - Hourly temperature and flows
  - Daily 7-day moving average of daily maximum temperature and 7-day average flow

**Table 2: CE-QUAL-W2 Model Scenario output locations, based on ODEQ (2003).**

<b>River Reach</b>	<b>Upstream Point Location</b>	<b>Downstream Point Location</b>	<b>River Mile Location for Output</b>	<b>Large Pt. Sources to be included in calibrated model</b>	<b>River</b>	<b>Landmarks</b>	<b>CE-QUAL-W2 Model</b>	<b>Model Seg</b>	<b>RM</b>
5.1 – 0	Gage nr Clackamas	Mouth	5.1 Gage #2110		Clackamas	USGS14211010	Clackamas	117	5.07
23.4 – 5.1	River Mill Dam	Gage Nr Clackamas	23.2 Gage #2100		Clackamas	USGS14210000	Clackamas	2	22.22
Row R	Dorena Lake dam	Mouth	Row R RM 5.4 Gage #1555		Row River	USGS14155500	Coast/Middle	206	5.51
Fall Creek	Fall Cr Dam	Mouth	Fall Cr RM 6.1 Gage #1510		Fall Creek	USGS14151000	Coast/Middle	363	6.29
11.2-0	Fall Creek	Dexter	11.2		Middle Fork		Coast/Middle	283	11.14
11.2-16.8	Dexter Dam	Fall Creek	14.2 Gage #1500		Middle Fork	USGS14150000	Coast/Middle	263	13.95
20.8-0	Row R	Mouth	20.8		Coast Fork		Coast/Middle	57	20.18
					Coast Fork		Coast/Middle	51	21.28
29.4–20.8	Gage below Cottage Grove	Row R	u/s Cottage Grove POTW	Cottage Grove POTW	Coast Fork		Coast/Middle	4	29.03
187–171.8	MF/CF confluence	McKenzie R	187	Eugene POTW (MWMC)	Willamette		Coast/Middle	354	187.06
25.7 – 0	Fern Ridge Dam	Mouth	6.7 Gage #1700		Long Tom	USGS14170000	Long Tom	153	4.64
13.1–3.4	Hawthorne Br	Multnomah Ch	13.1	Wacker Siltronics, OMSI	Willamette		Lower Willamette	64	13.05
24.8–13.1	Clackamas R	Hawthorne Br	24.8	Tryon Creek POTW, Oak Lodge POTW, Kellogg Cr. POTW	Willamette		Lower Willamette	6	24.80
					Willamette		Lower Willamette	89	4.13
3.4–0	Multnomah Ch		3.4	Oregon Steel Mills	Willamette		Lower Willamette	85	6.13
13.7 – 0	Mohawk R.	Mouth	13.7	WeyCo Springfield	McKenzie		McKenzie	337	9.75
41.3 – 13.7	Vida	Mohawk R	41.3		McKenzie		McKenzie	150	37.99
59.8 – 41.3	South Fork	Vida	59.8		McKenzie	USGS14159500	McKenzie	4	60.39

35.7–24.8	Molalla River	Clackamas R	35.7	TriCities POTW, Blue Heron, West Linn Paper, Canby POTW	Willamette		Middle Willamette	338	35.72
54.9–35.7	Yamhill River	Molalla River	54.9	Wilsonville POTW, SP Newsprint, Newberg POTW	Willamette		Middle Willamette	198	55.09
84.1–54.9	Salem Gage	Yamhill River	84.1	Salem Willow Creek POTW	Willamette		Middle Willamette	4	84.69
109-84.1	Santiam R	Salem Gage	109		Willamette		Upper Willamette	508	108.60
119.4-109	Calapooia/ Albany Gage	Santiam R	119.4	Albany POTW, WeyCo Albany	Willamette		Upper Willamette	433	120.11
132.1-119.4	Marys River	Calapooia/ Albany Gage	132.1	Corvallis POTW	Willamette		Upper Willa mette	342	133.00
149-132.1	Long Tom R	Marys River	149	Halsey Fort James, Pope & Talbot, Evanite	Willamette		Upper Willamette	239	149.40
161.2–149	Harrisburg Gage	Long Tom R	161.2		Willamette		Upper Willamette	156	161.98
171.8–161.2	McKenzie R	Harrisburg Gage	171.8		Willamette		Upper Willamette	68	175.30

2. Longitudinal Plots for August 10, 2001
  - 7-day moving average of daily maximum temperature
  - The following model scenarios were compared:

**Table 3: Longitudinal Plot Sensitivity Analysis Comparisons**

Model Sensitivity Comparisons, Longitudinal Plots	Comparison Simulations
Sensitivity to point sources	3 vs. 5
Sensitivity to boundary flow rate (boundary flows adjusted +/- 20%):	1 vs. 15 and 16
Sensitivity to boundary temperature (boundary temps adjusted +/- 5°C)	1 vs. 18 and 19
Sensitivity to vegetative shade (System Potential shade vs. no vegetative shade)	1 vs. 20 and 21
Sensitivity to biological opinion flows – pre-bio opinion operation vs. post-biological opinion operation	1 vs. 17

3. Contour Plots over the each model reach and over the 2001 simulation time period
  - 7-day moving average of daily maximum temperature
  - The following model scenarios were compared:

**Table 4: Contour Plot Sensitivity Analysis Comparisons**

Model Sensitivity Comparisons, Contour Plots	Comparison Simulations
Sensitivity to point sources	3 vs. 5
Sensitivity to boundary flow rate reduction (boundary flow rates reduced 20%)	1 vs. 15
Sensitivity to boundary flow rate increase (boundary flow rates increased 20%)	1 vs. 16
Sensitivity to boundary temperature reduction (boundary temperatures reduced 5°C)	1 vs. 18
Sensitivity to boundary temperature increase (boundary temperatures increased 5°C)	1 vs. 19
Sensitivity to vegetative shade (System Potential shade vs. no vegetative shade)	21 vs. 20
Sensitivity to biological opinion flows – pre-bio opinion operation vs. post-biological opinion operation	1 vs. 17

Each model results section presents the figures with results from the furthest up stream reaches of the coast and Middle Forks of the Willamette River downstream to the Lower Willamette River with any modeled tributaries presented before each Willamette River Reach. The model reaches are presented in the following order:

- Coast/Middle Fork Willamette River
- McKenzie River
- Long Tom River
- Upper Willamette River
- Middle Willamette River
- Clackamas River
- Lower Willamette River

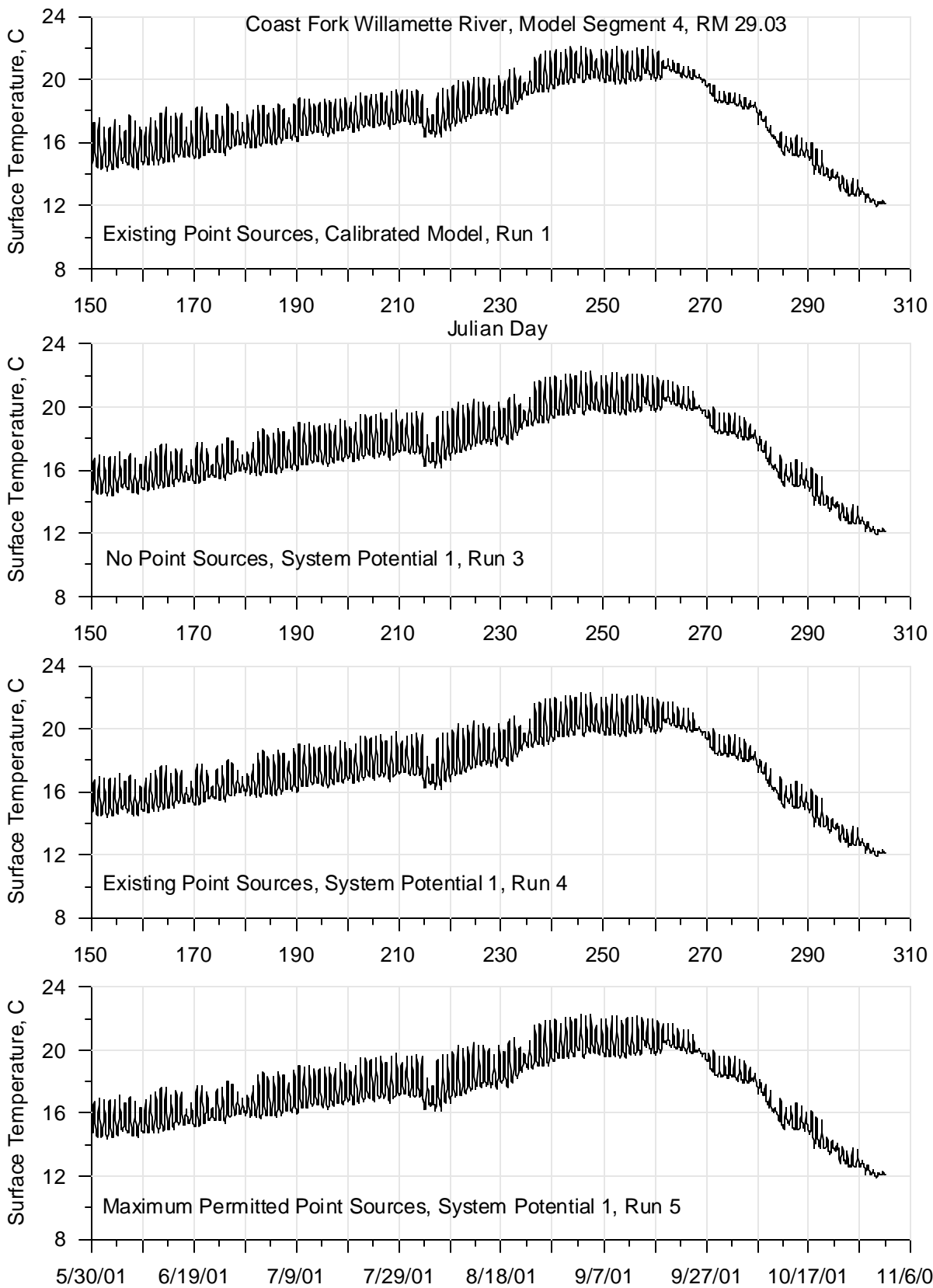
## **Time Series Comparisons**

### ***System Potential 1, 2001***

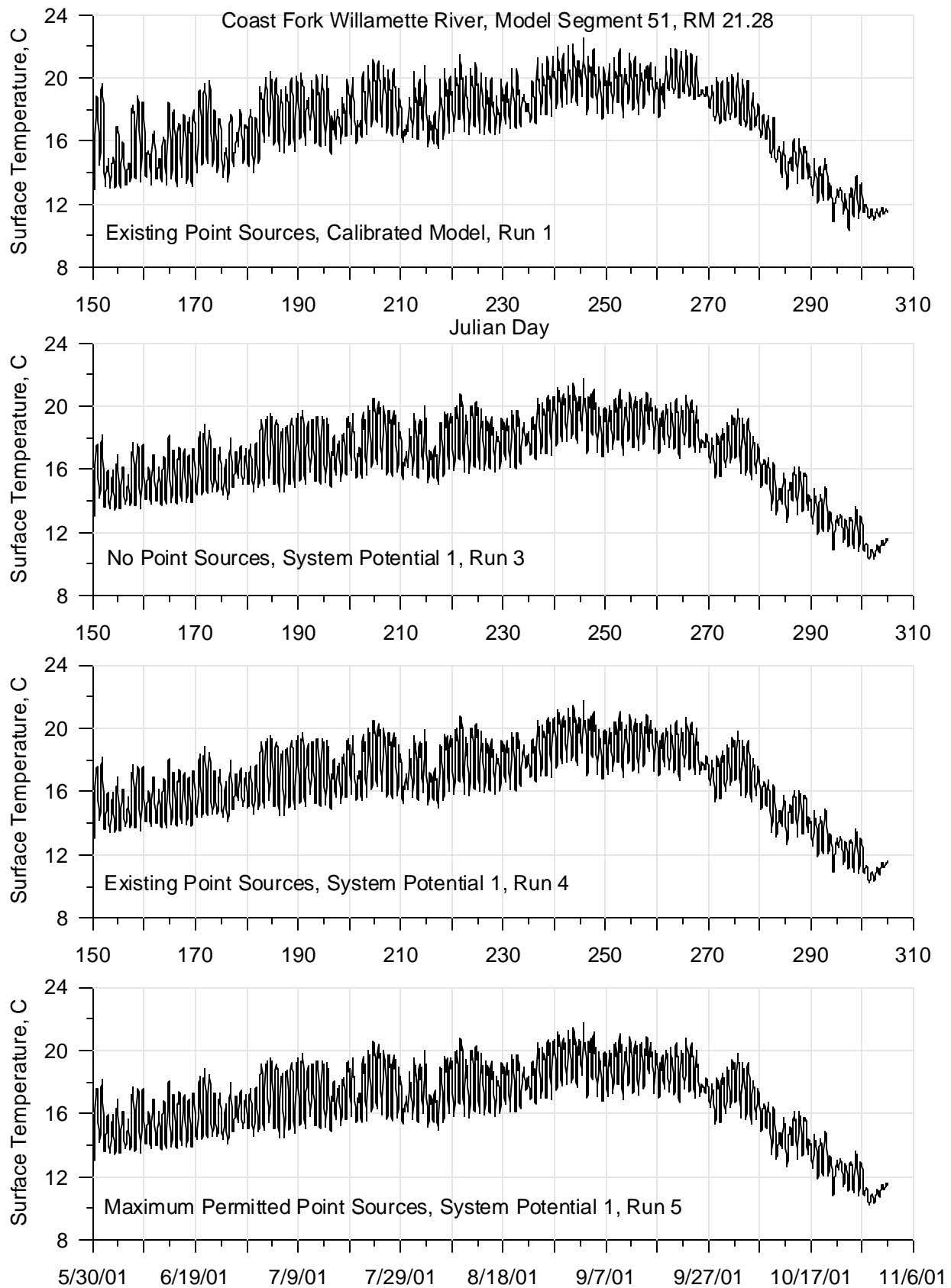
System Potential 1 (ODEQ, 2003) was run for the summer of 2001 for three scenarios with varying discharges from the large point sources in the Willamette River system. The point sources were simulated as having no discharge, their current discharge in 2001, and their maximum permitted discharge. These results were then compared with the results of the calibrated model in a series of time series plots. There are four types of time series output for each of the 21 locations identified above in Table 2: continuous temperature, continuous flow, the seven-day moving average of the daily maximum temperature, and the seven-day average of daily average flow.

### **Continuous Temperature**

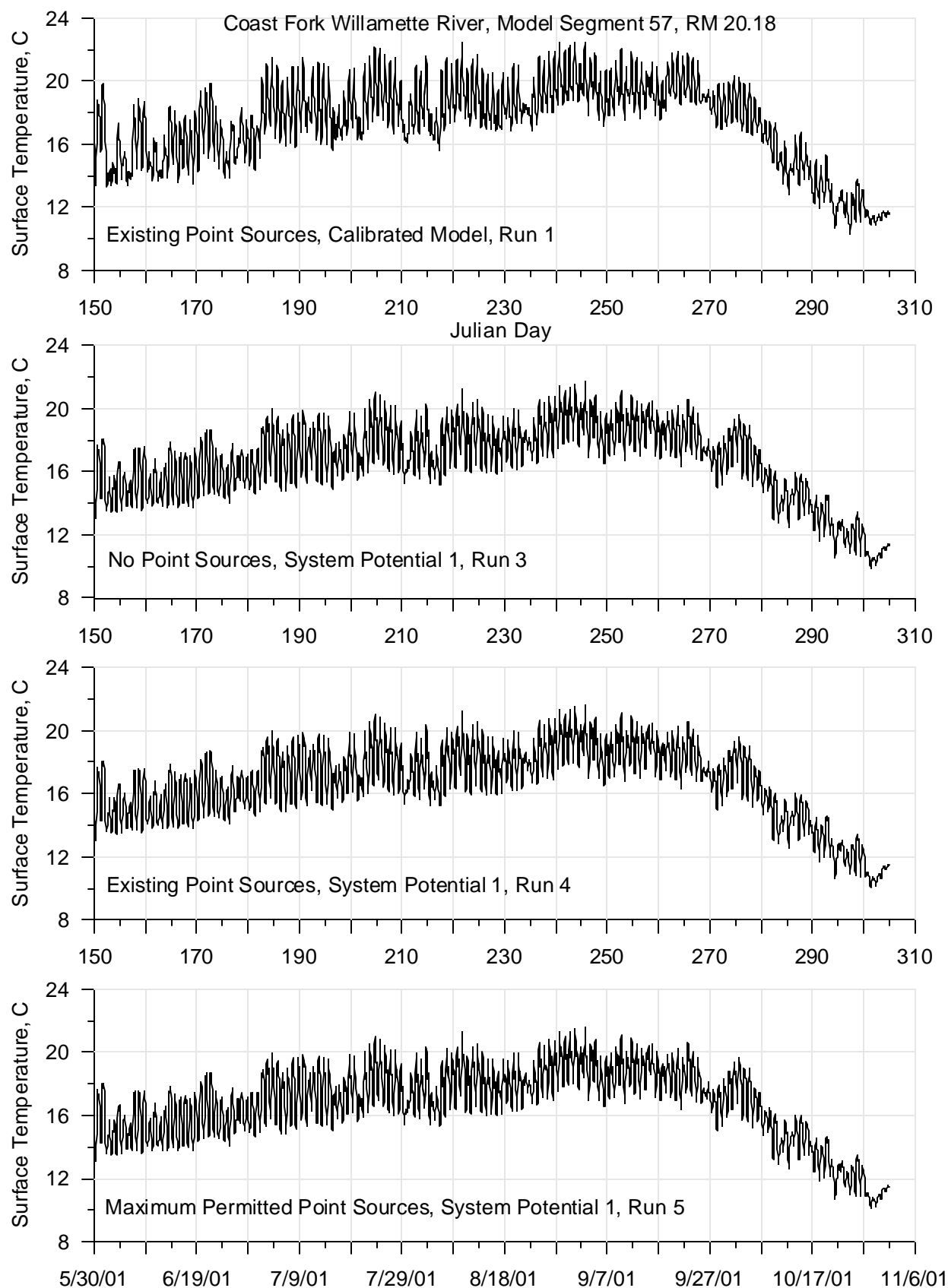




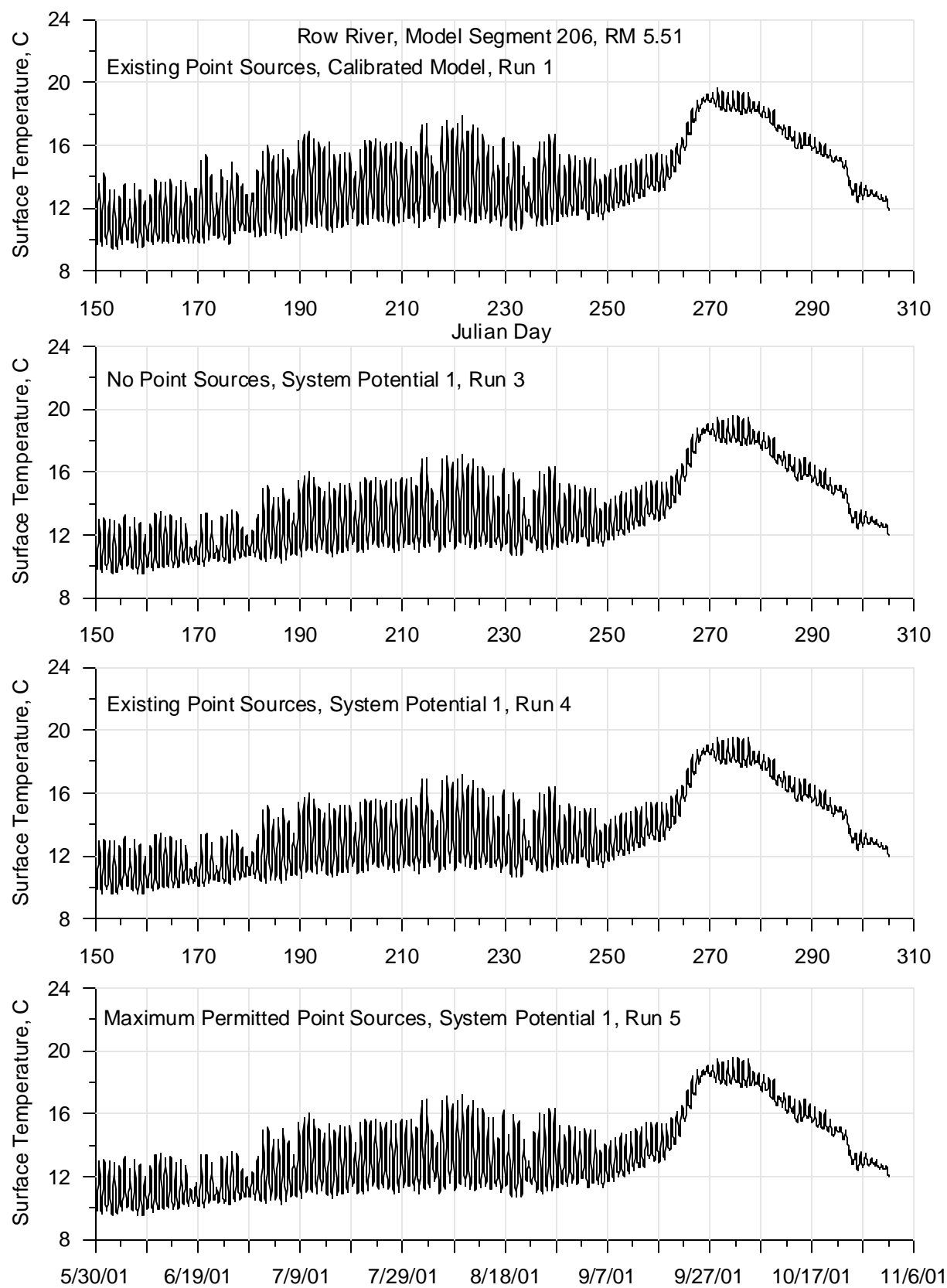
**Figure 3: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Coast Fork Willamette River at RM 29.03**



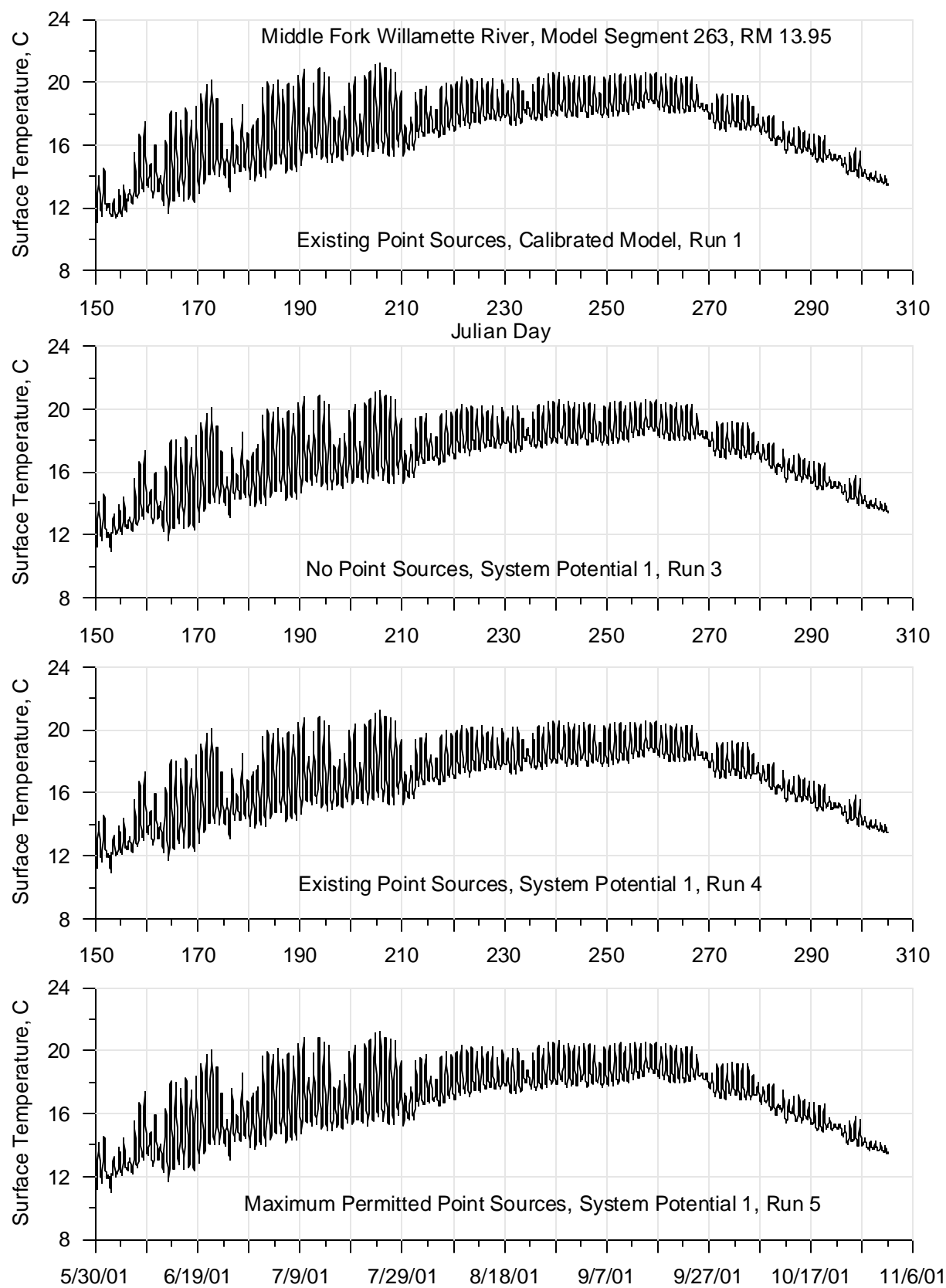
**Figure 4: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Coast Fork Willamette River at RM 21.28**



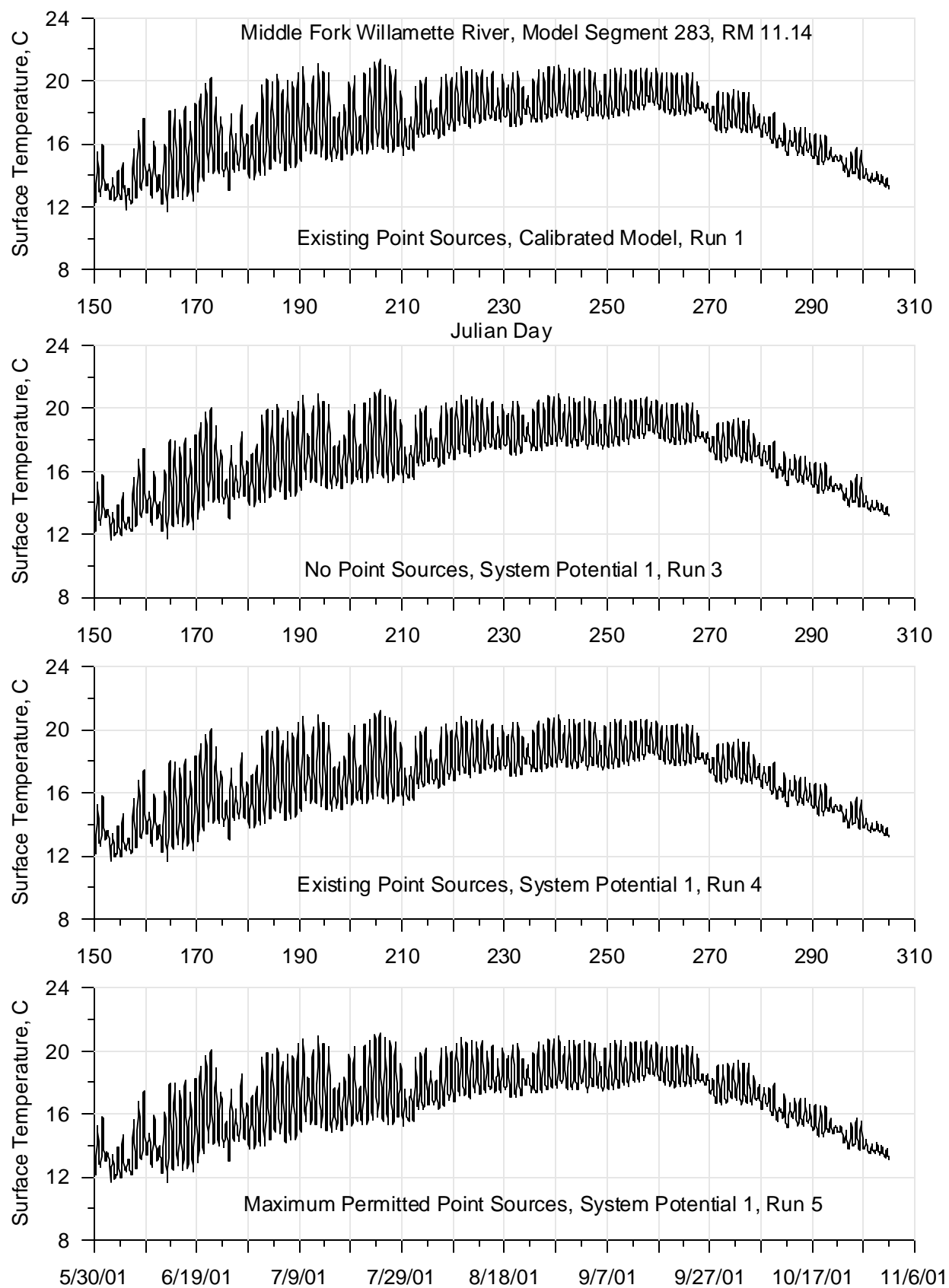
**Figure 5: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Coast Fork Willamette River at RM 20.18**



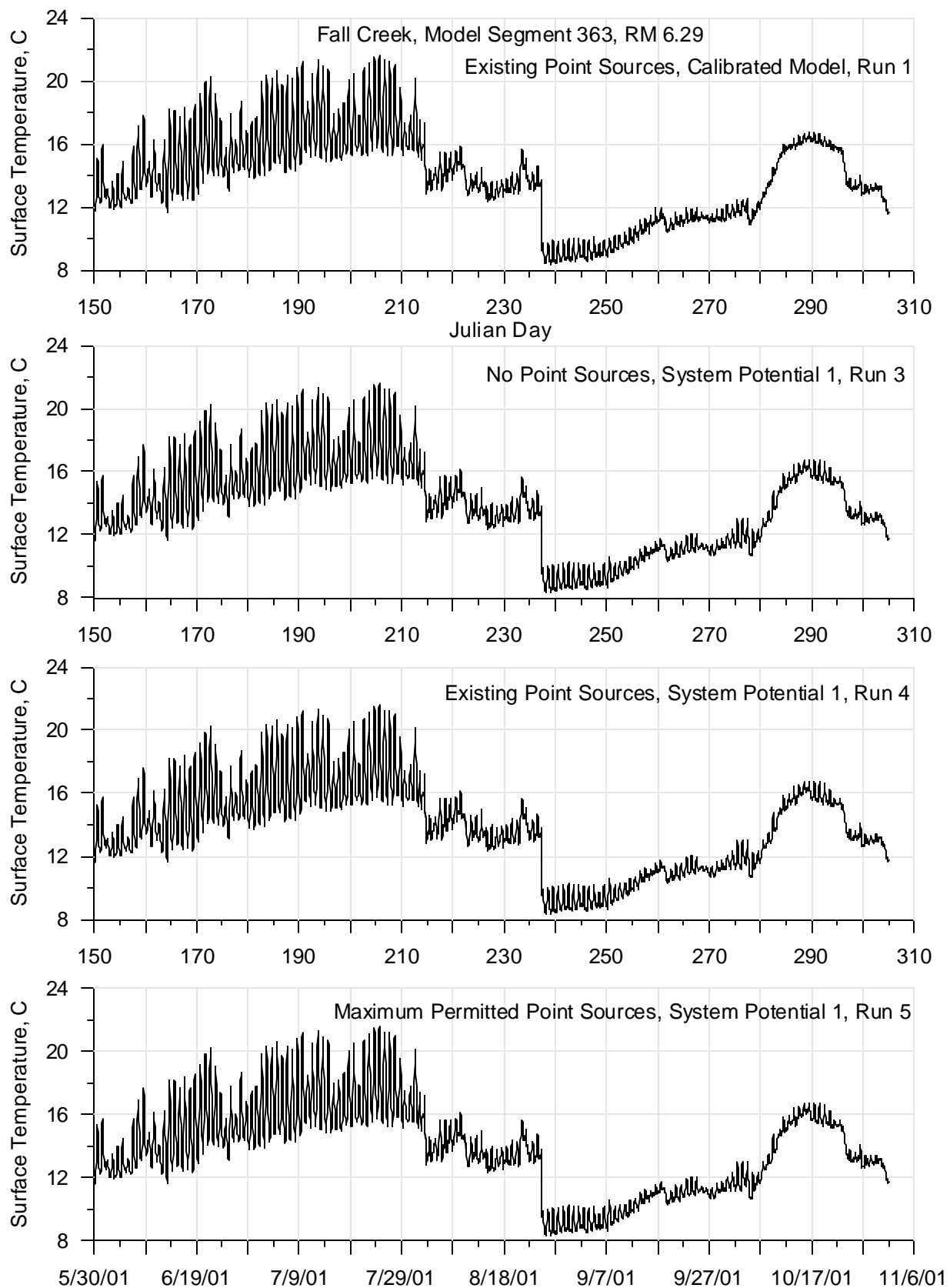
**Figure 6: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Row River at RM 5.51**



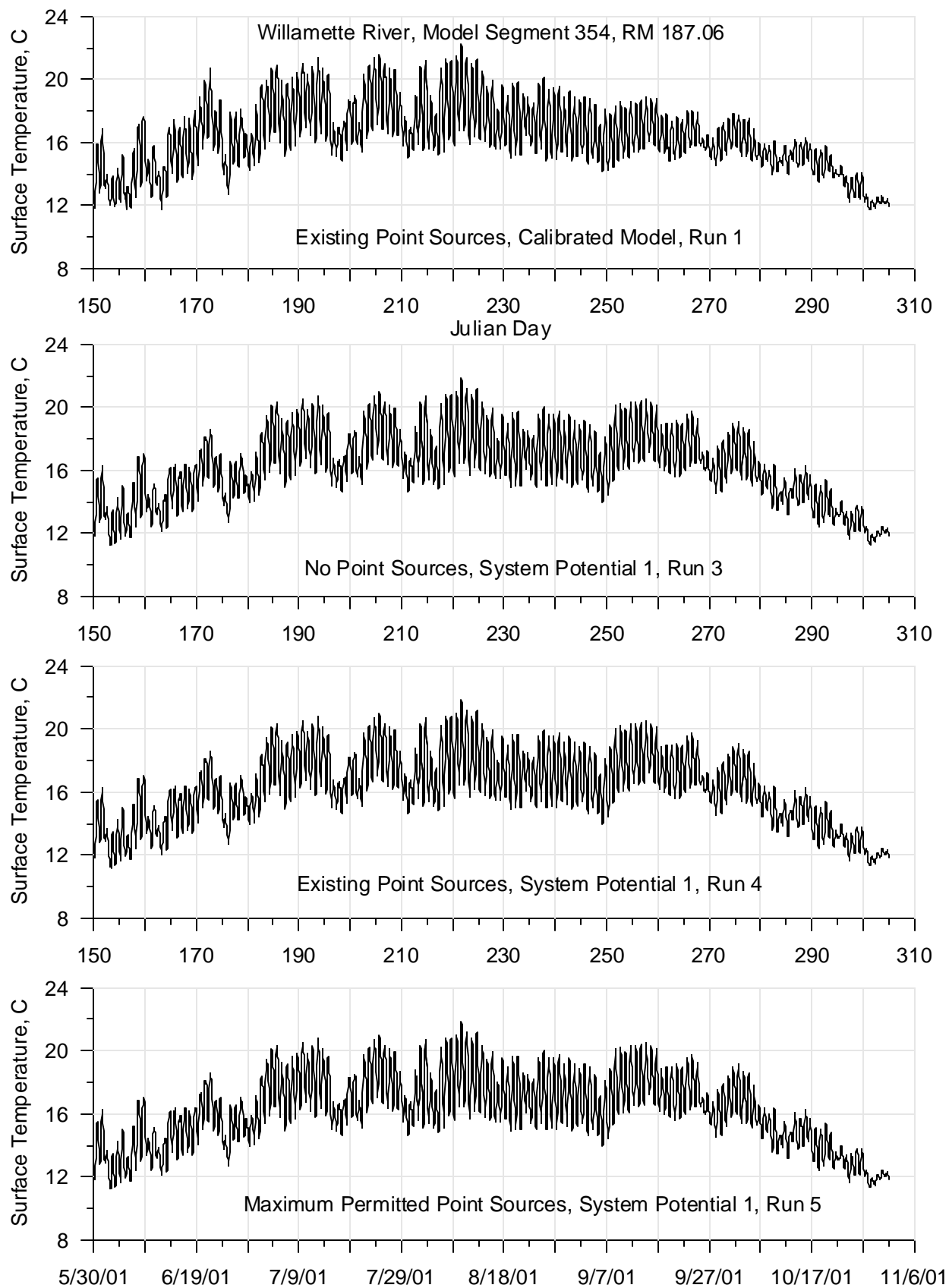
**Figure 7: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 8: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Middle Fork Willamette River at RM 11.14**

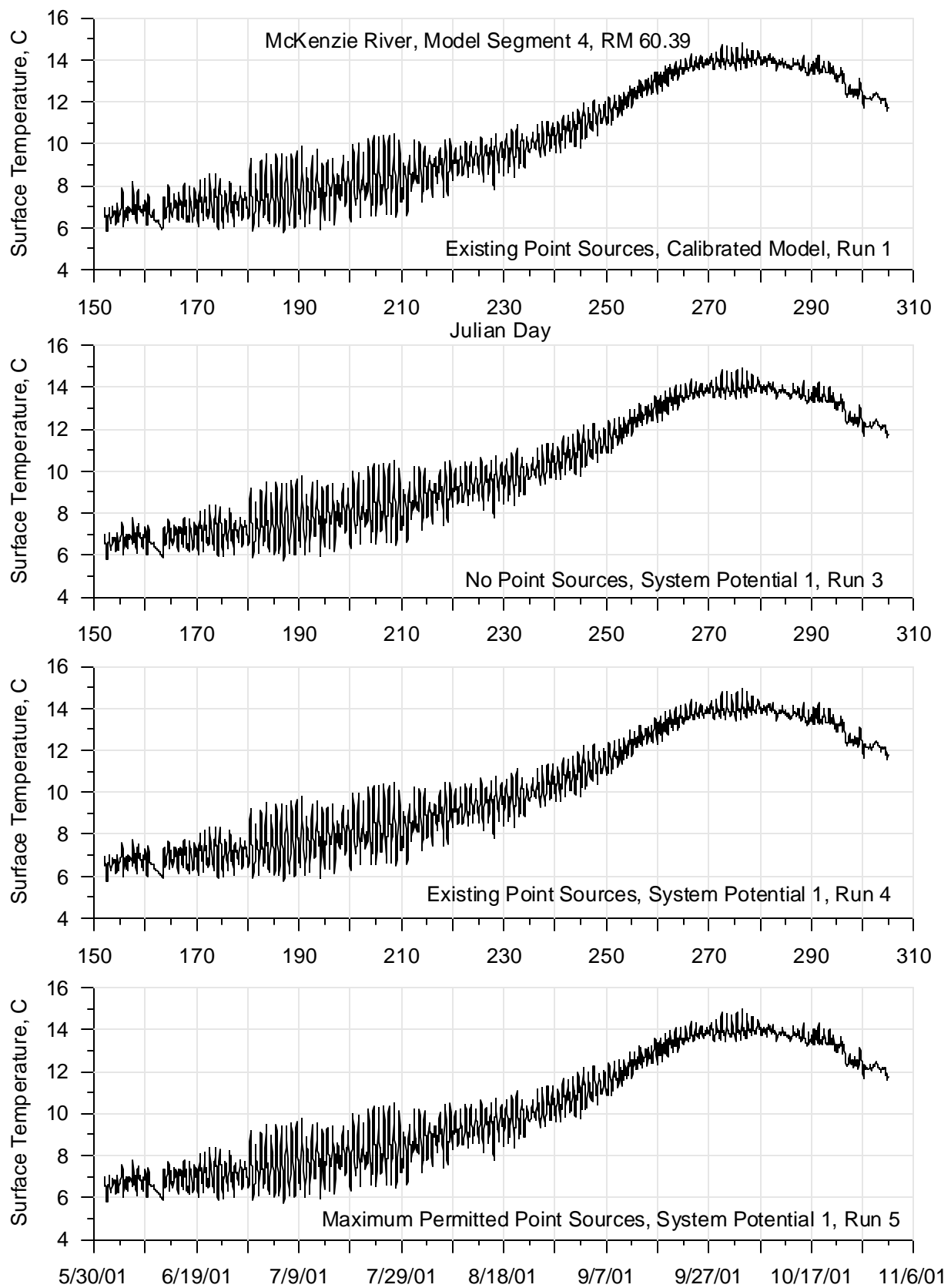


**Figure 9: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Fall Creek at RM 6.29**

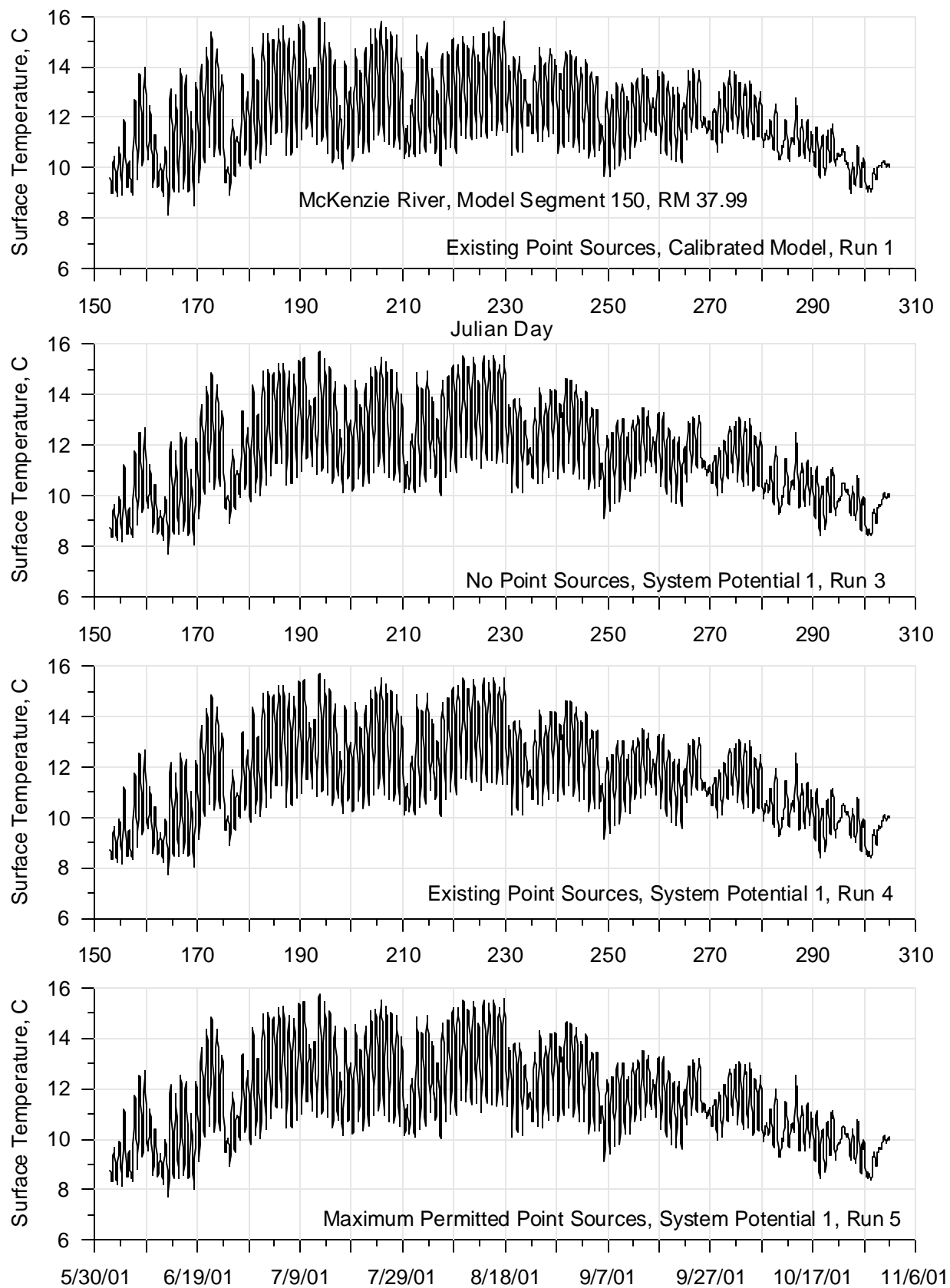


**Figure 10: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 187.03**

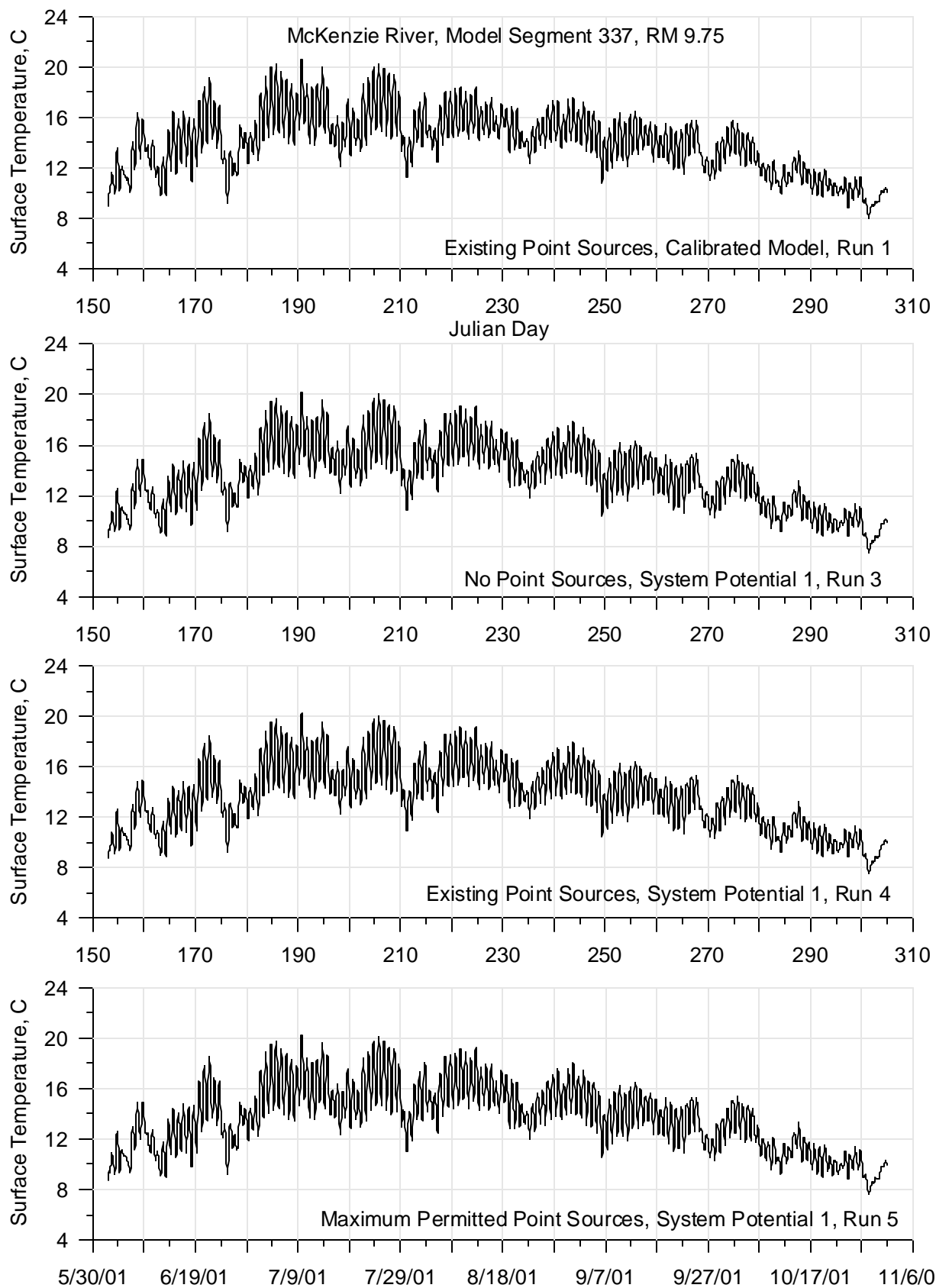




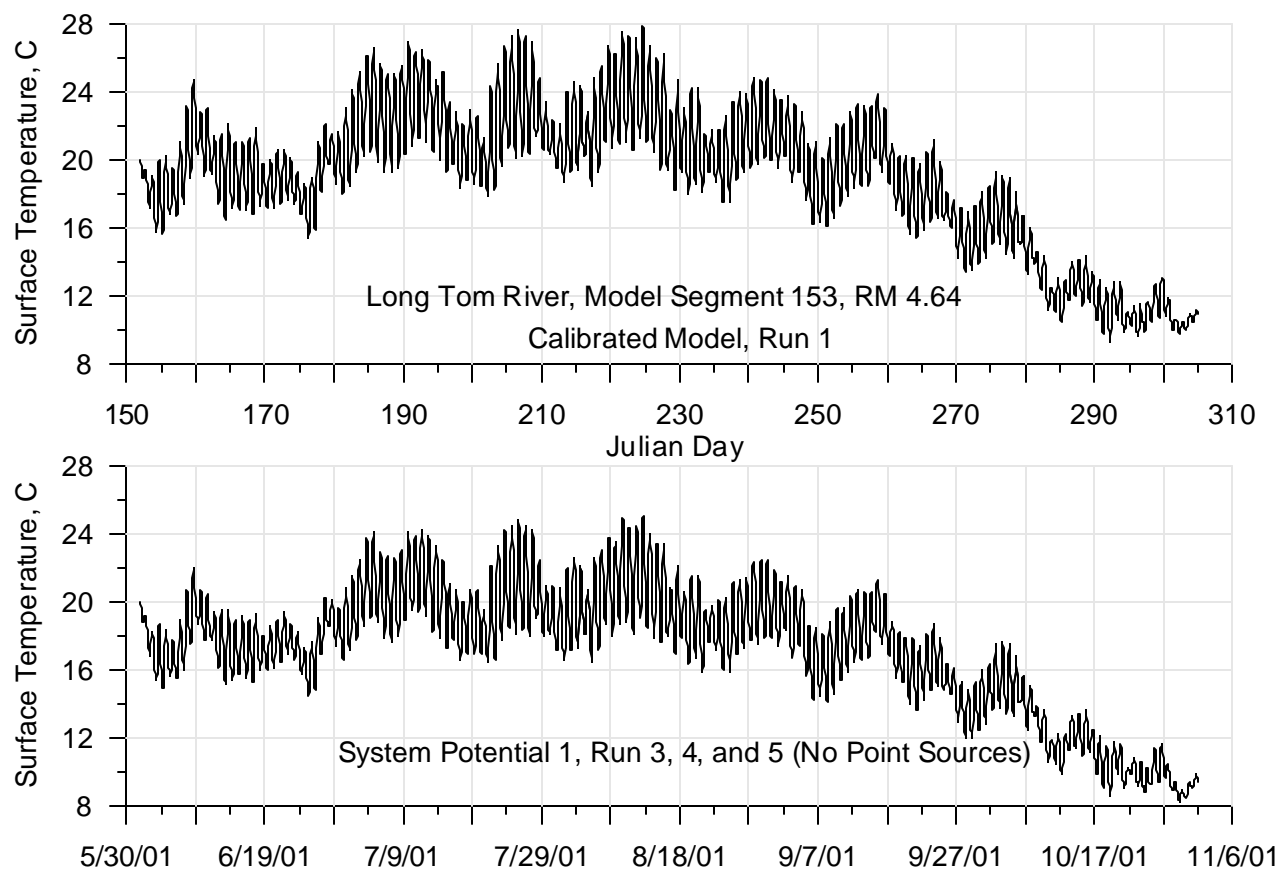
**Figure 11: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the McKenzie River at RM 60.39**



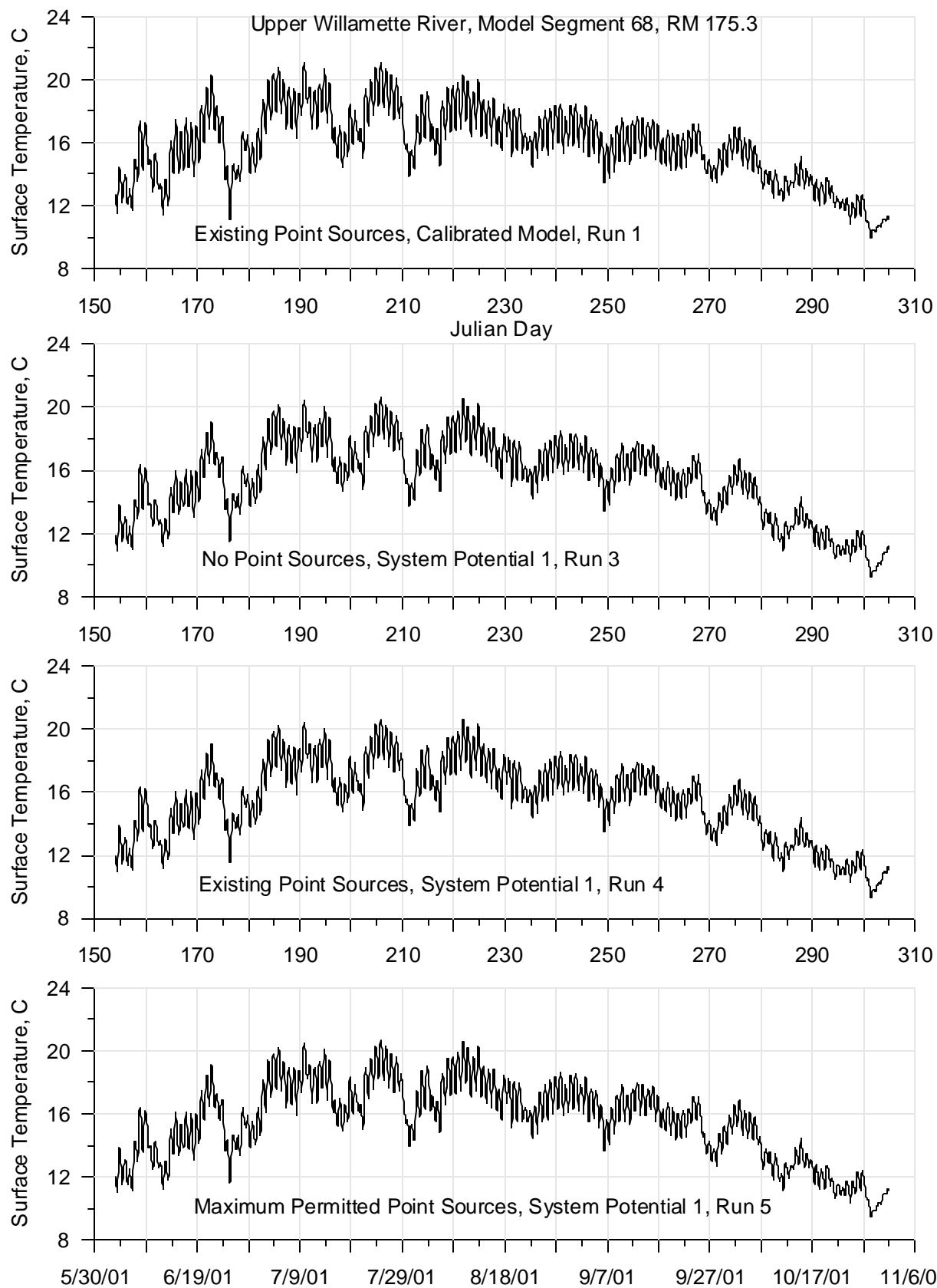
**Figure 12: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the McKenzie River at RM 37.99**



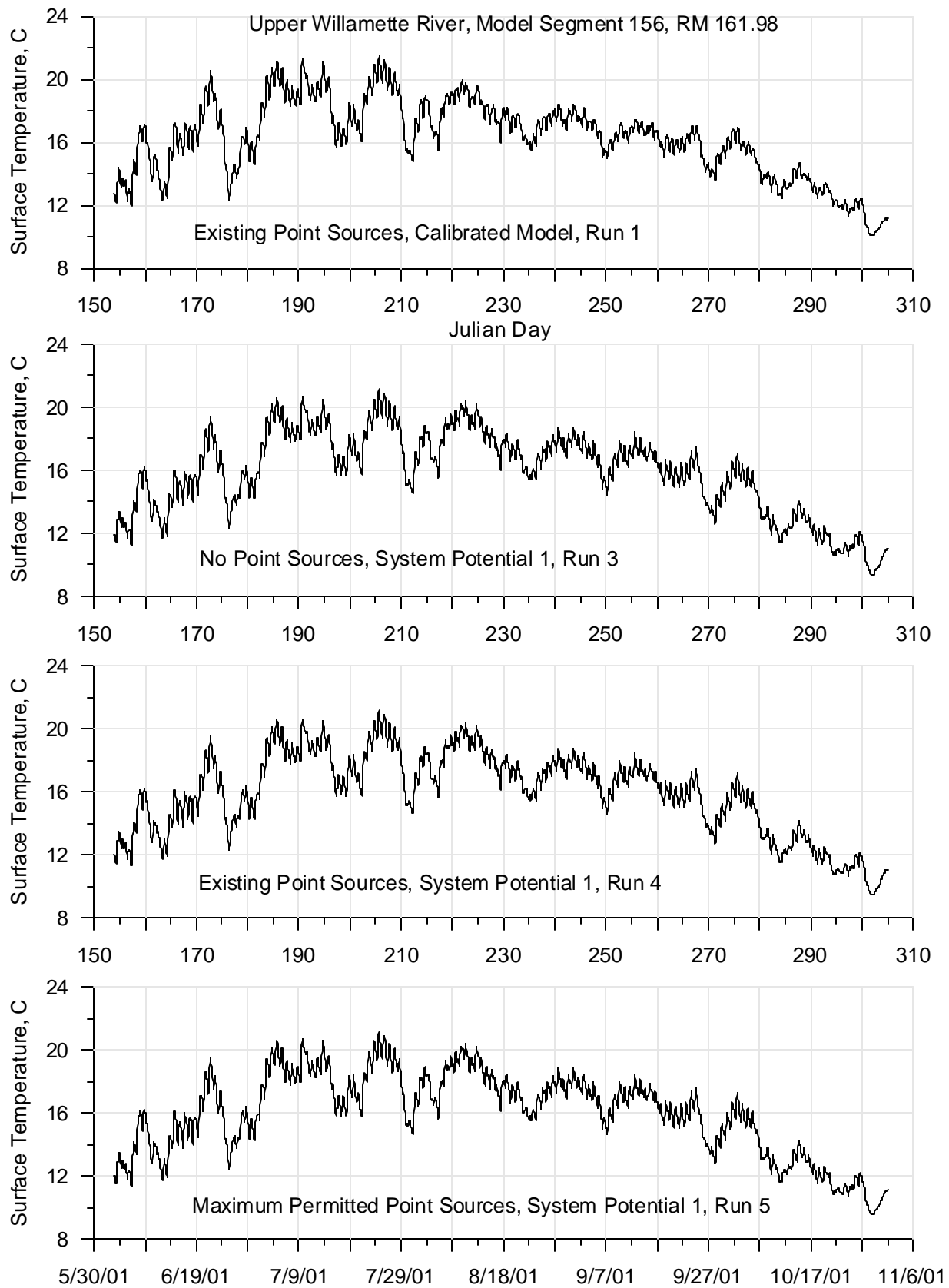
**Figure 13: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the McKenzie River at RM 9.75**



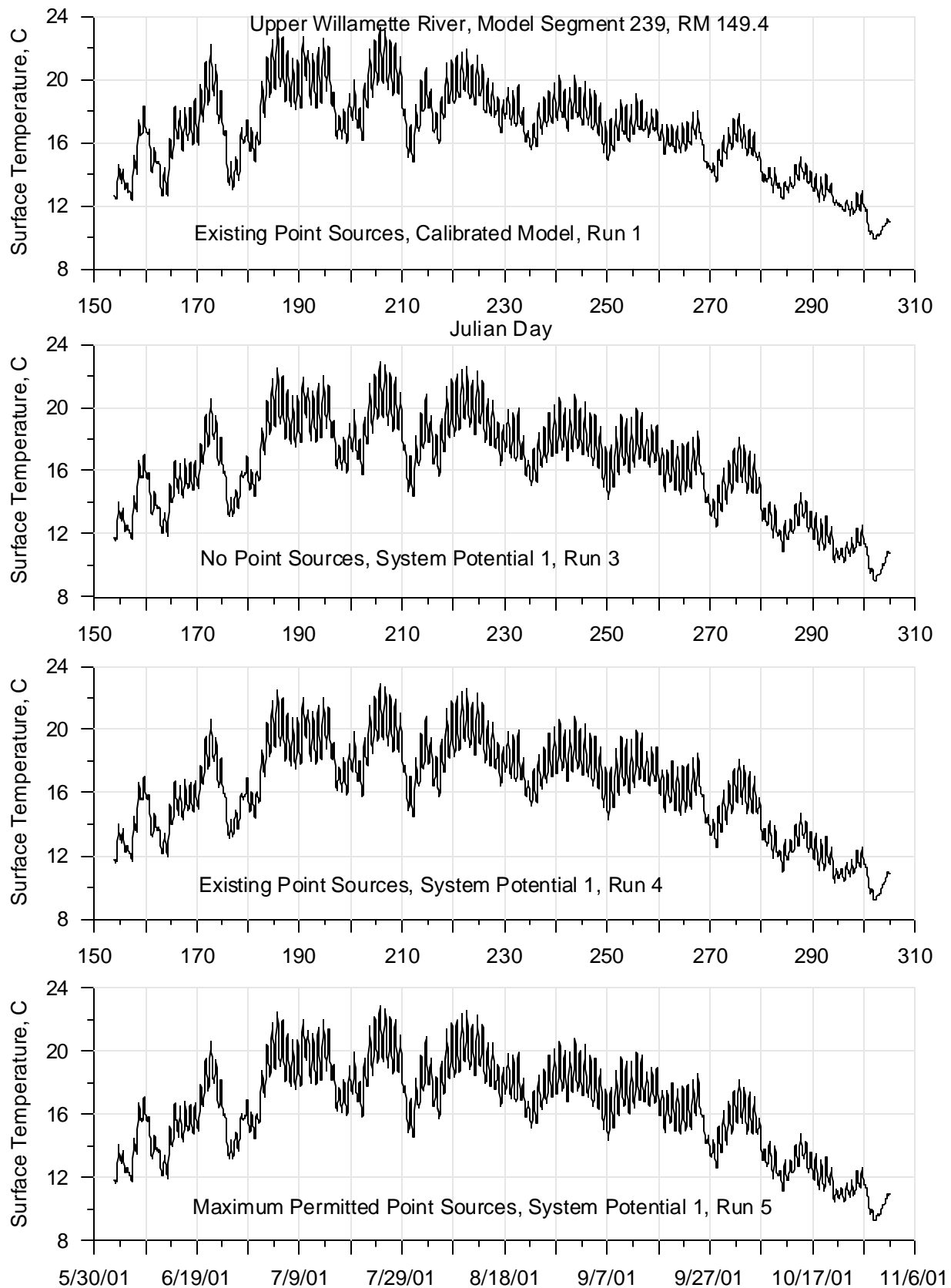
**Figure 14: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Long Tom River at RM 4.64**



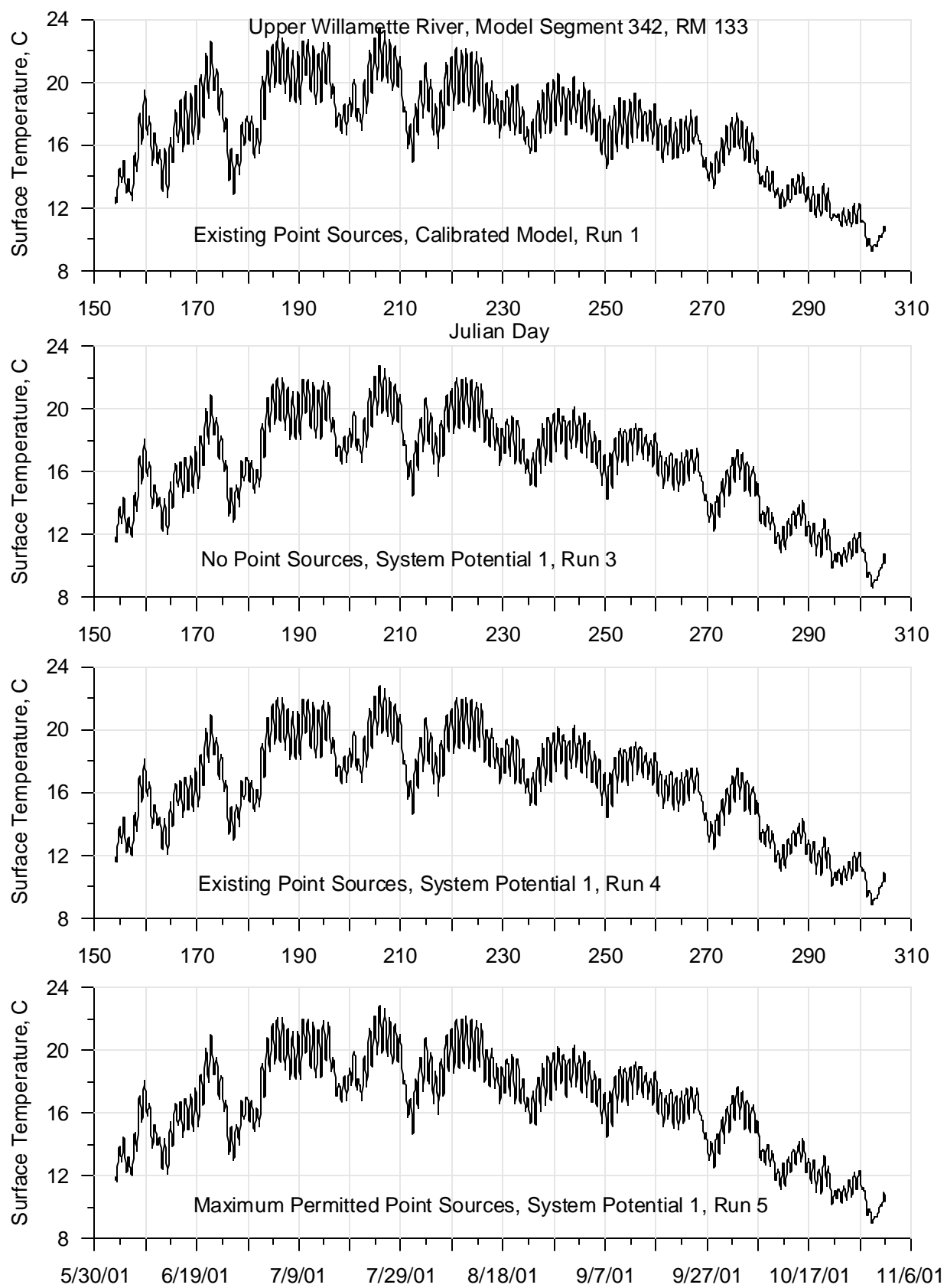
**Figure 15: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 175.3**



**Figure 16: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 161.98**

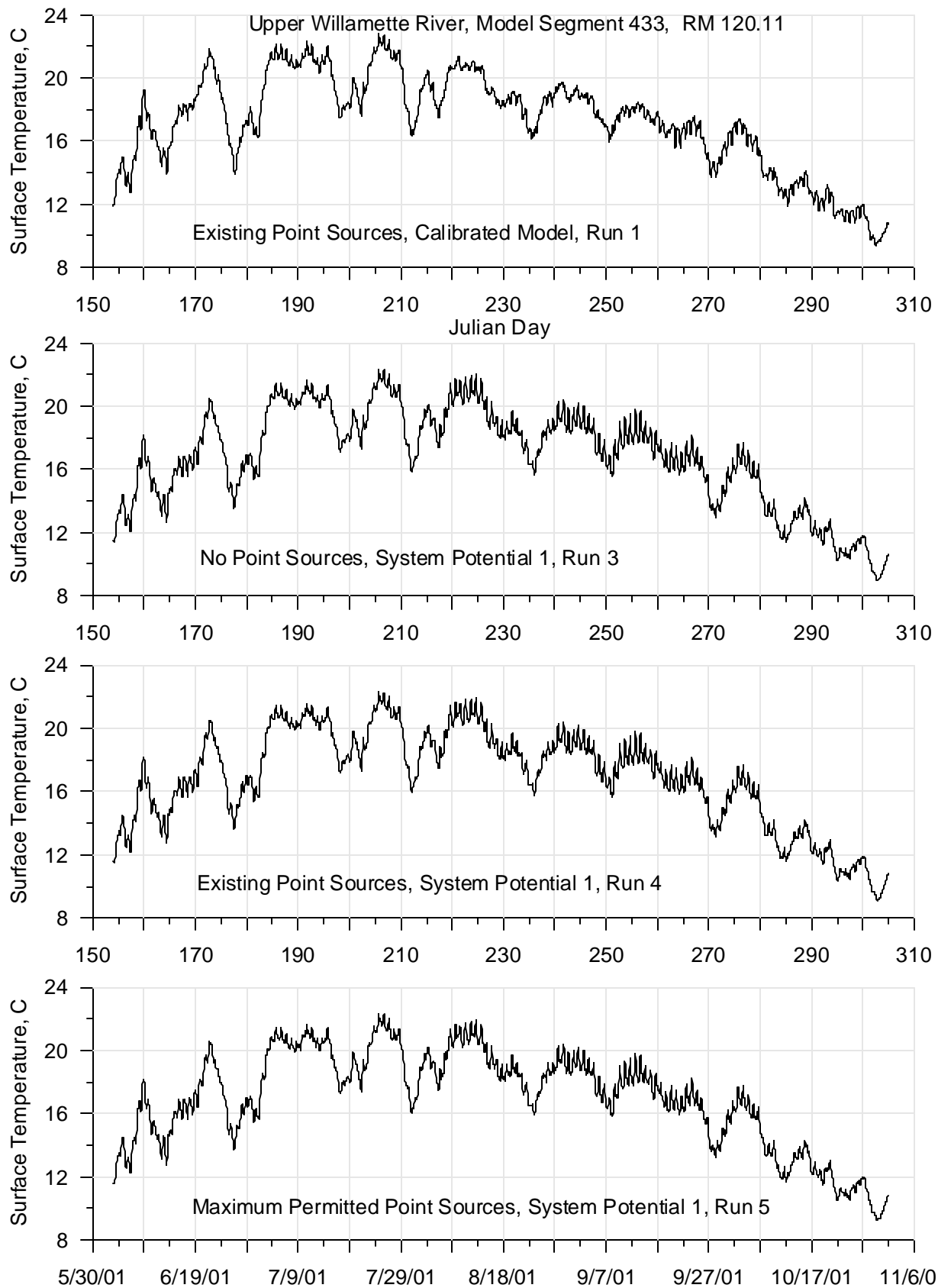


**Figure 17: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 149.4**

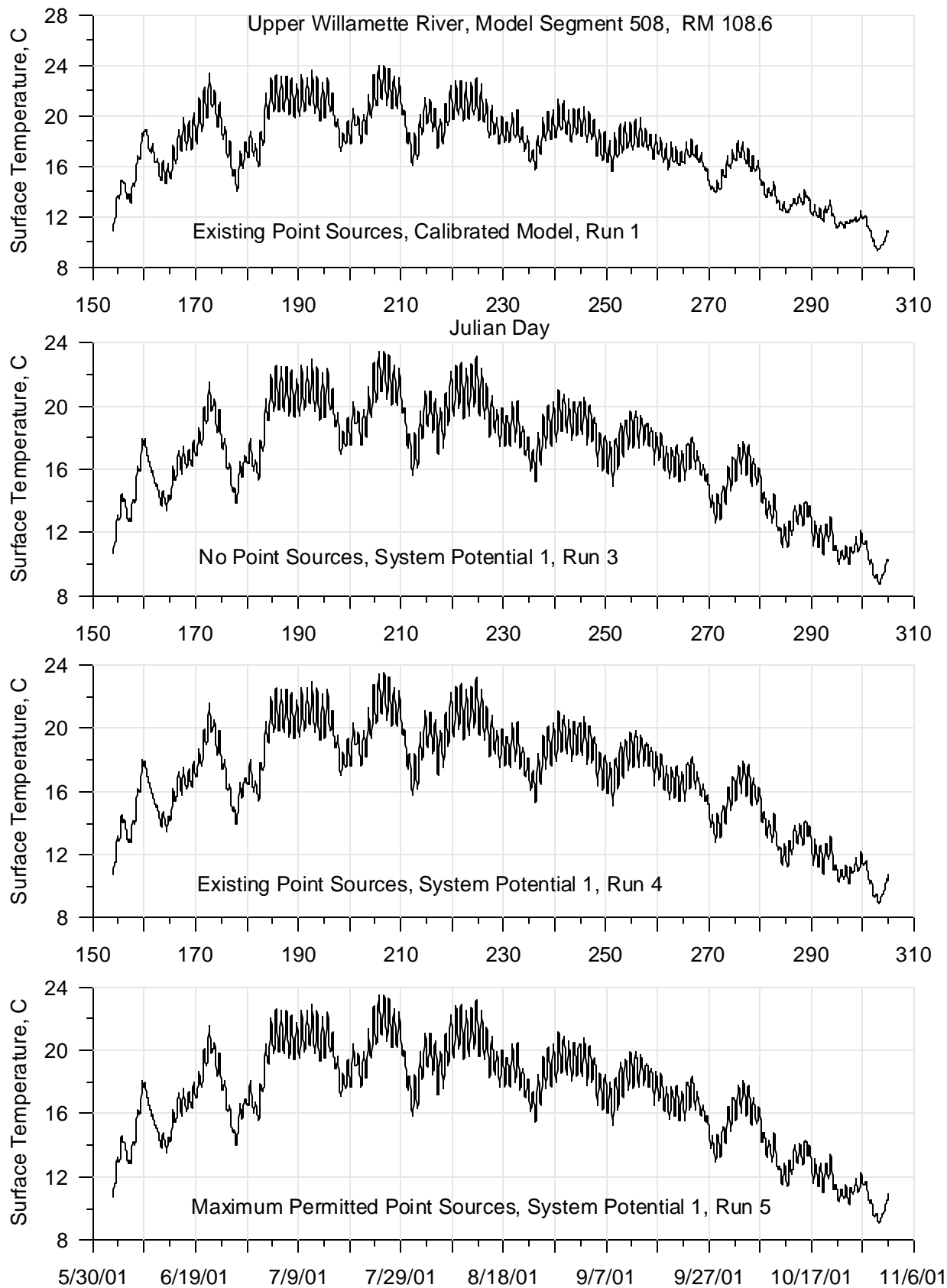


**Figure 18: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 133**

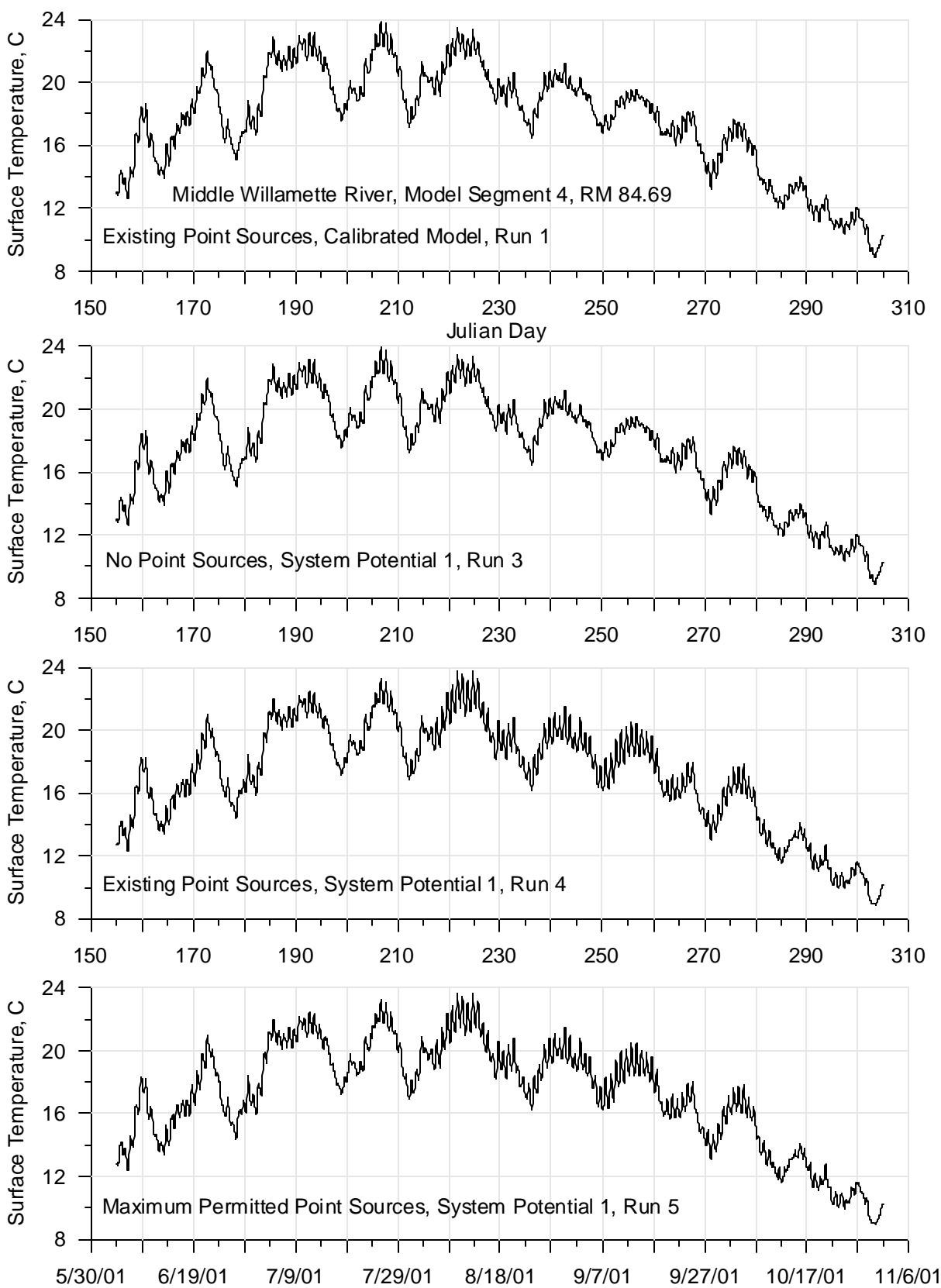




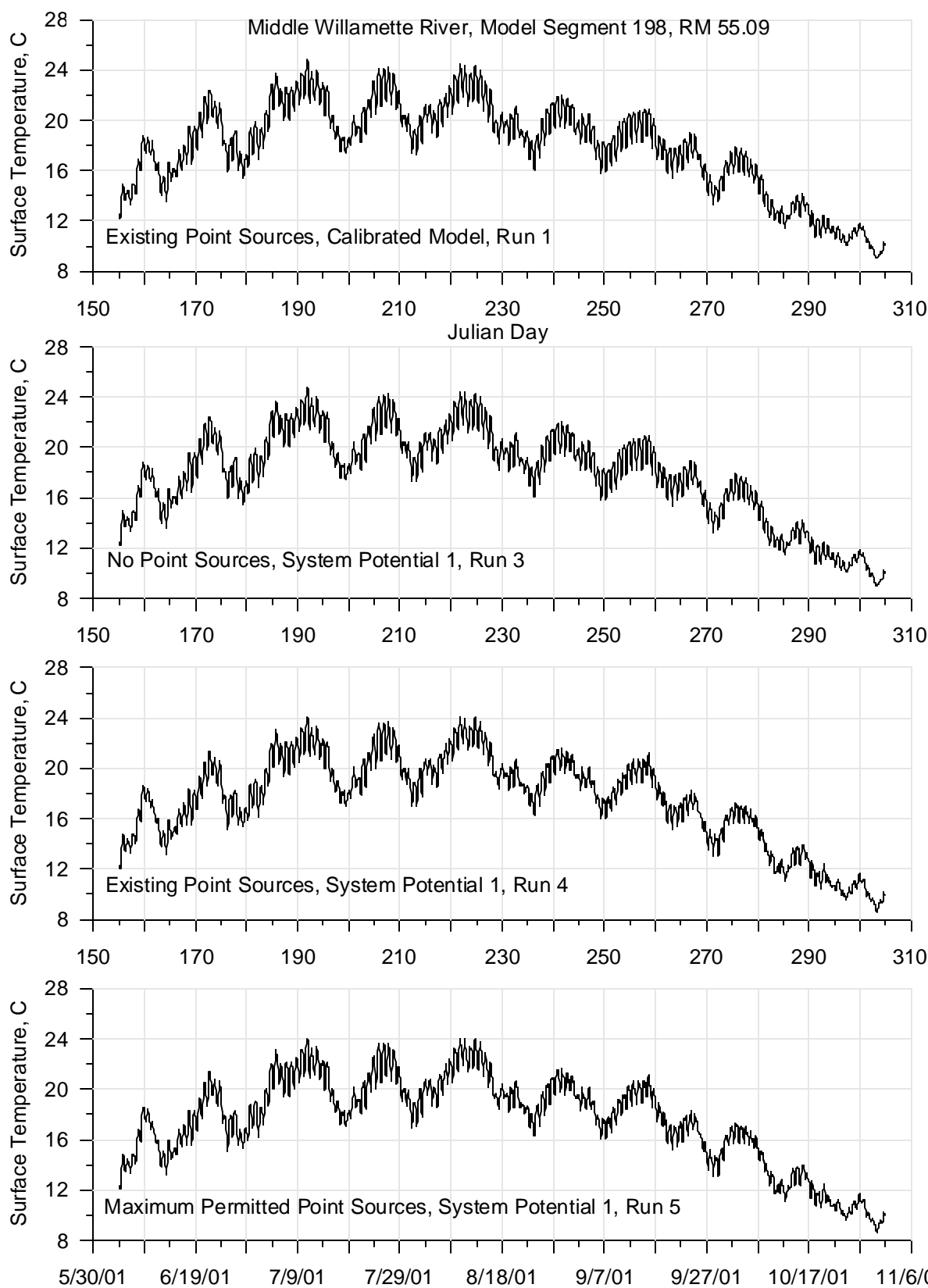
**Figure 19: Calibrated model and System Potential 1 (var ying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 120.11**



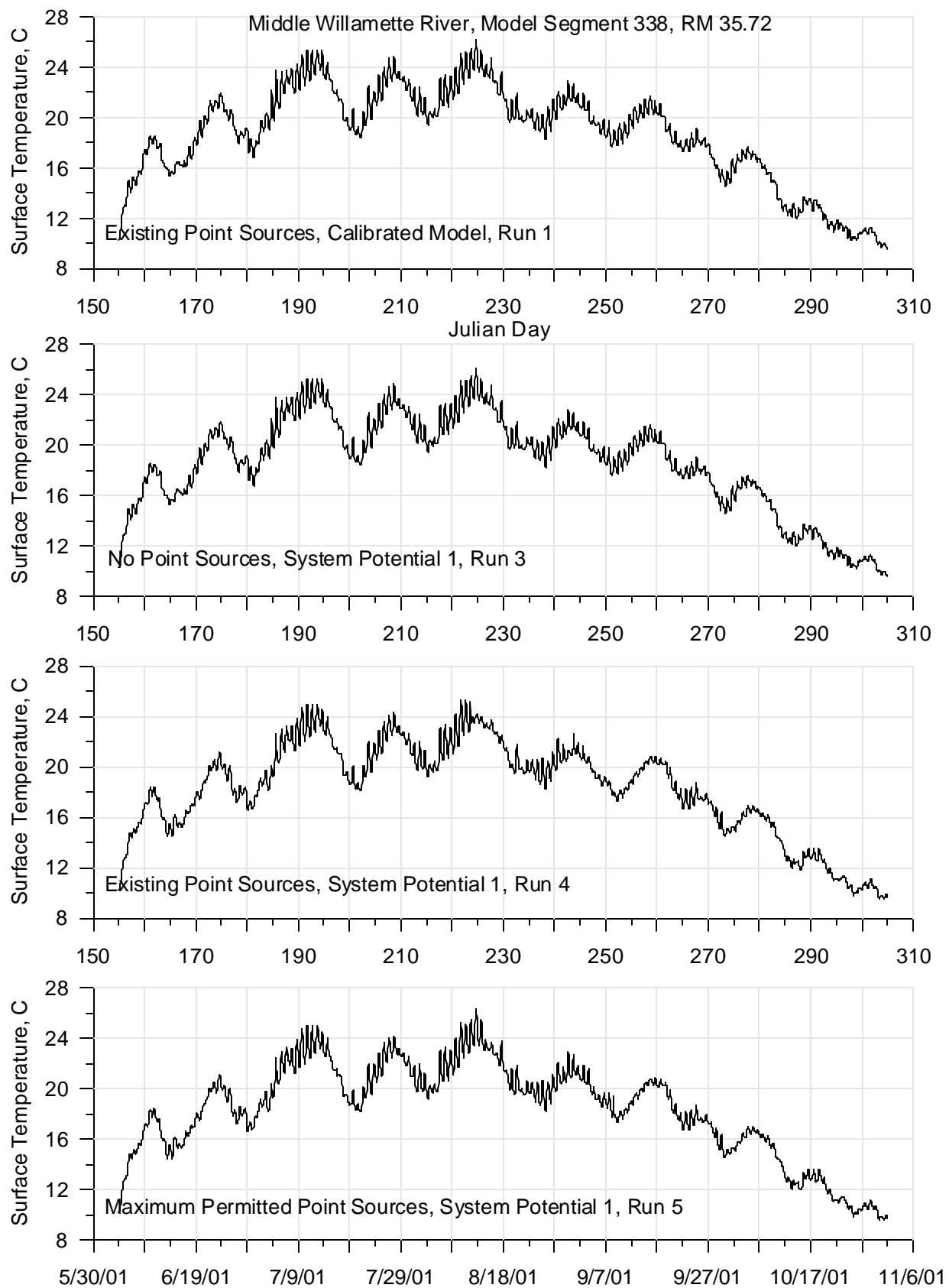
**Figure 20: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 108.6**



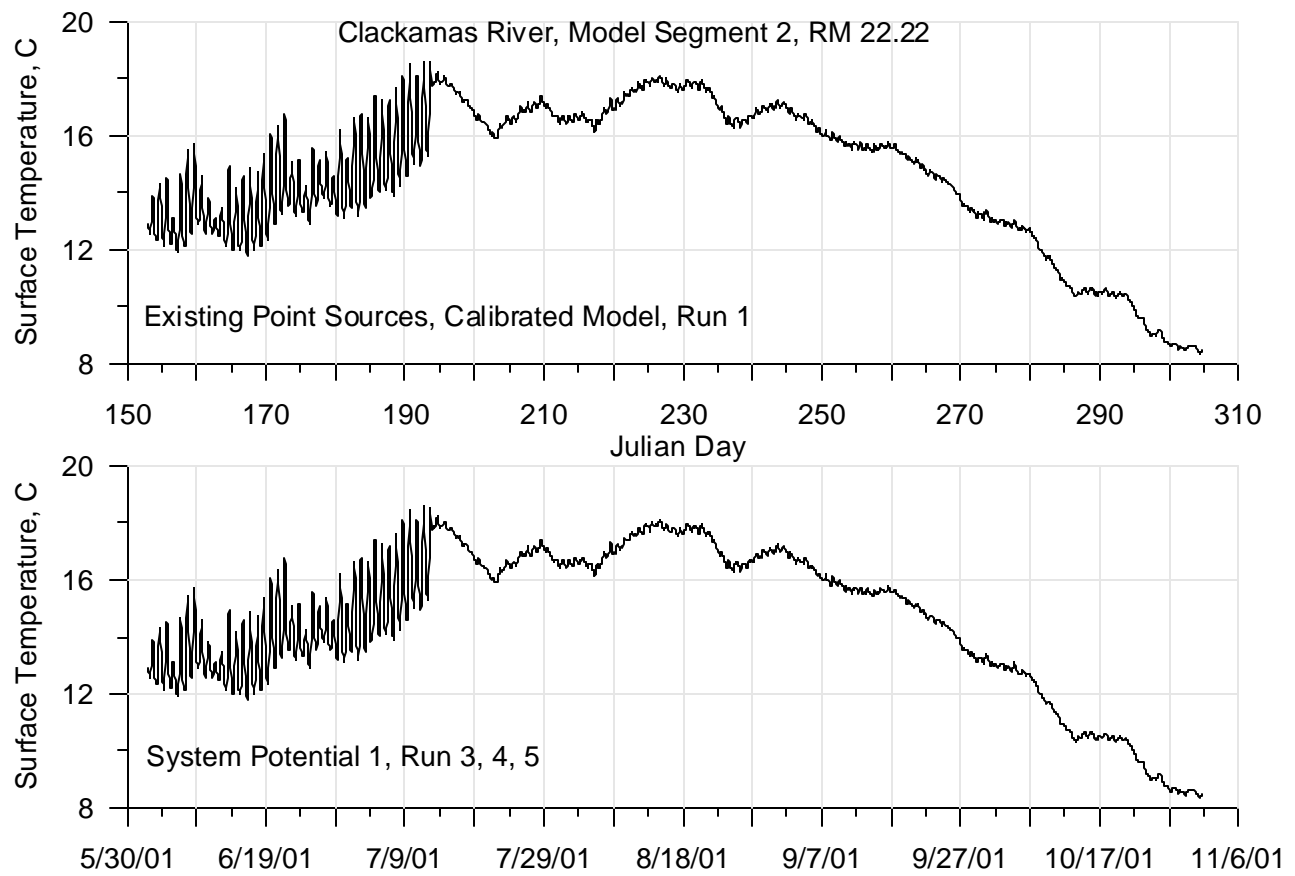
**Figure 21: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 84.69**



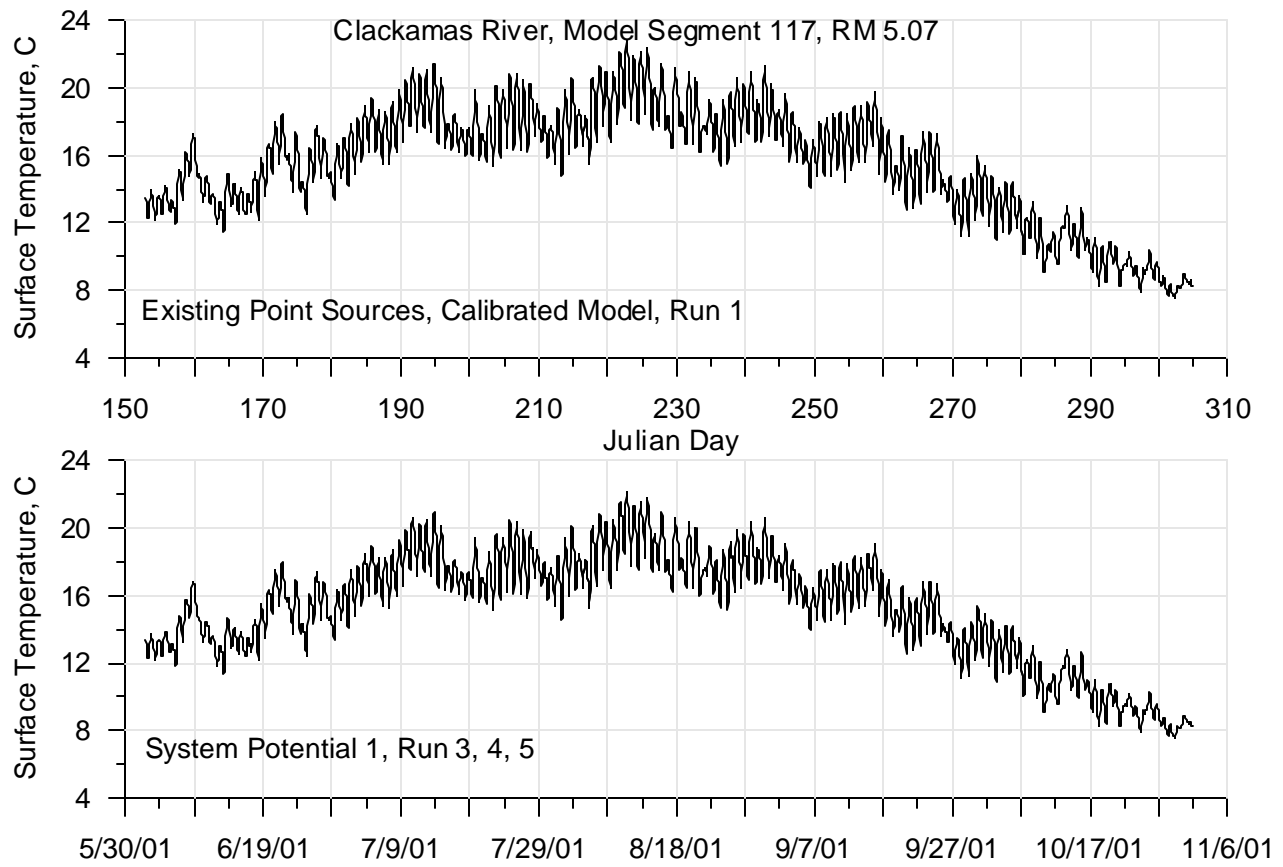
**Figure 22: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 55.09**



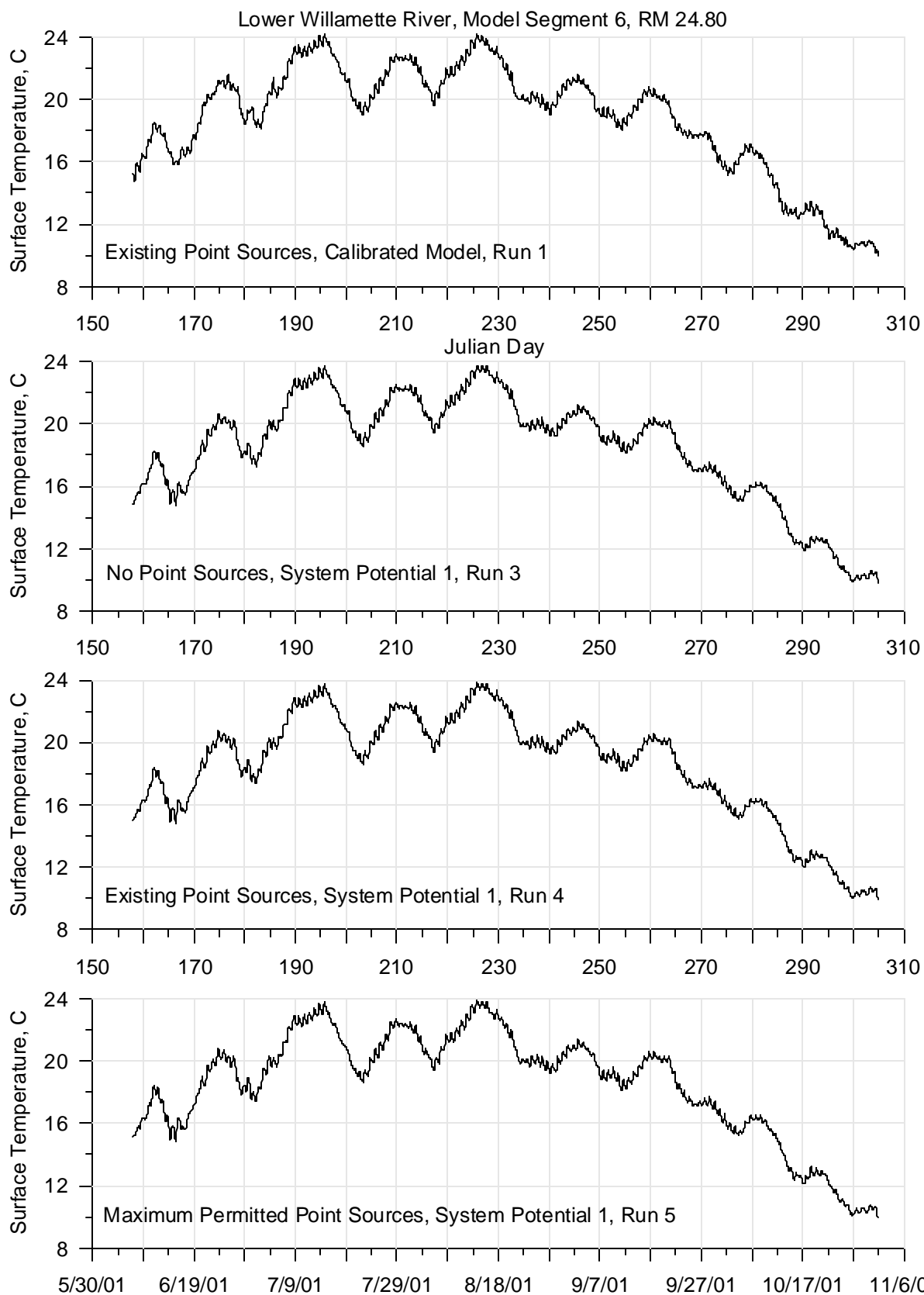
**Figure 23: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 35.72**



**Figure 24: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Clackamas River at RM 22.22**

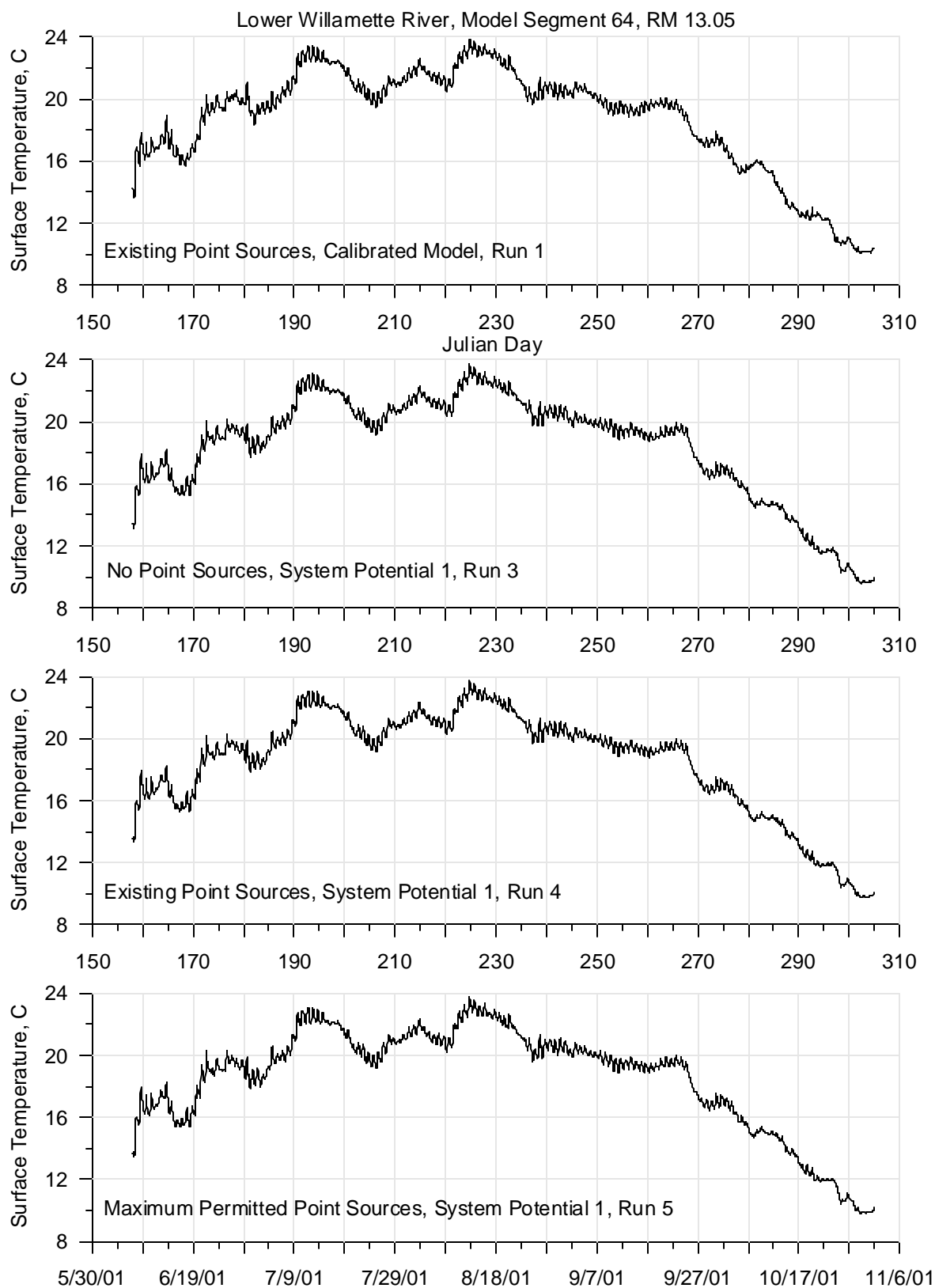


**Figure 25: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Clackamas River at RM 5.07**

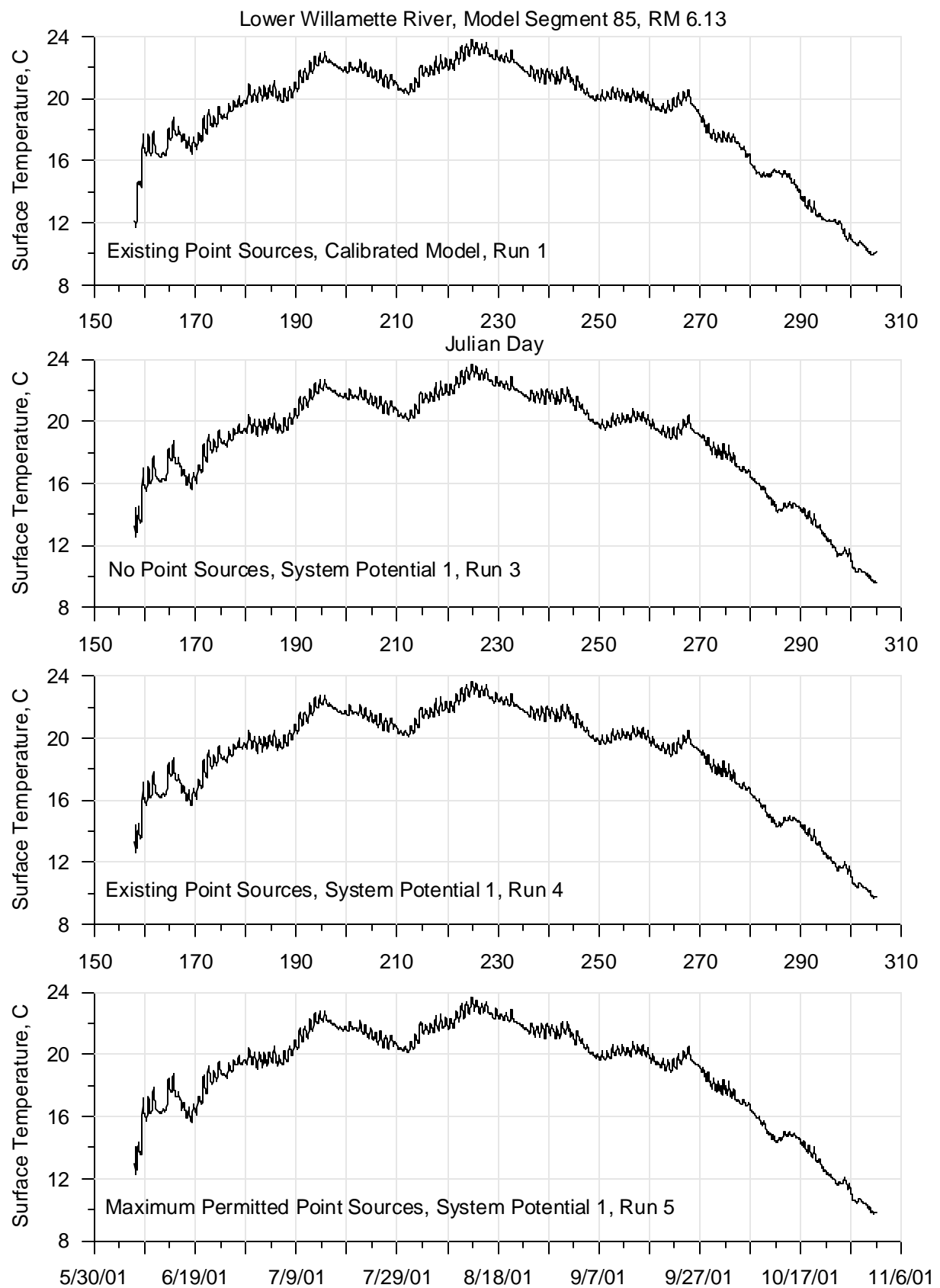


**Figure 26: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 24.8**





**Figure 27: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 13.05**



**Figure 28: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 6.13**

Continuous Flow

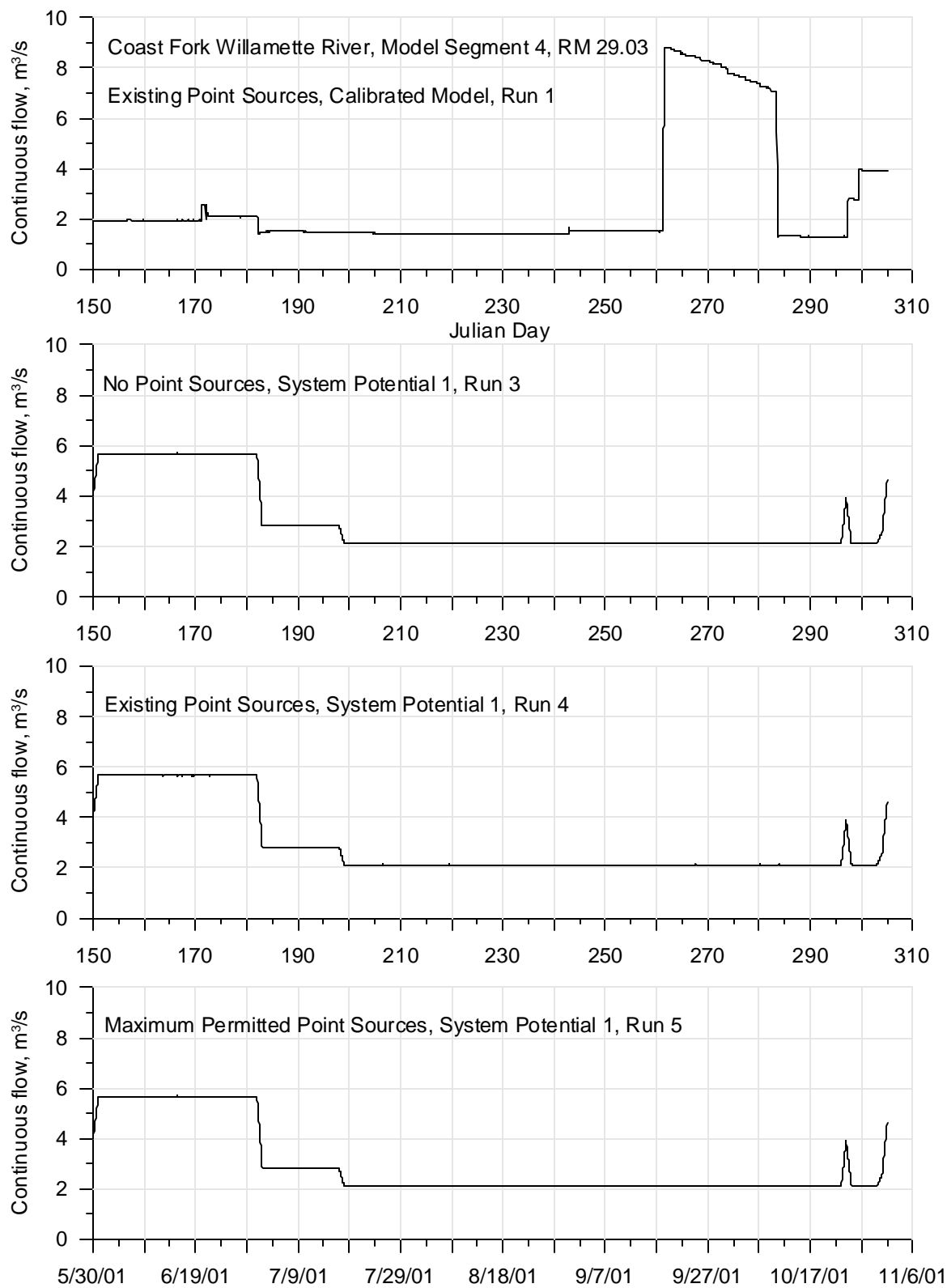
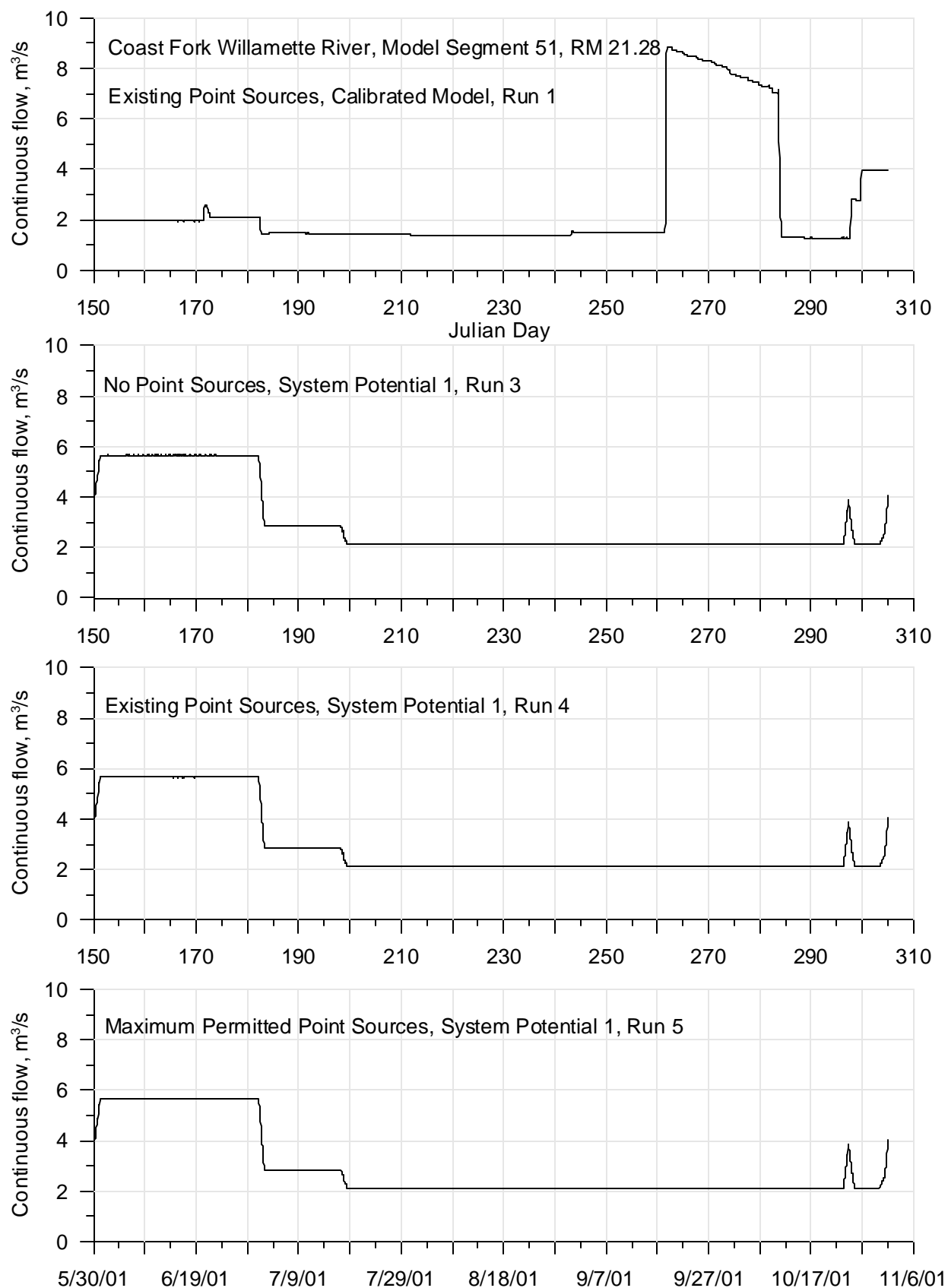
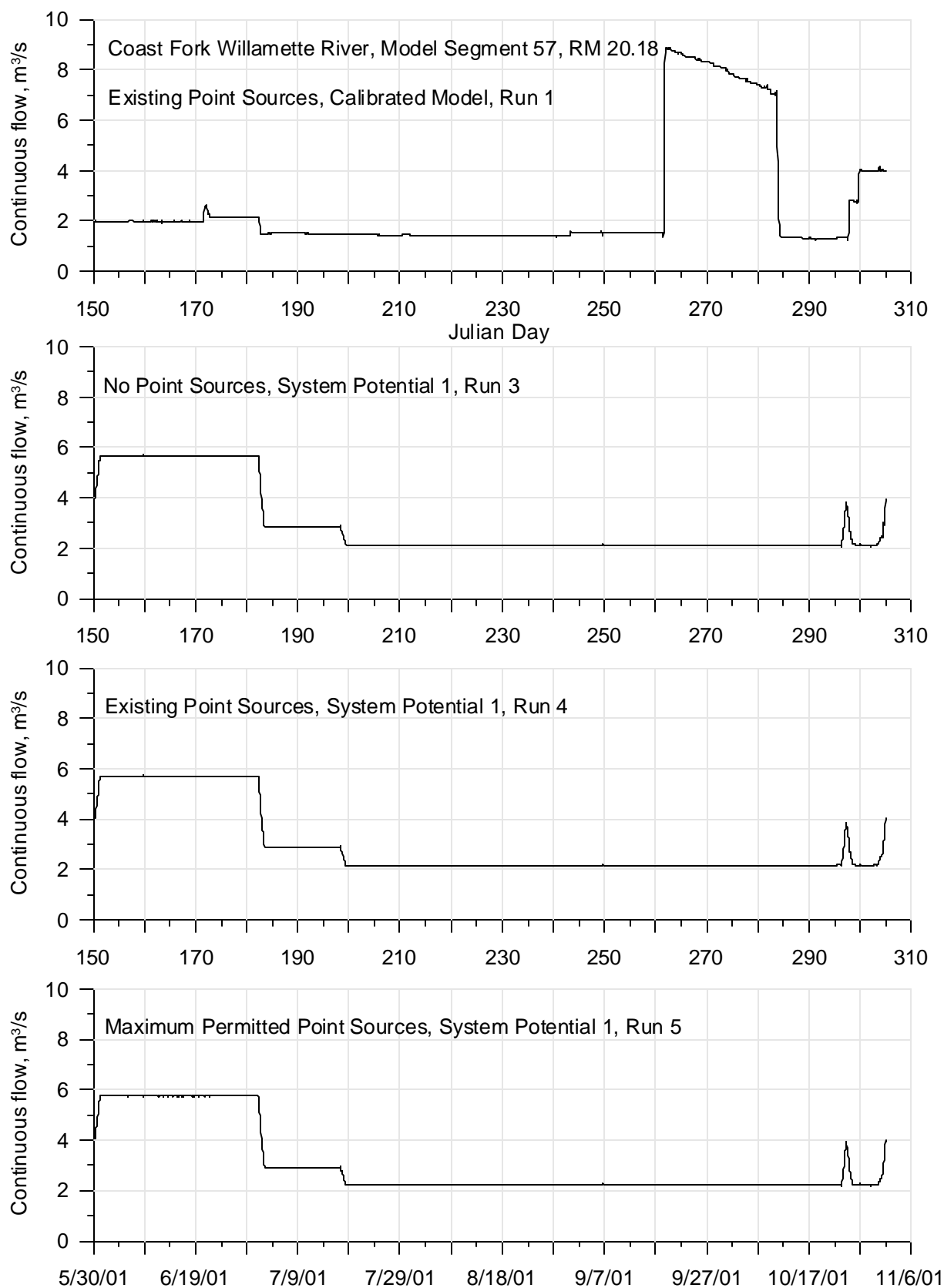


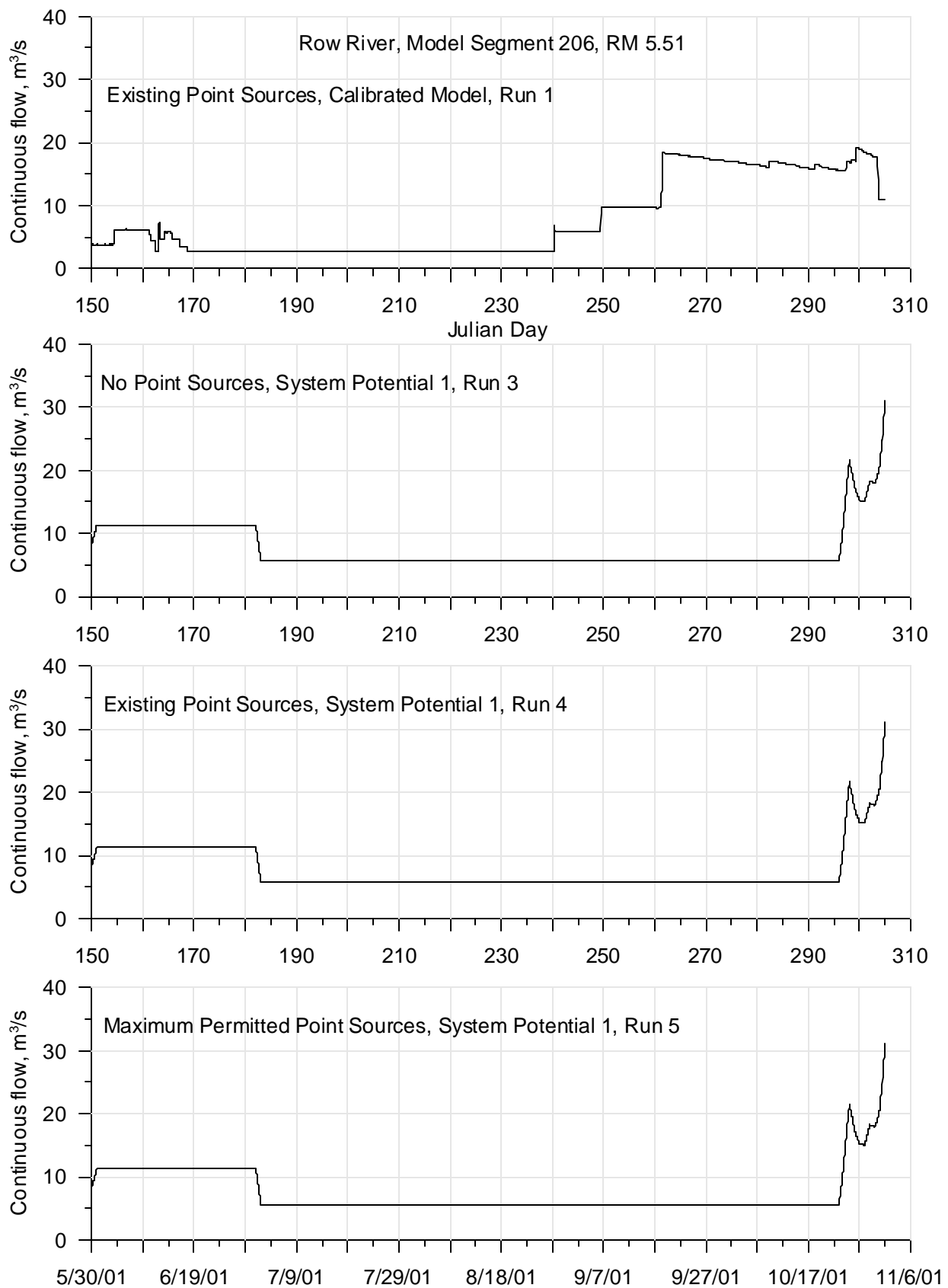
Figure 29: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Coast Fork Willamette River at RM 29.03



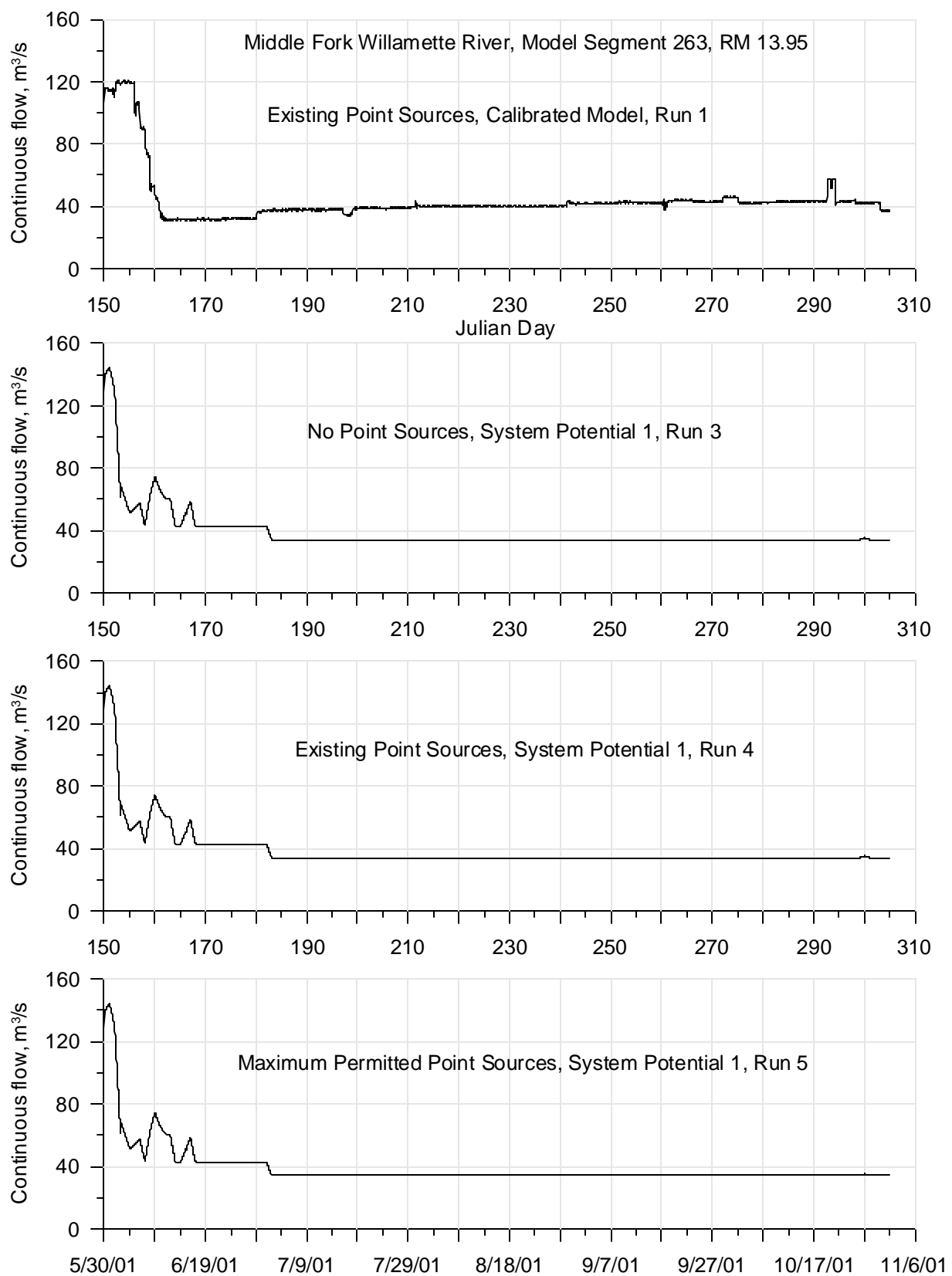
**Figure 30: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Coast Fork Willamette River at RM 21.28**



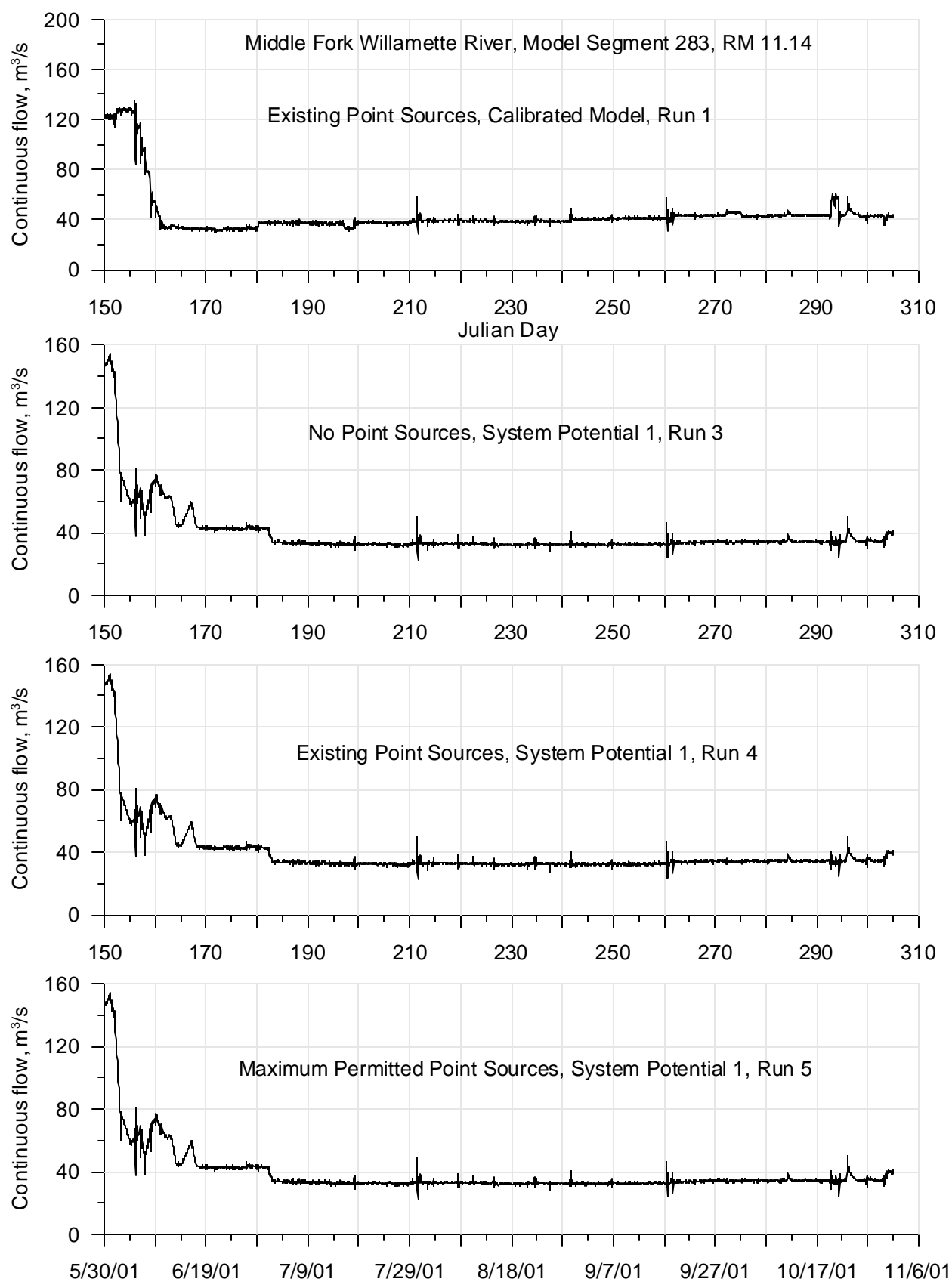
**Figure 31: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Coast Fork Willamette River at RM 20.18**



**Figure 32: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Row River at RM 5.51**

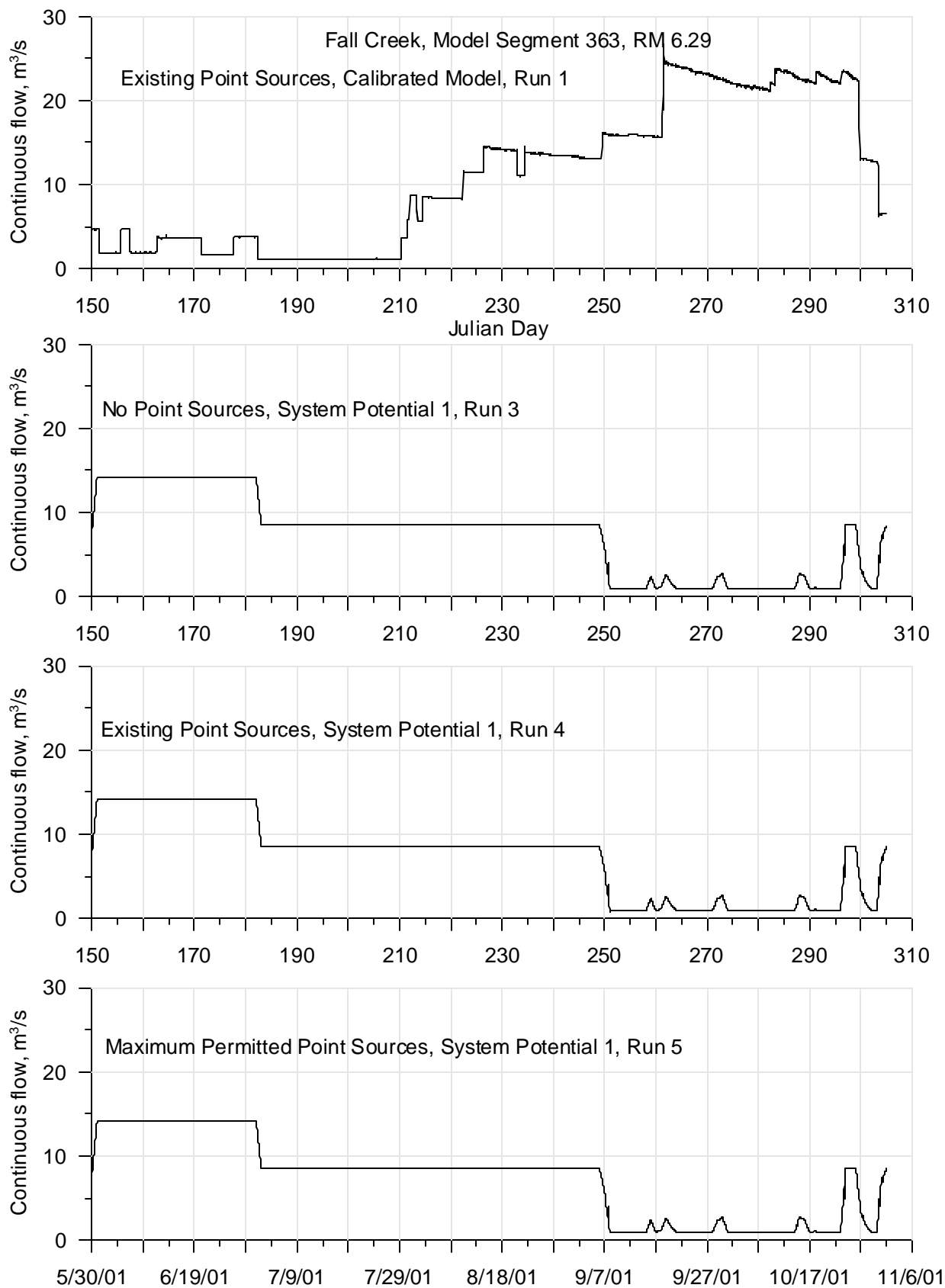


**Figure 33: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Middle Fork Willamette River at RM 13.95**

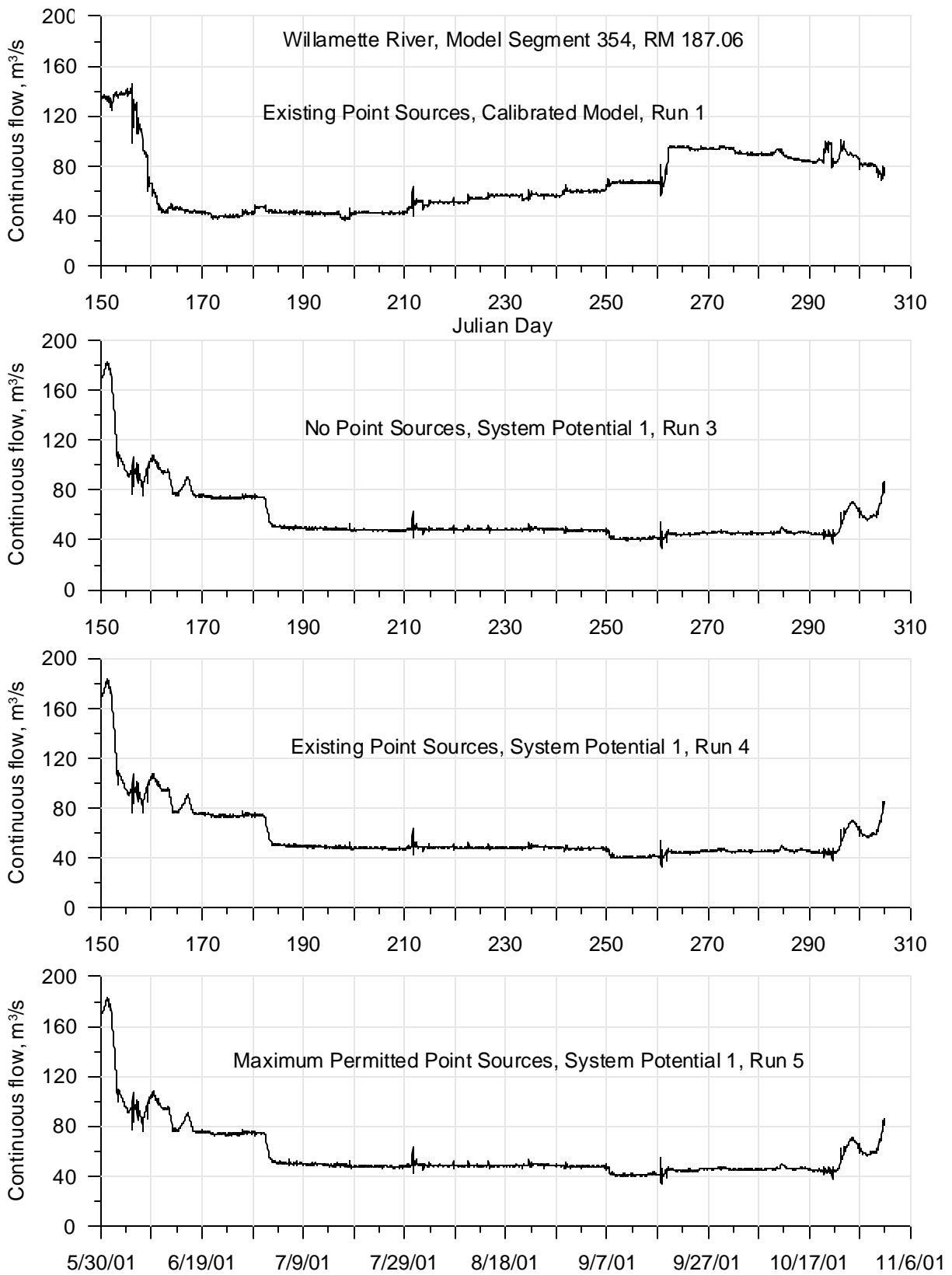


**Figure 34: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Middle Fork Willamette River at RM 11.14**

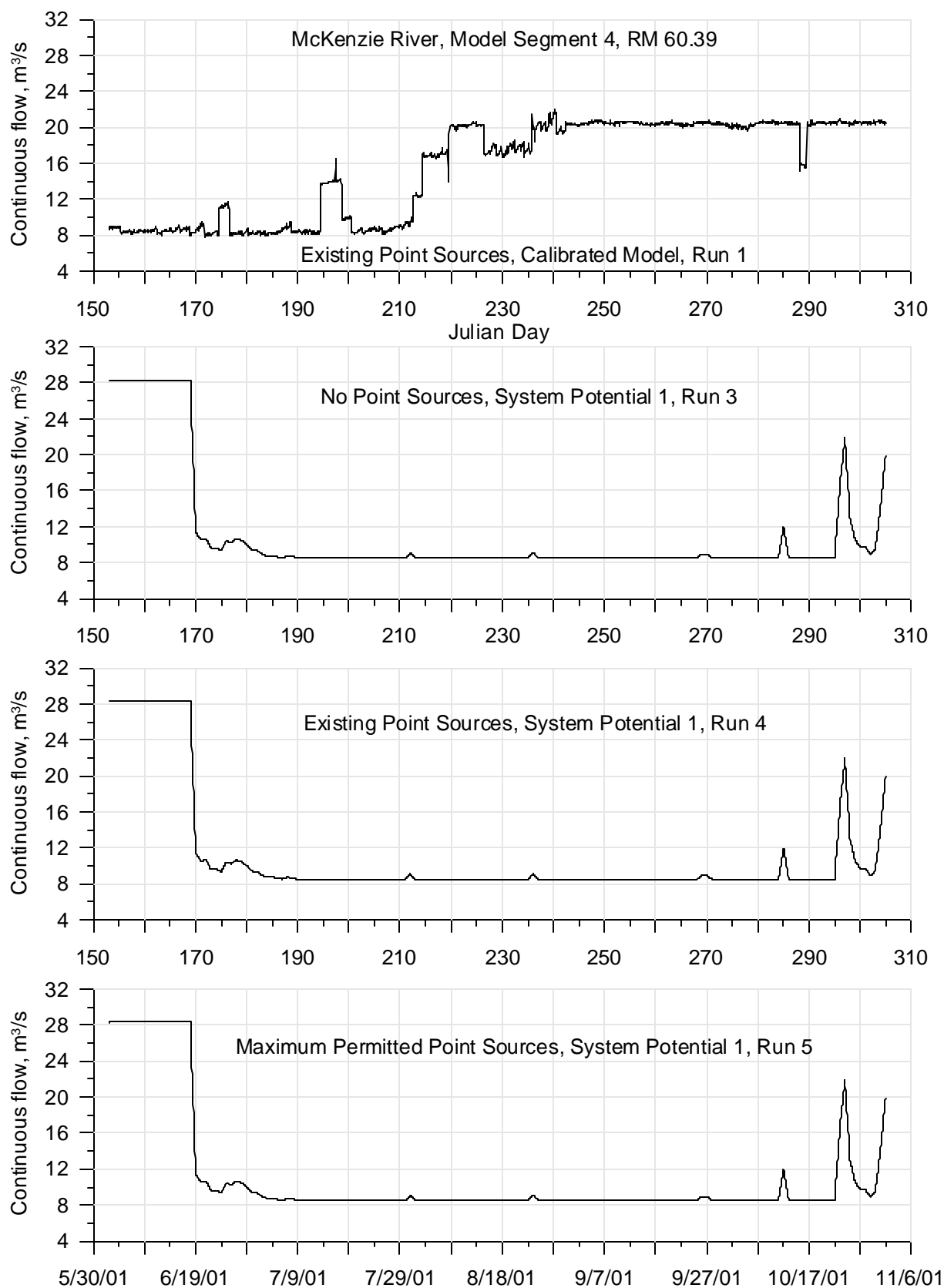




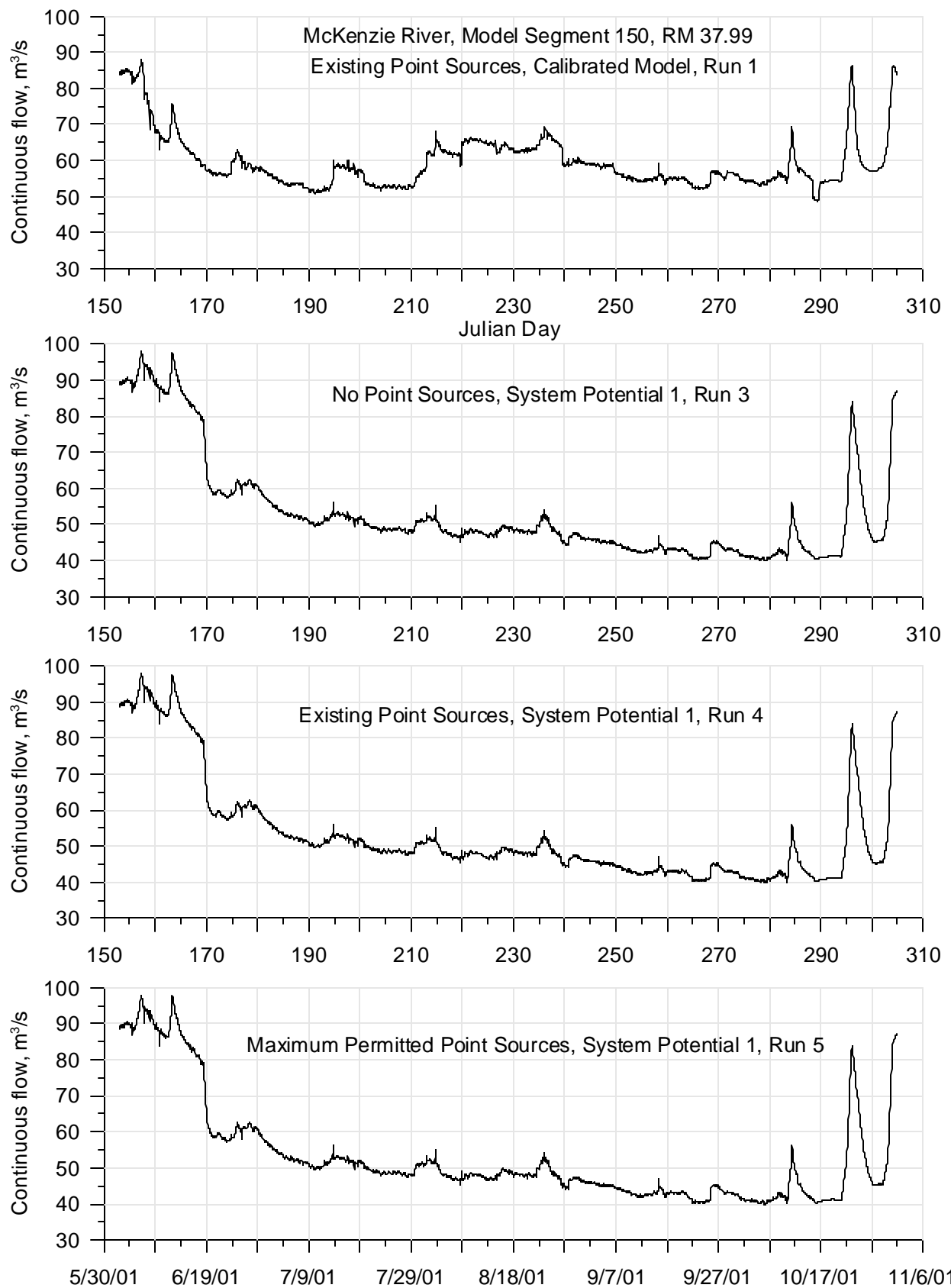
**Figure 35: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Fall Creek at RM 6.29**



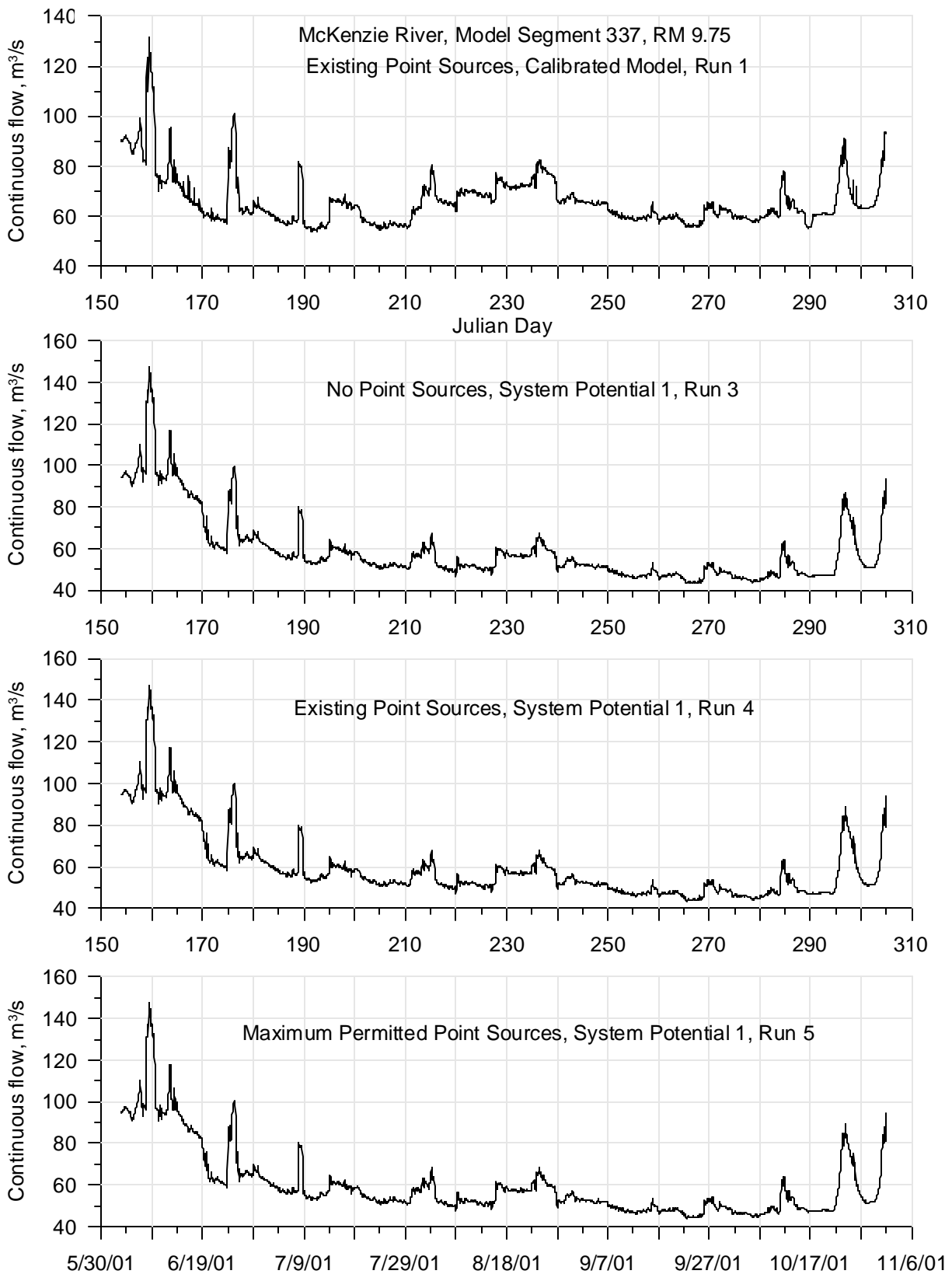
**Figure 36: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 187.06**



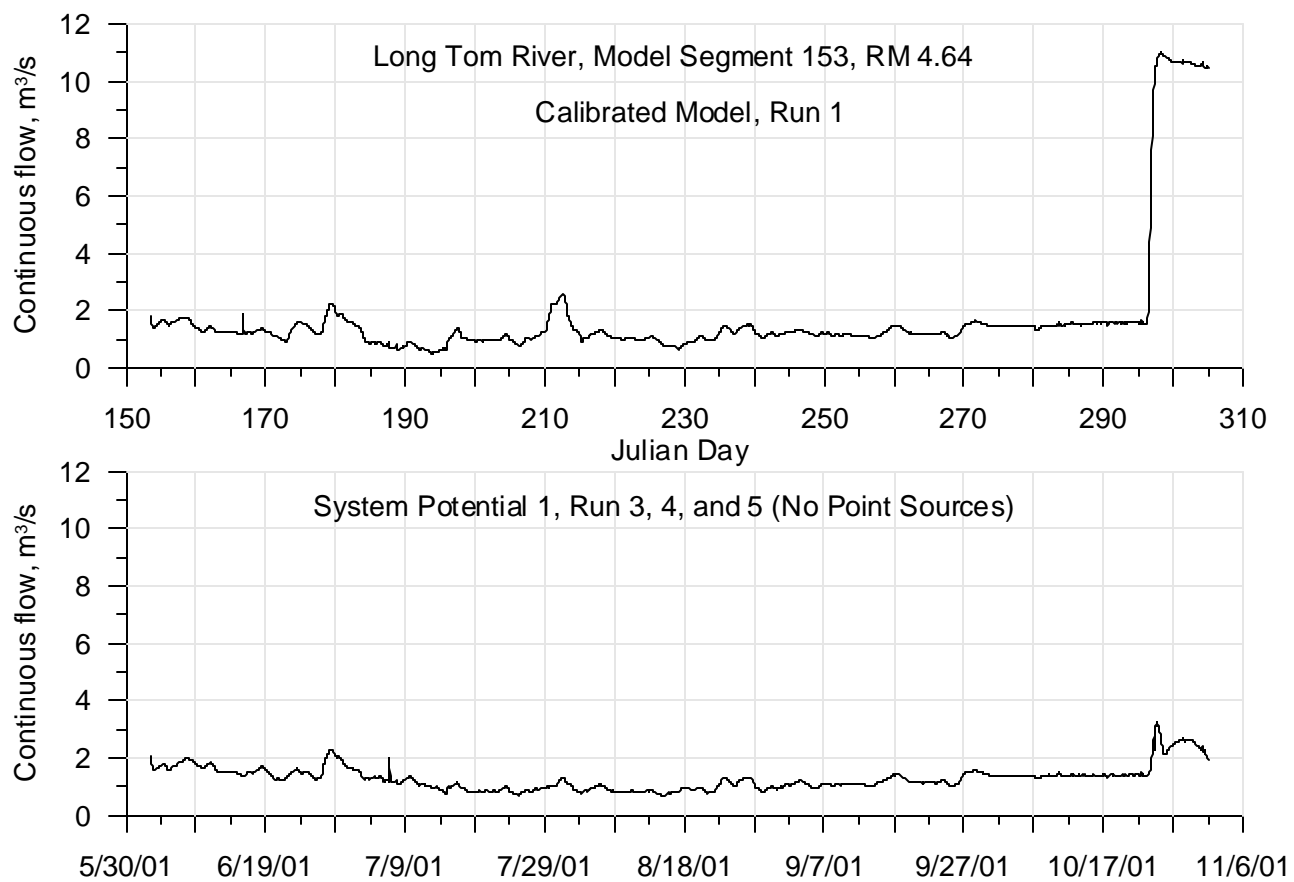
**Figure 37: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the McKenzie River at RM 60.39**



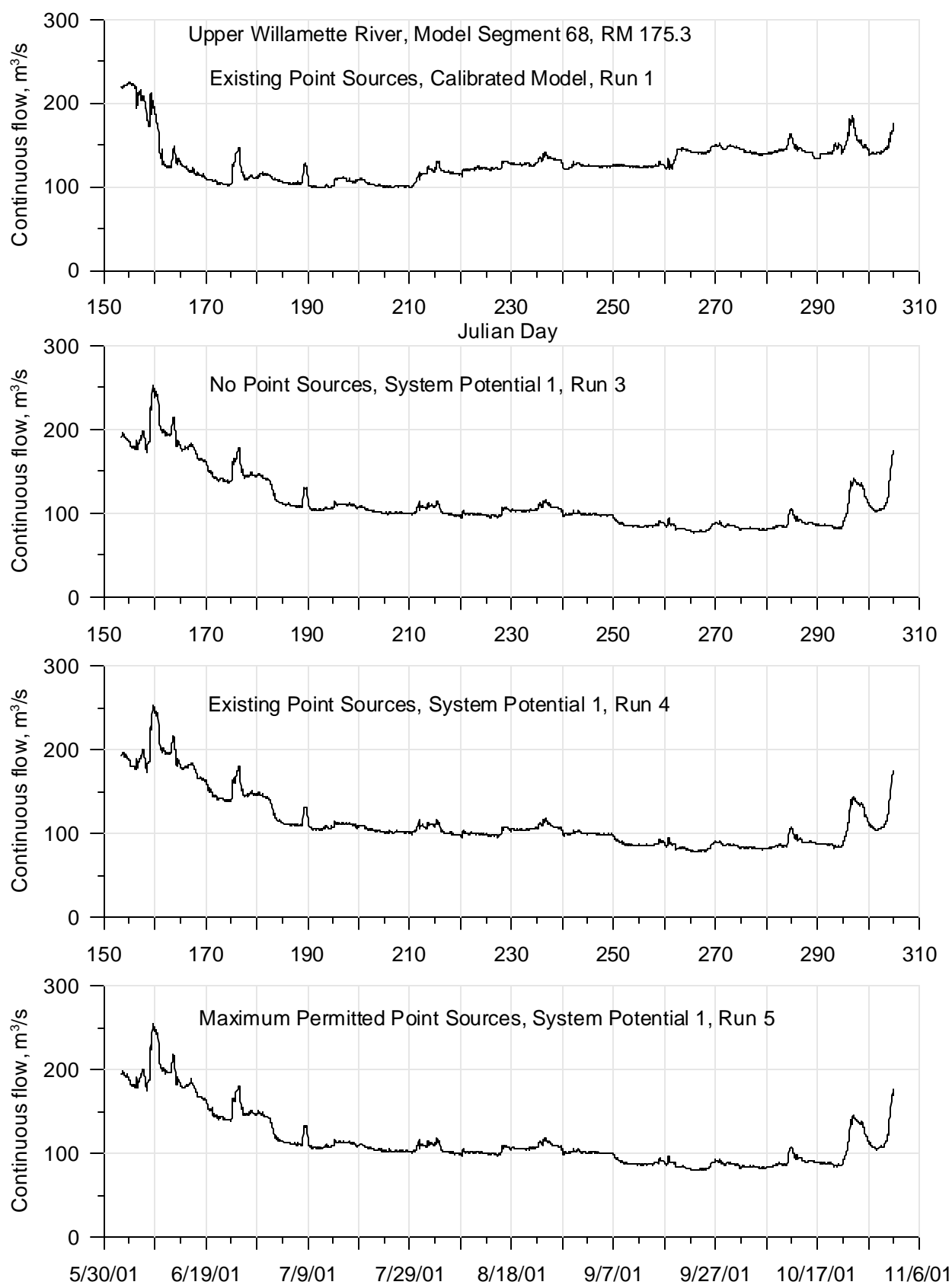
**Figure 38: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the McKenzie River at RM 37.99**



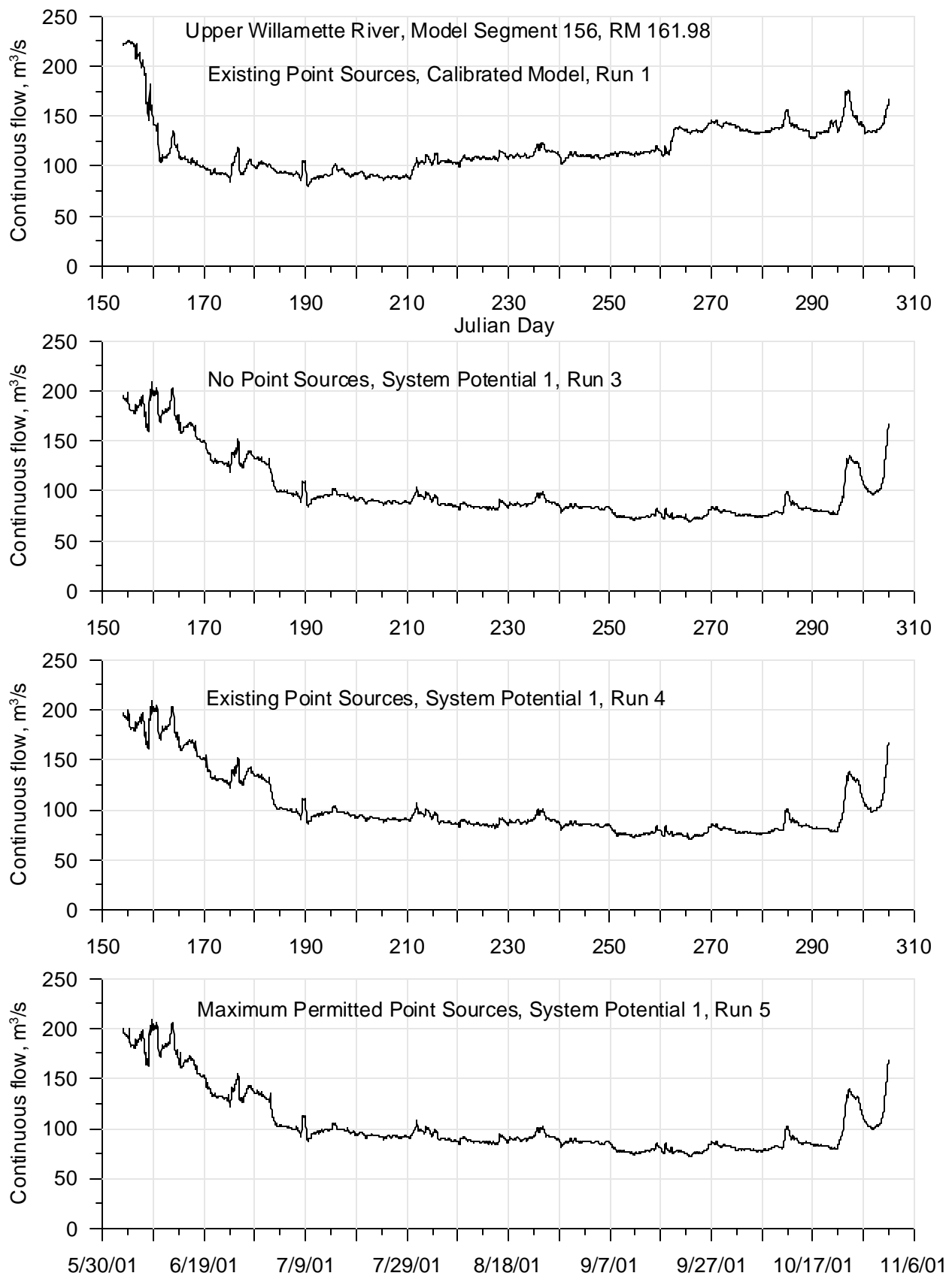
**Figure 39: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the McKenzie River at RM 9.75**



**Figure 40: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Long Tom River at RM 4.64**

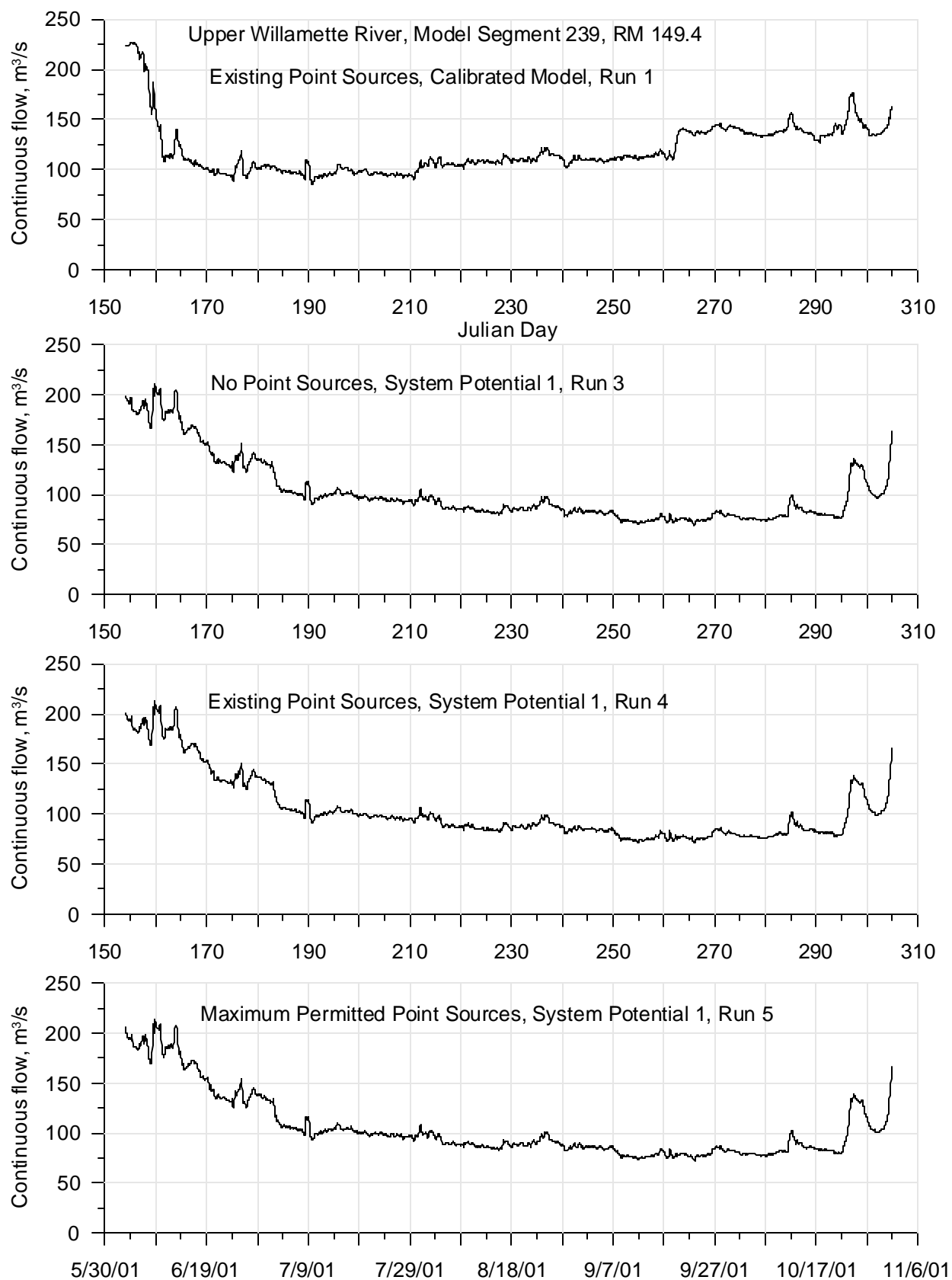


**Figure 41: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 175.3**

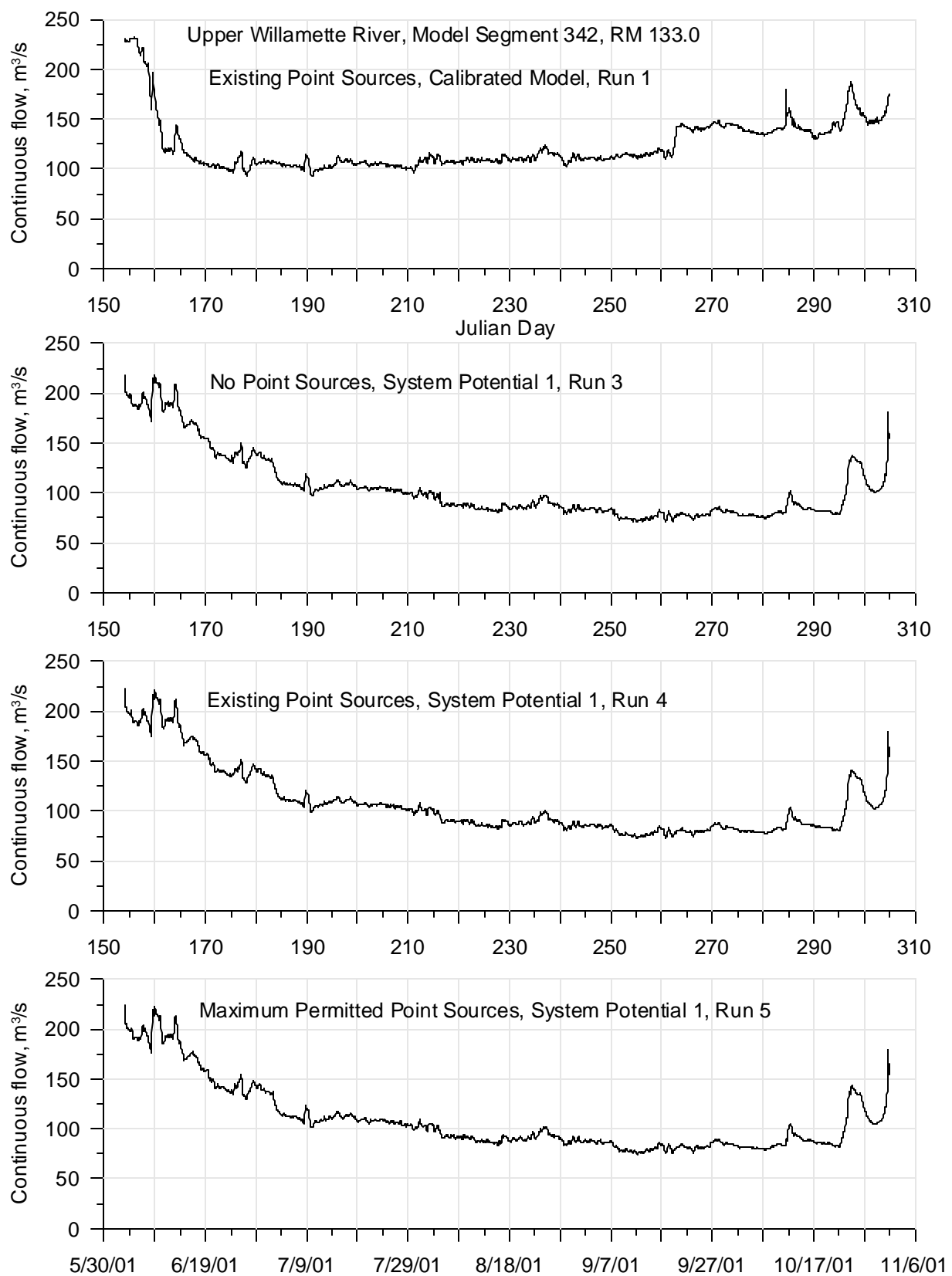


**Figure 42: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 161.98**

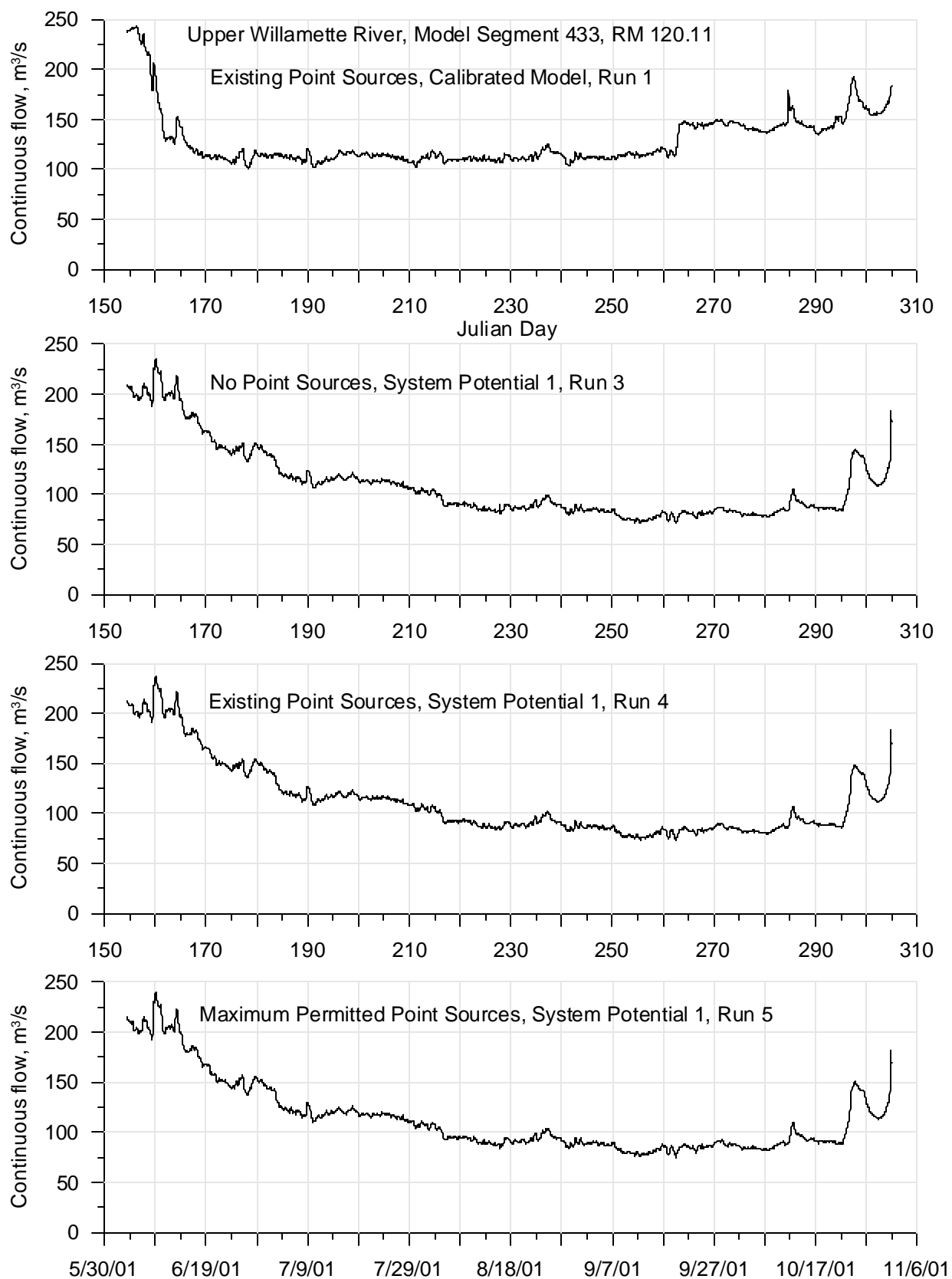




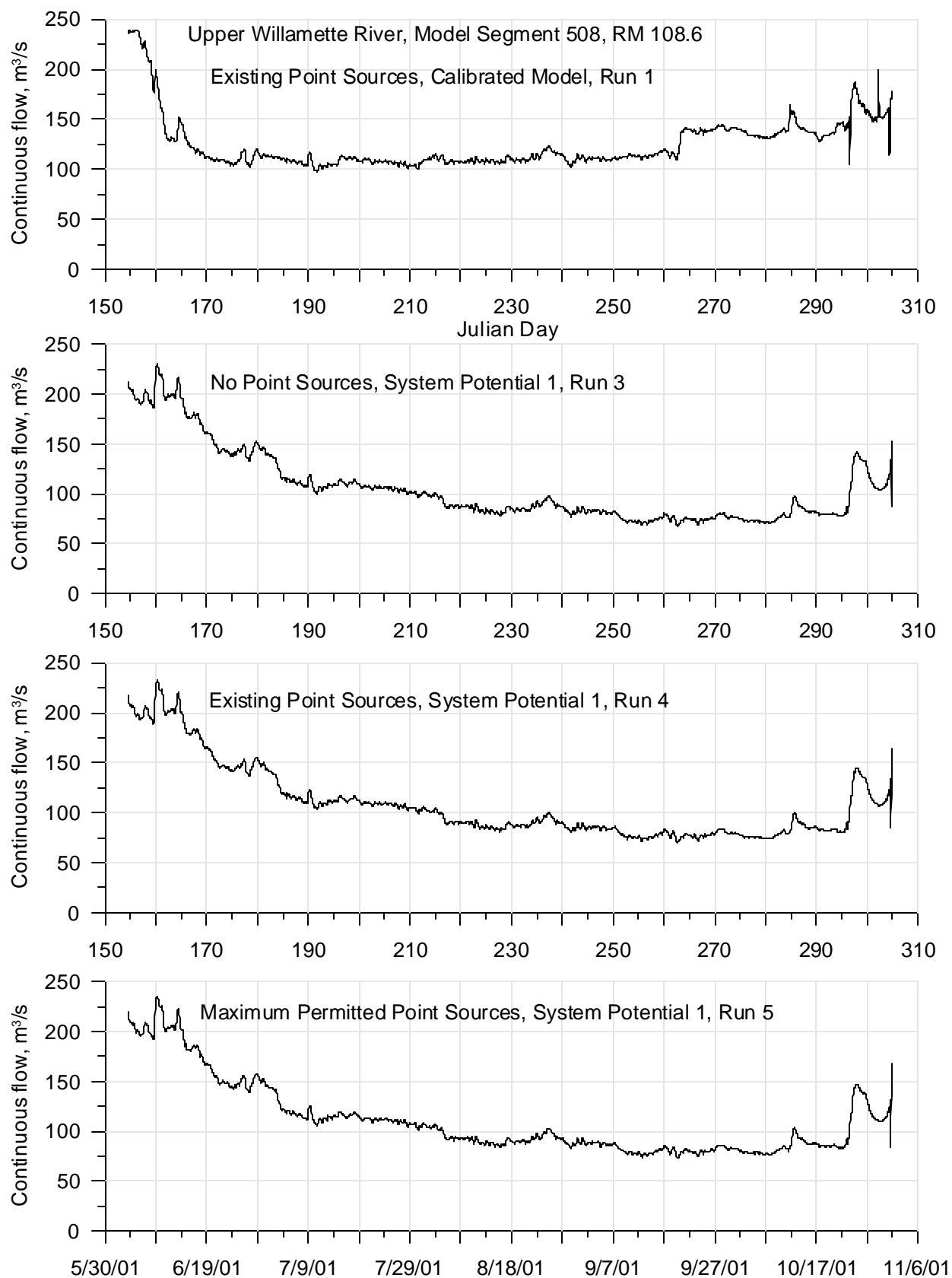
**Figure 43: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 149.4**



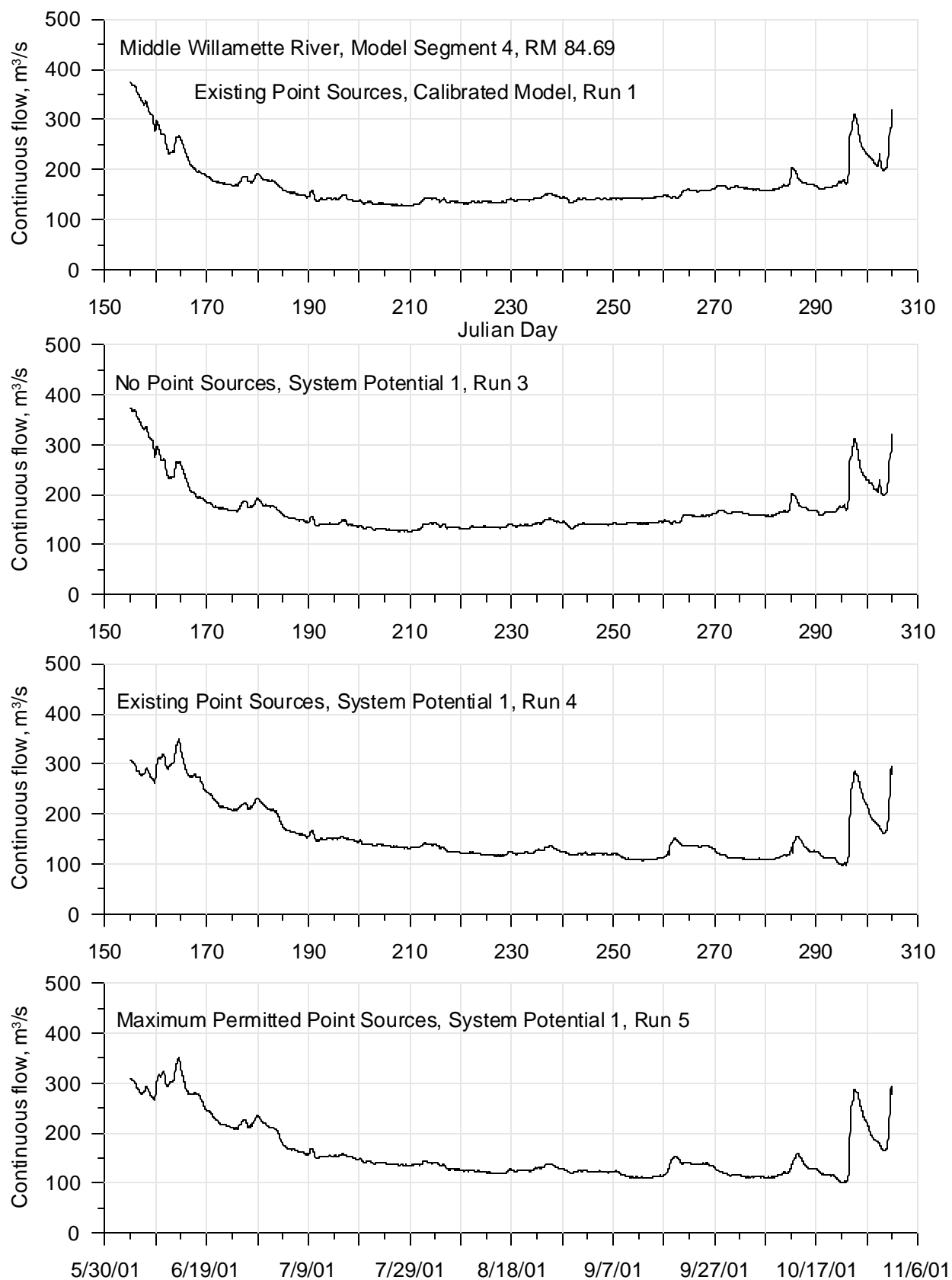
**Figure 44: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 133**



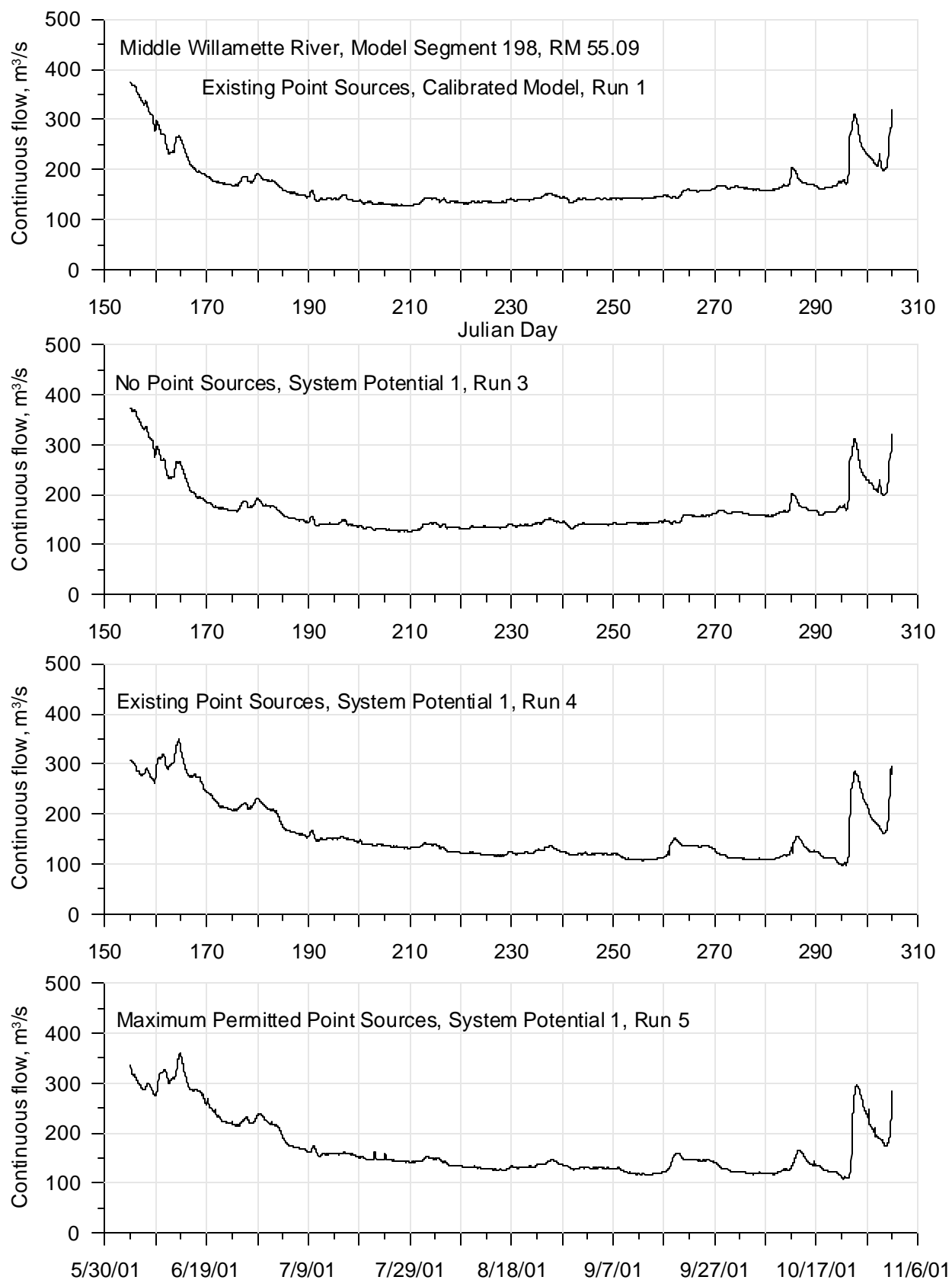
**Figure 45: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 120.11**



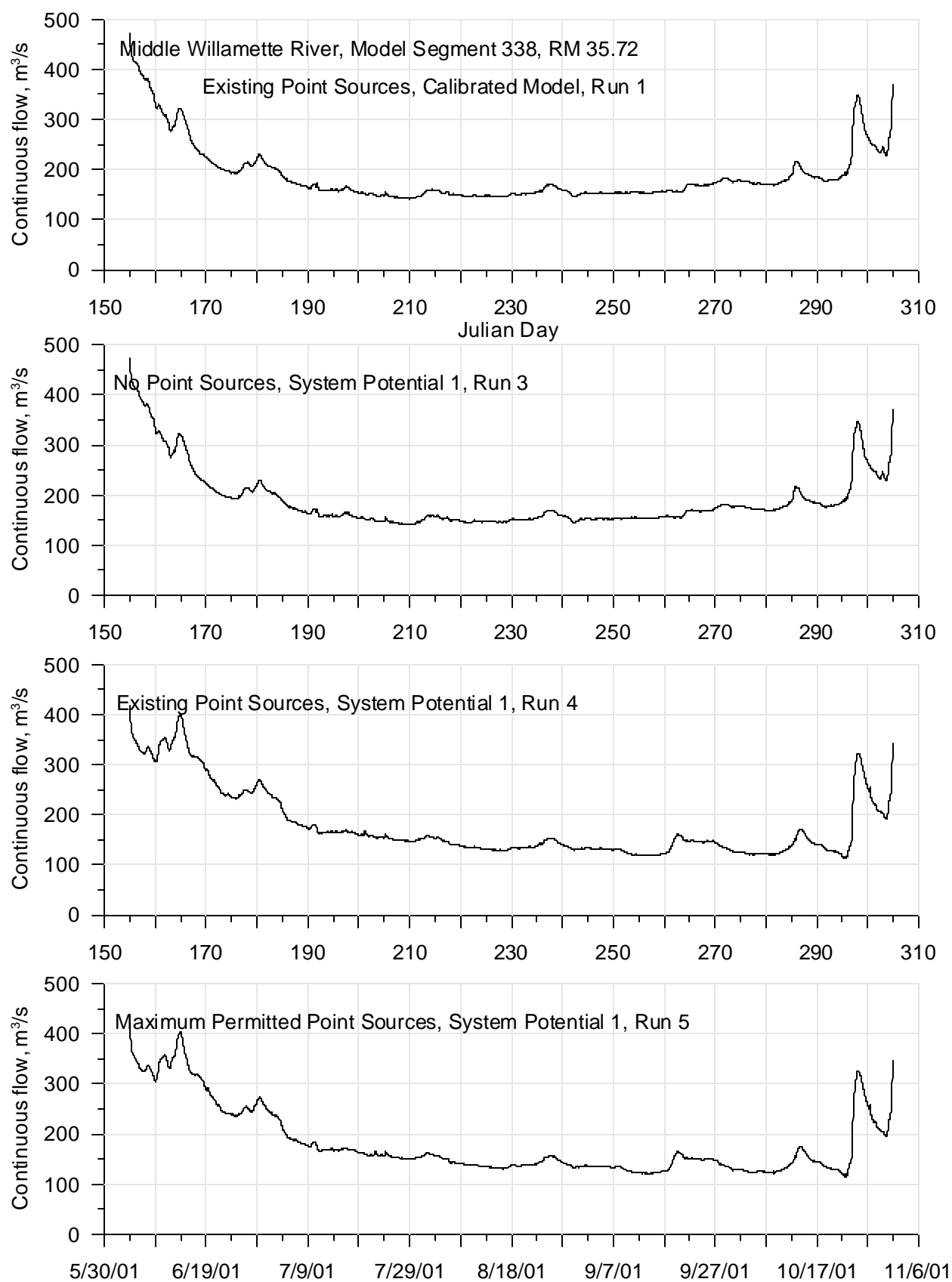
**Figure 46: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 108.6**



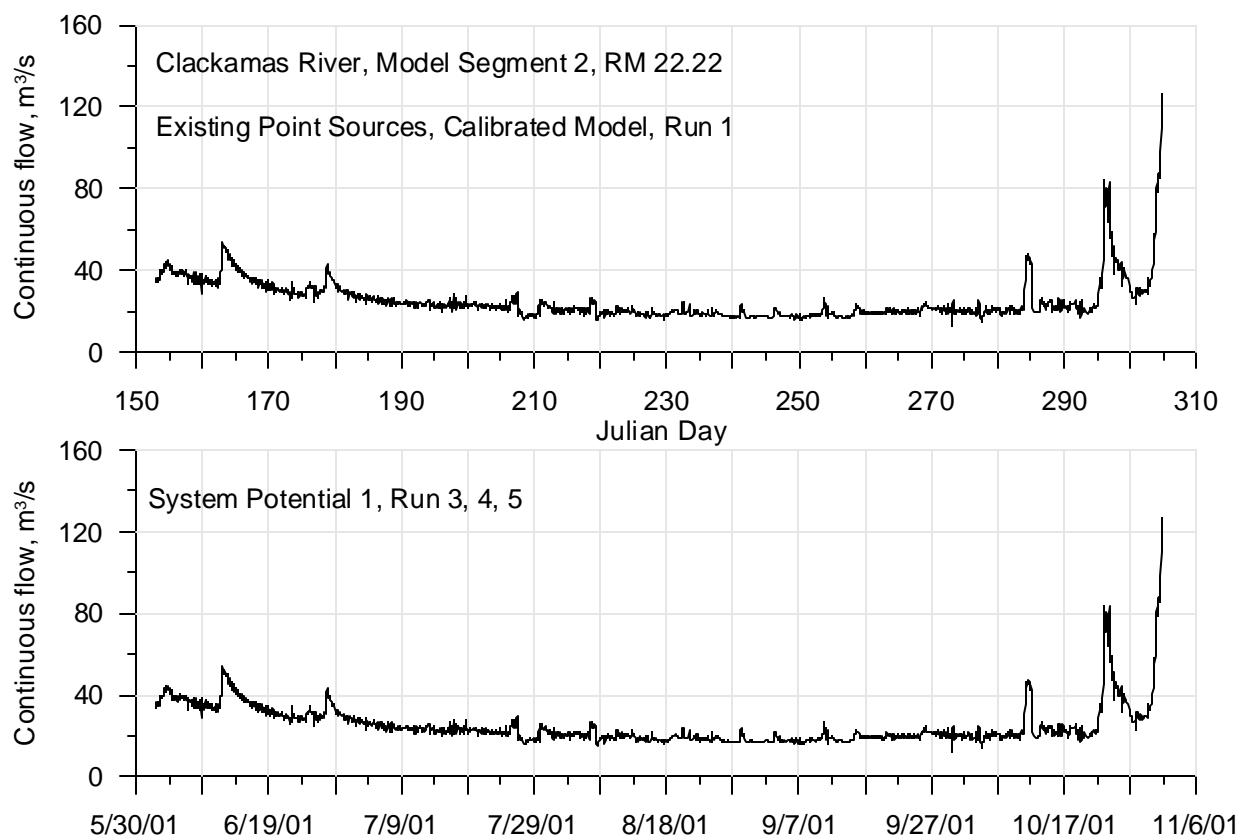
**Figure 47: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 84.69**



**Figure 48: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 55.09**

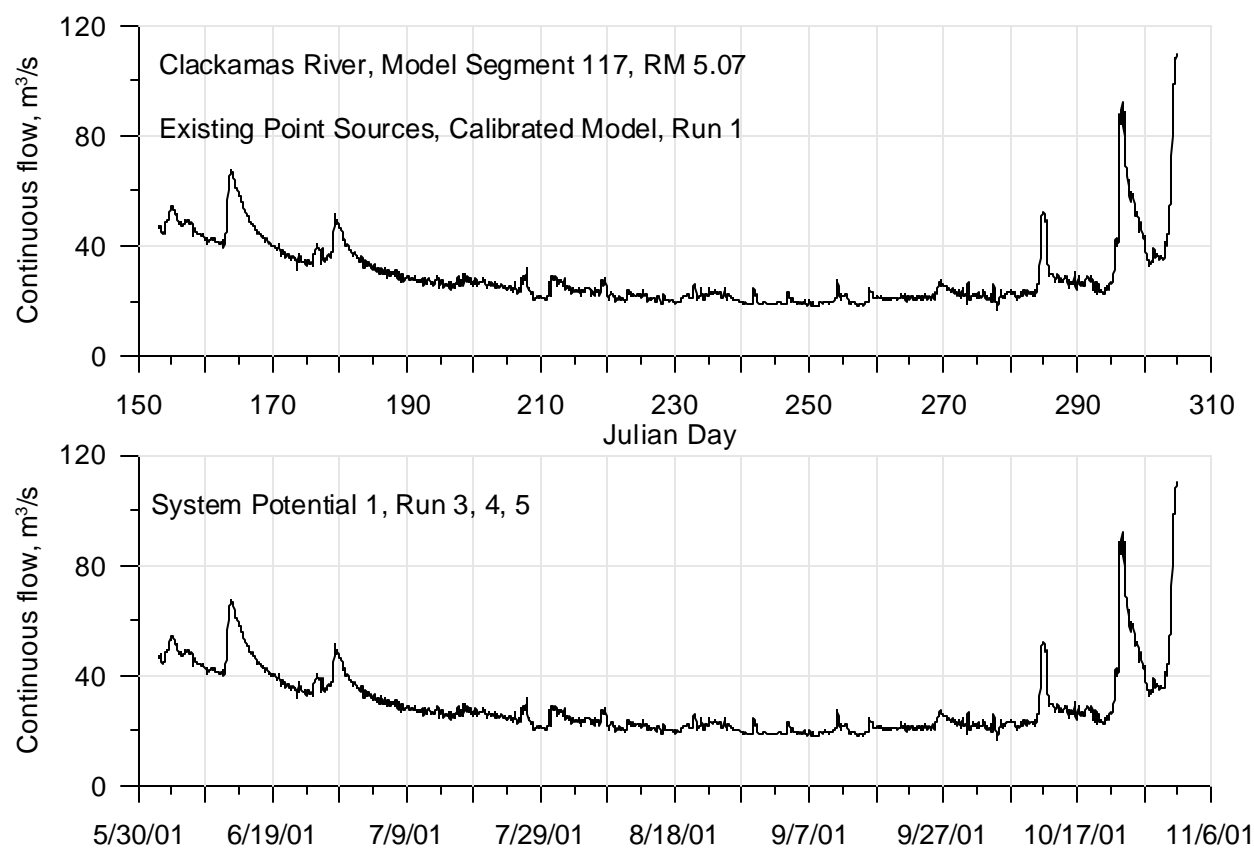


**Figure 49: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 35.72**

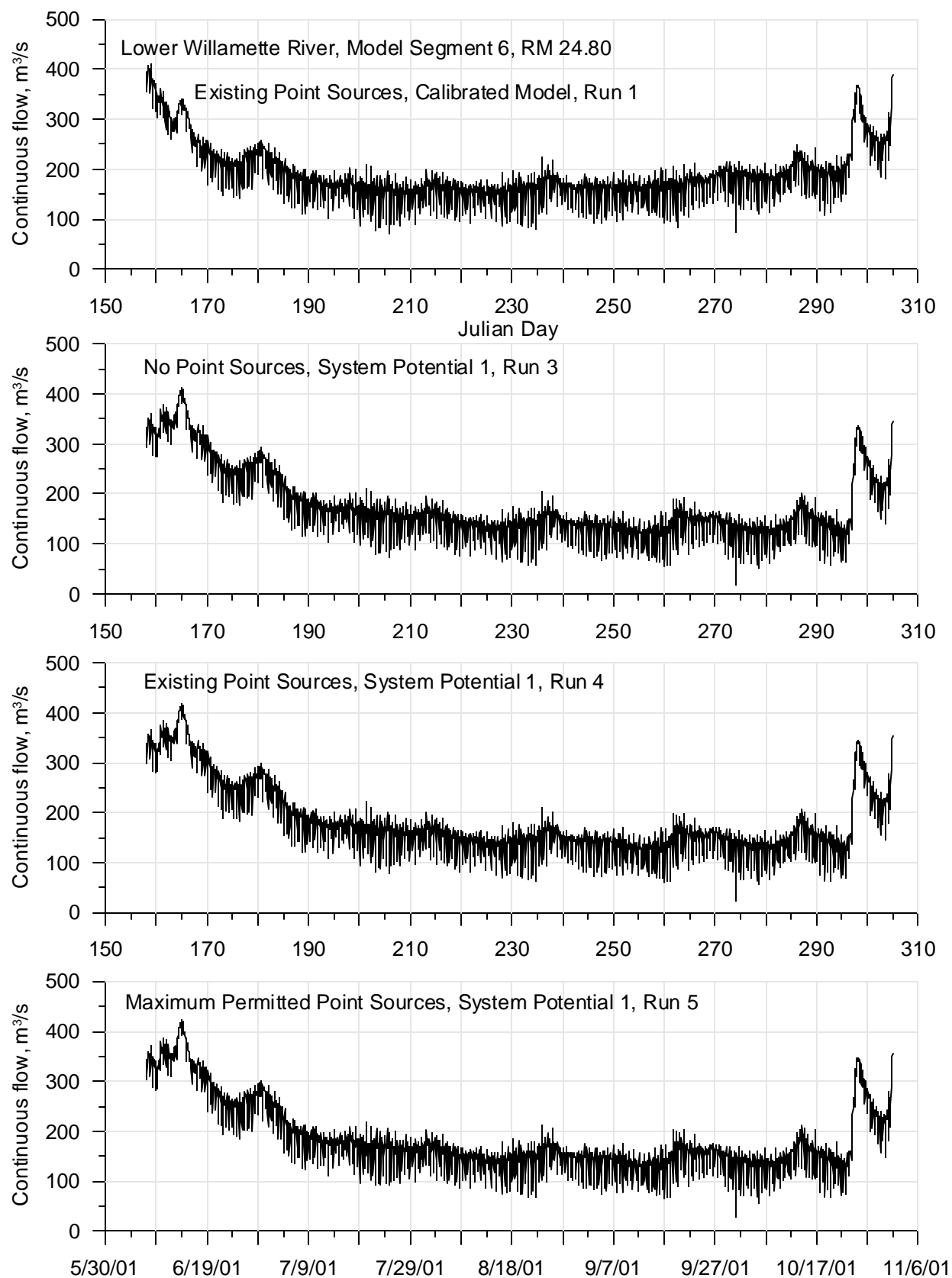


**Figure 50: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Clackamas River at RM 22.22**

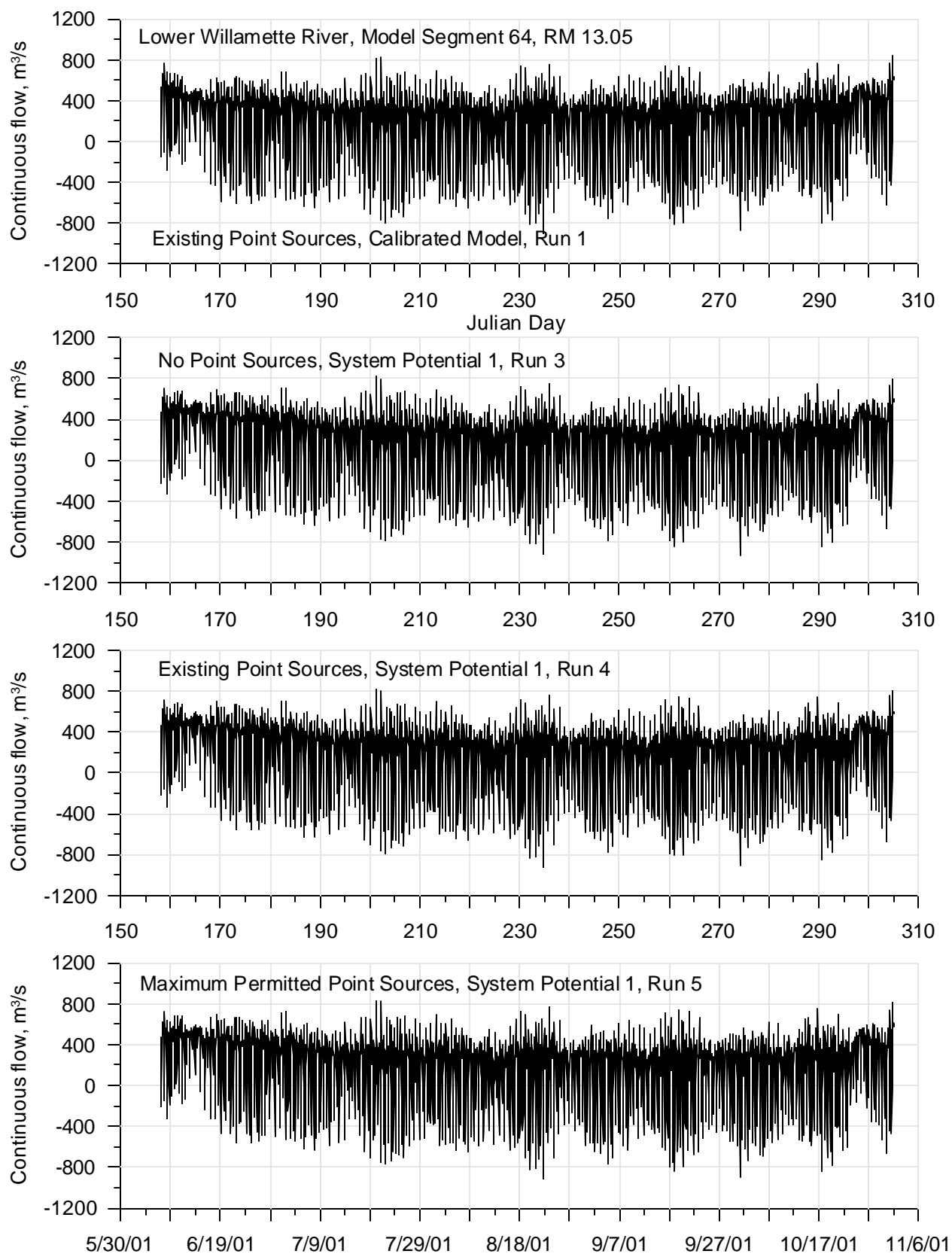




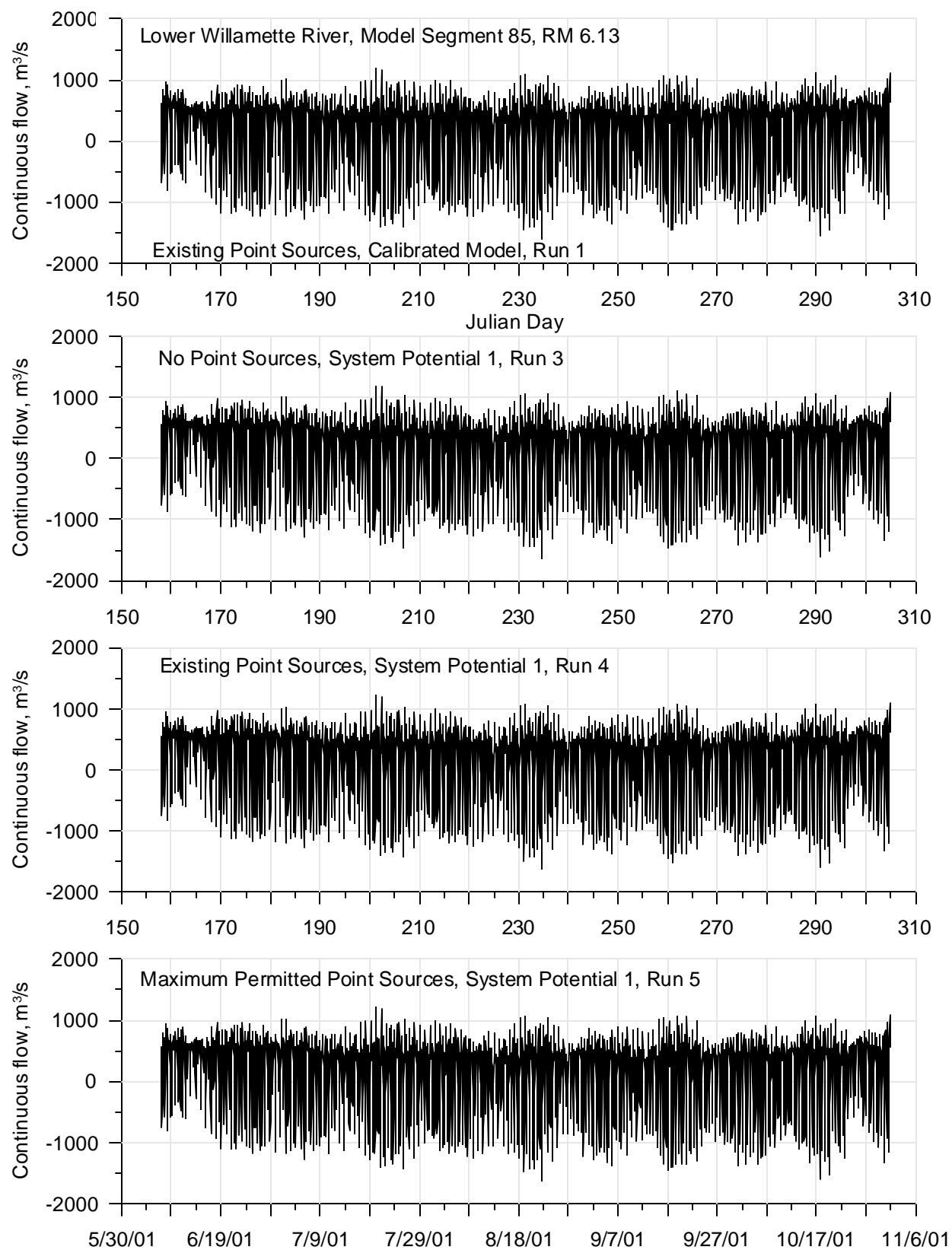
**Figure 51: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Clackamas River at RM 5.07**



**Figure 52: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 24.8**

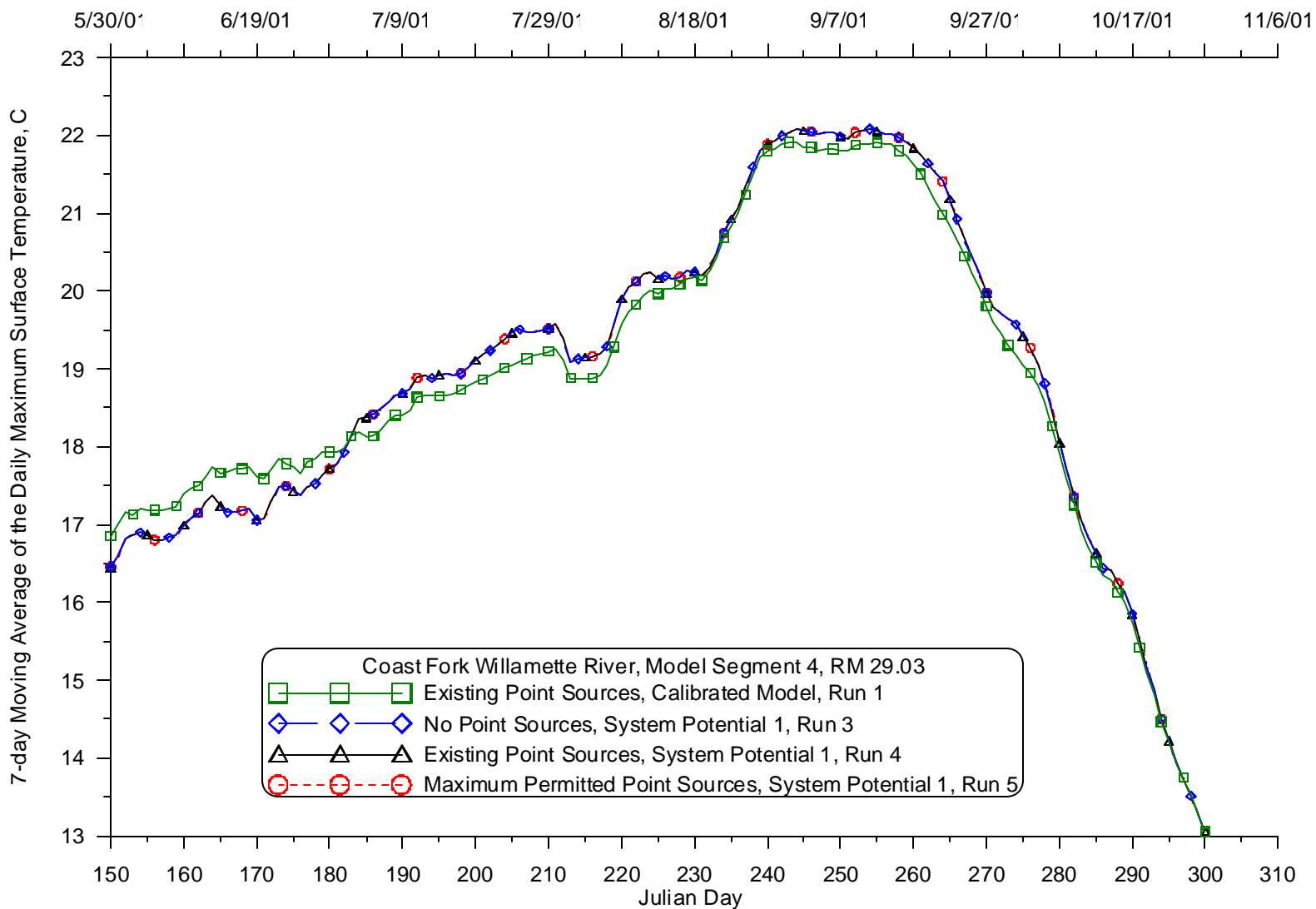


**Figure 53: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 13.05**

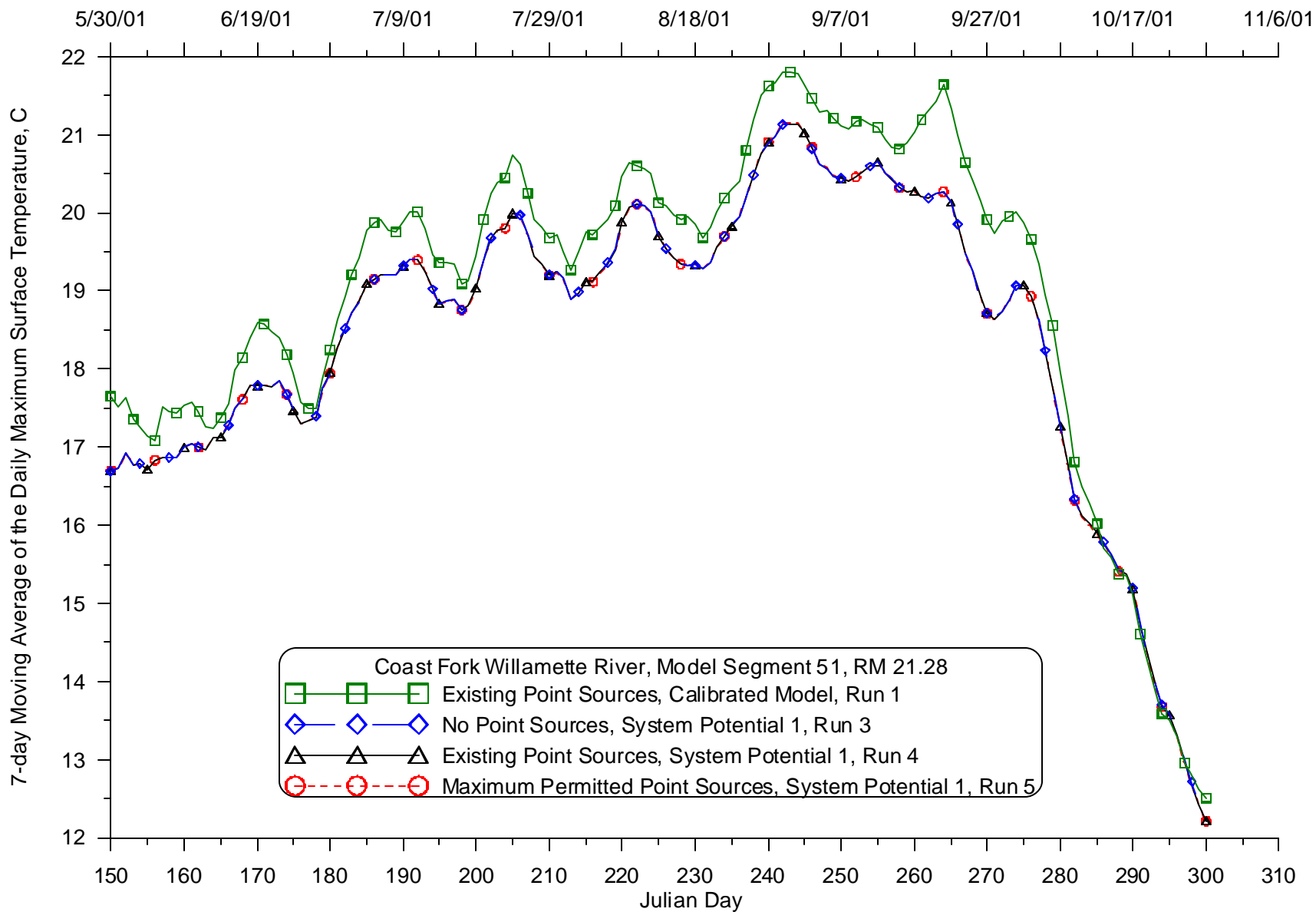


**Figure 54: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 6.13**

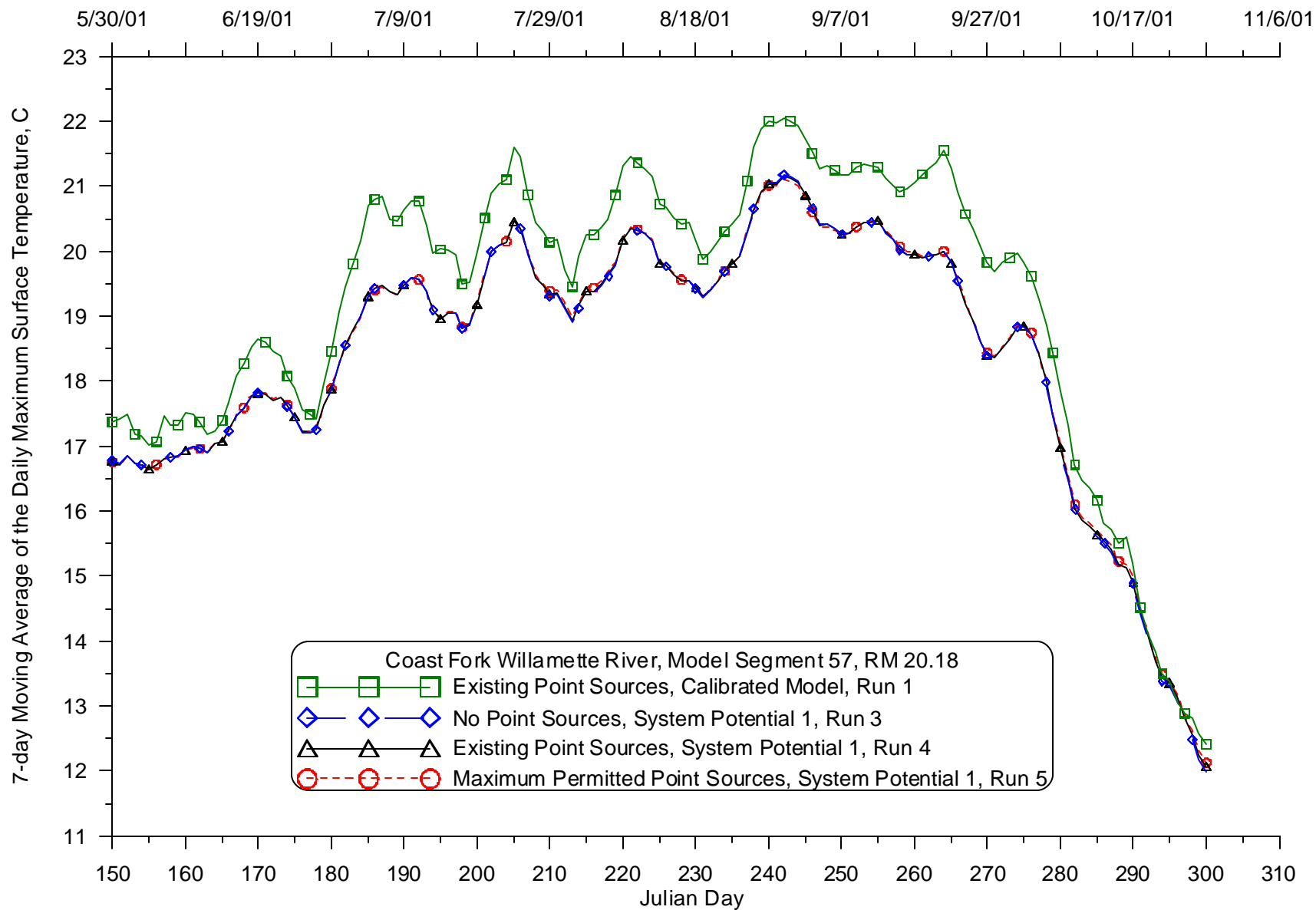
## Daily seven day moving average of daily maximum temperature



**Figure 55: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Coast Fork Willamette River at RM 29.03**



**Figure 56: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Coast Fork Willamette River at RM 21.28**



**Figure 57: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Coast Fork Willamette River at RM 20.18**

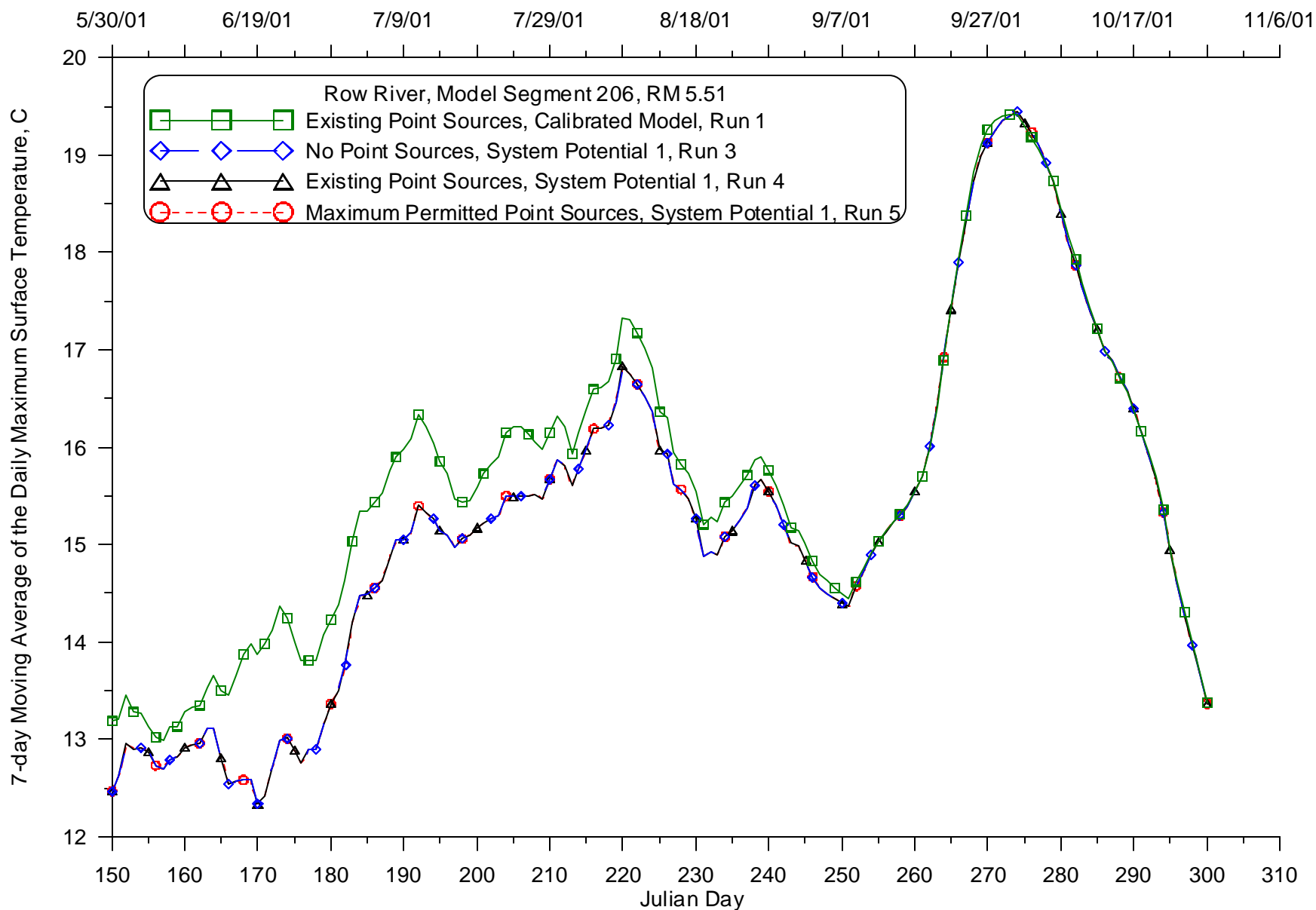
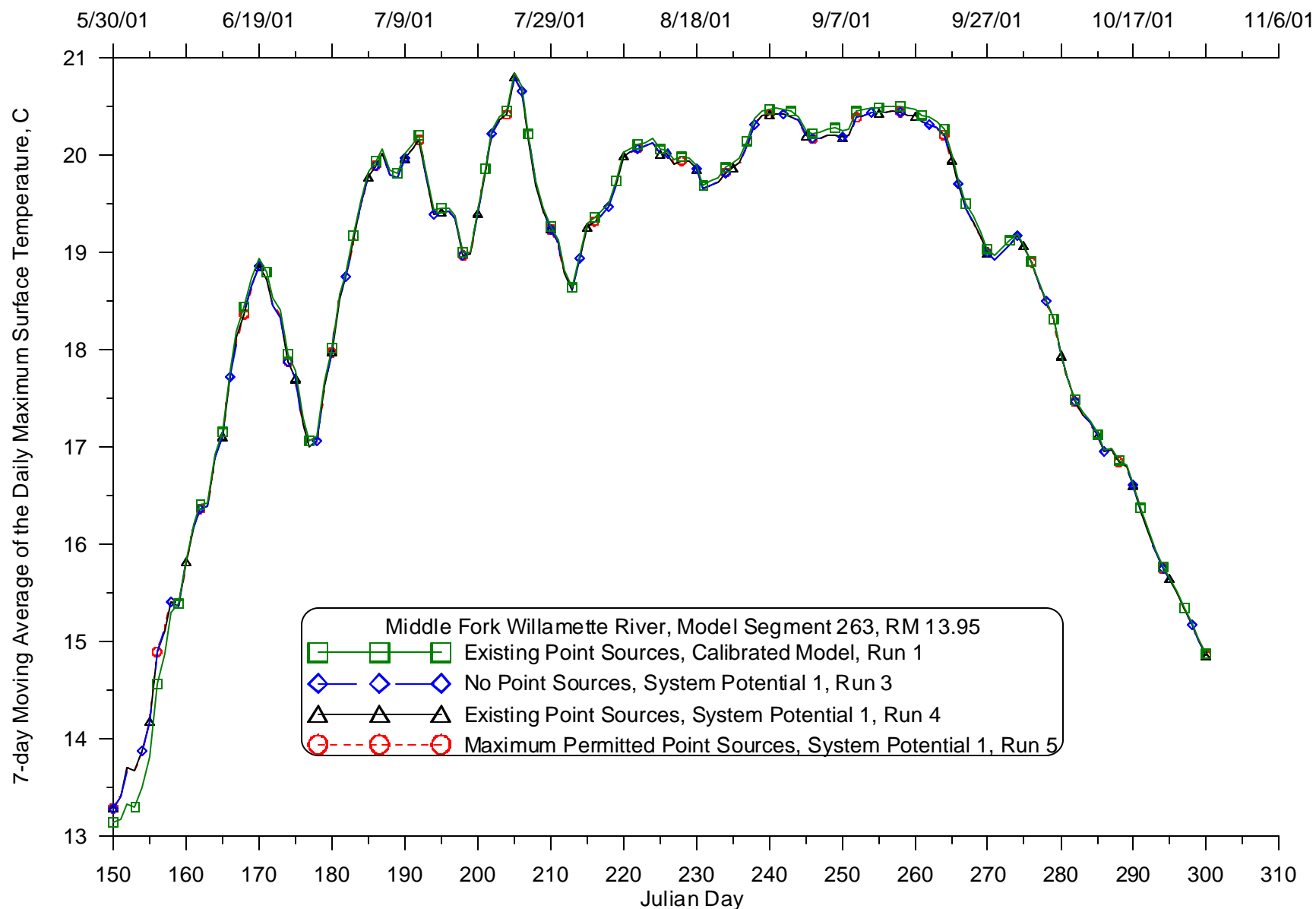
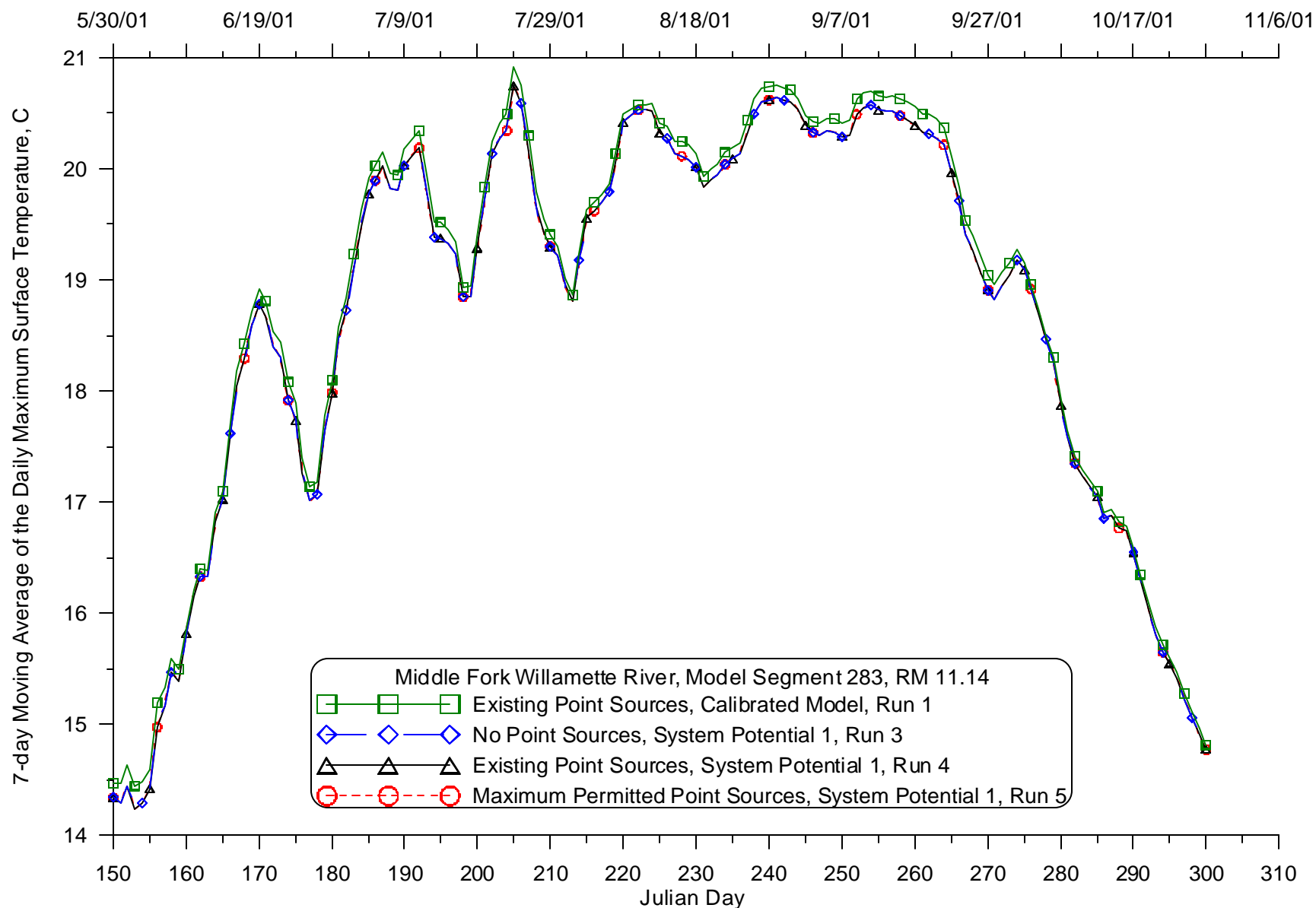


Figure 58: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Row River at RM 5.51





**Figure 59: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 60: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Middle Fork Willamette River at RM 11.14**

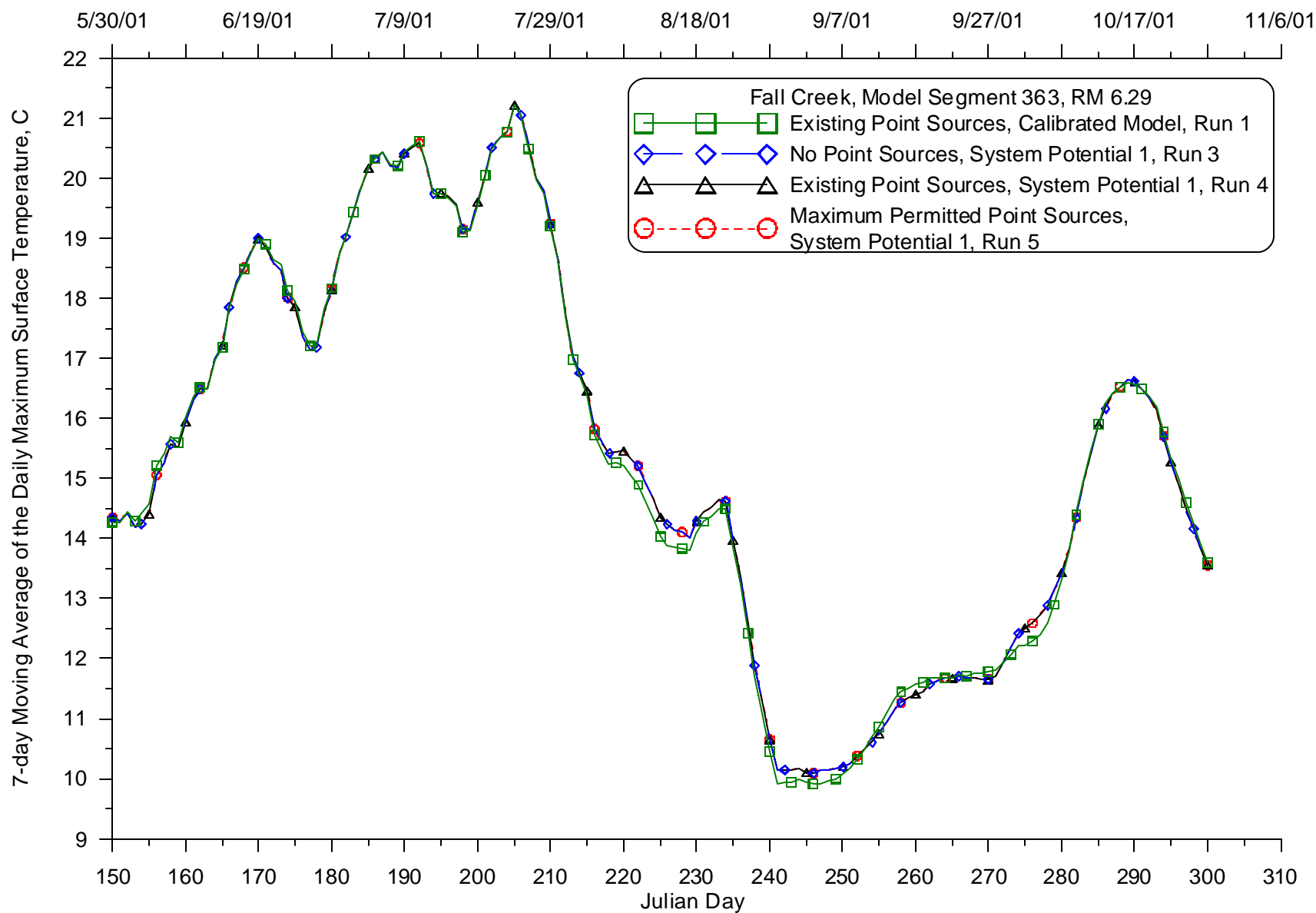
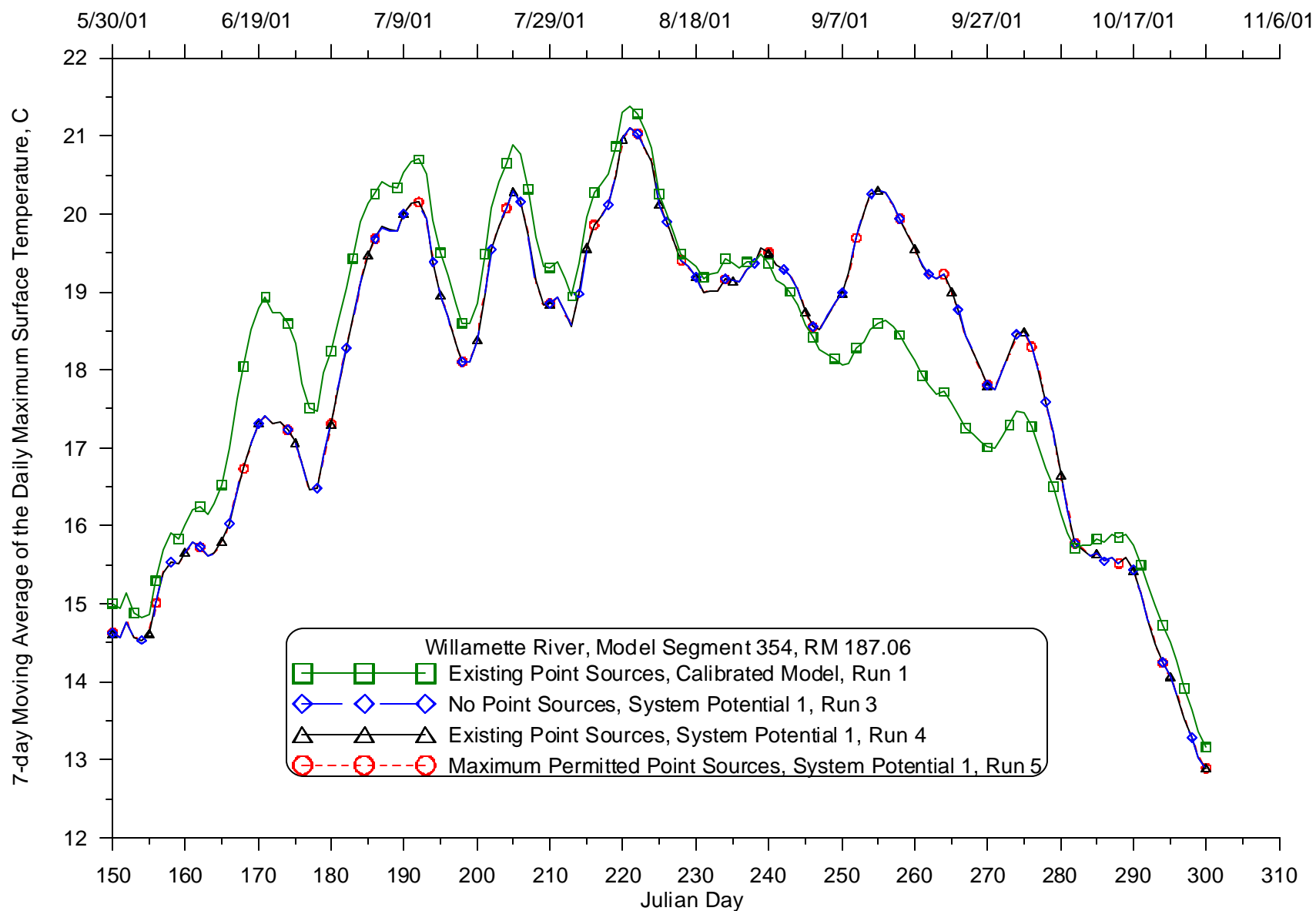
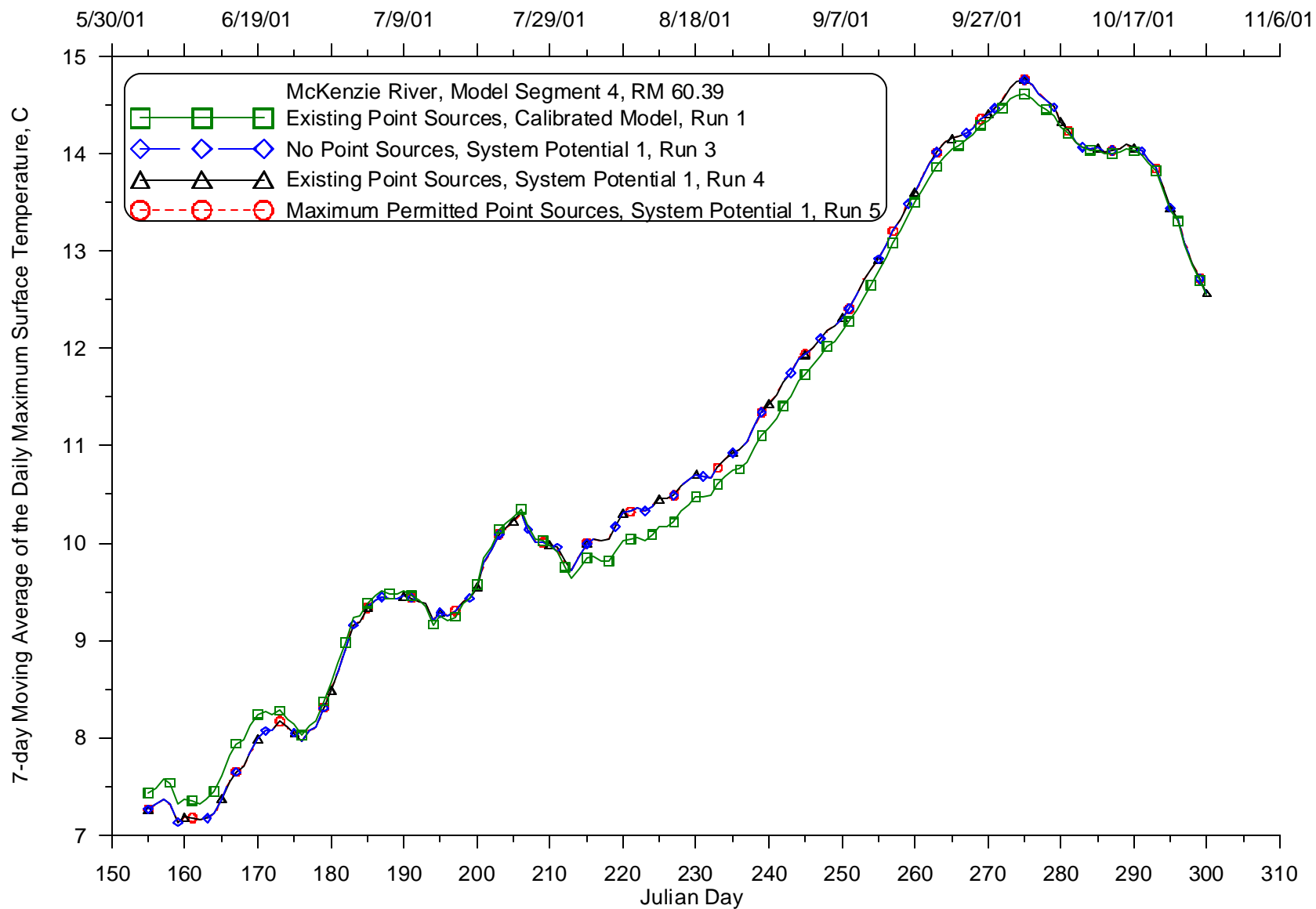


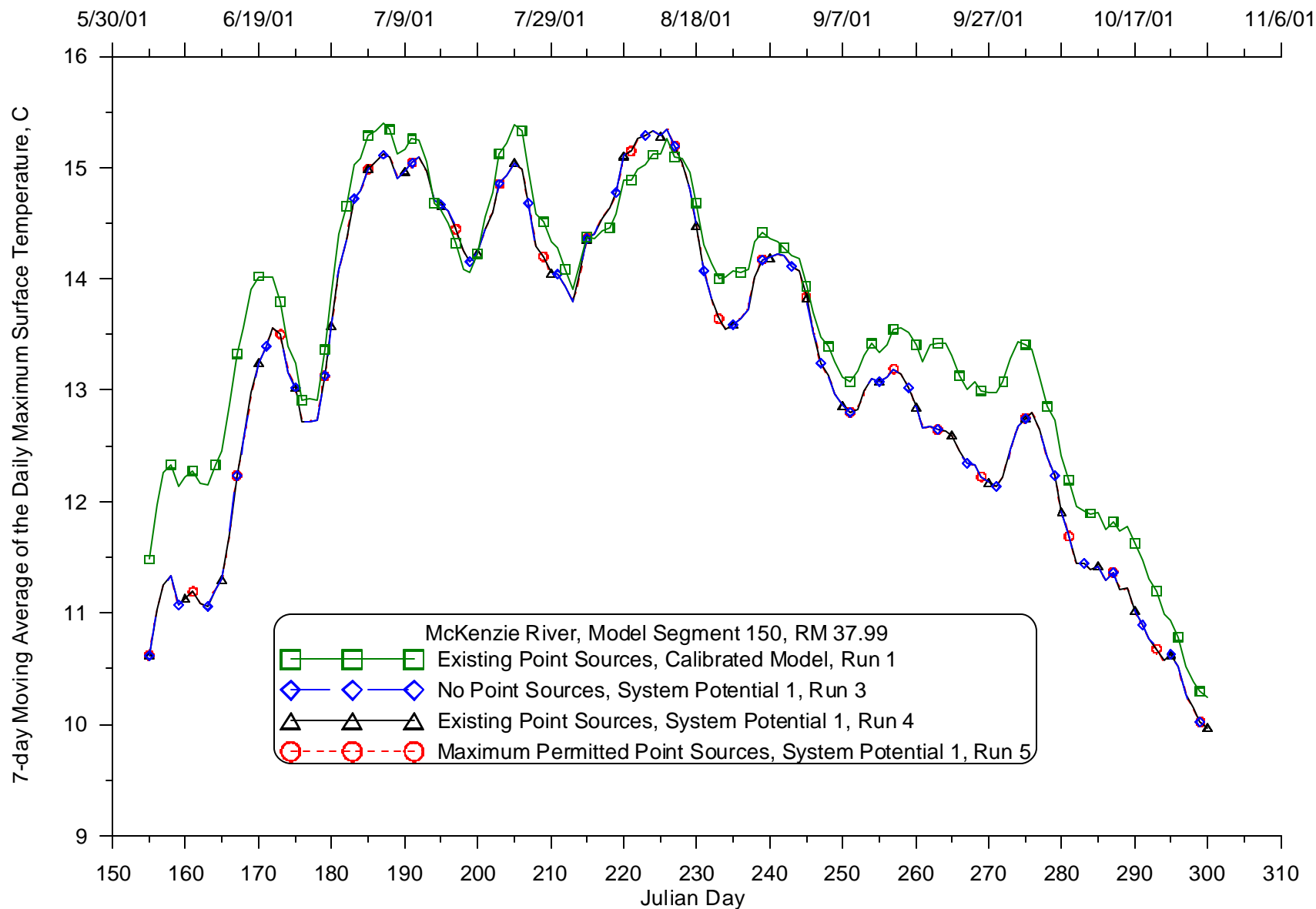
Figure 61: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Fall Creek at RM 6.29



**Figure 62: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 187.06**



**Figure 63: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the McKenzie River at RM 60.39**



**Figure 64: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the McKenzie River at RM 37.99**

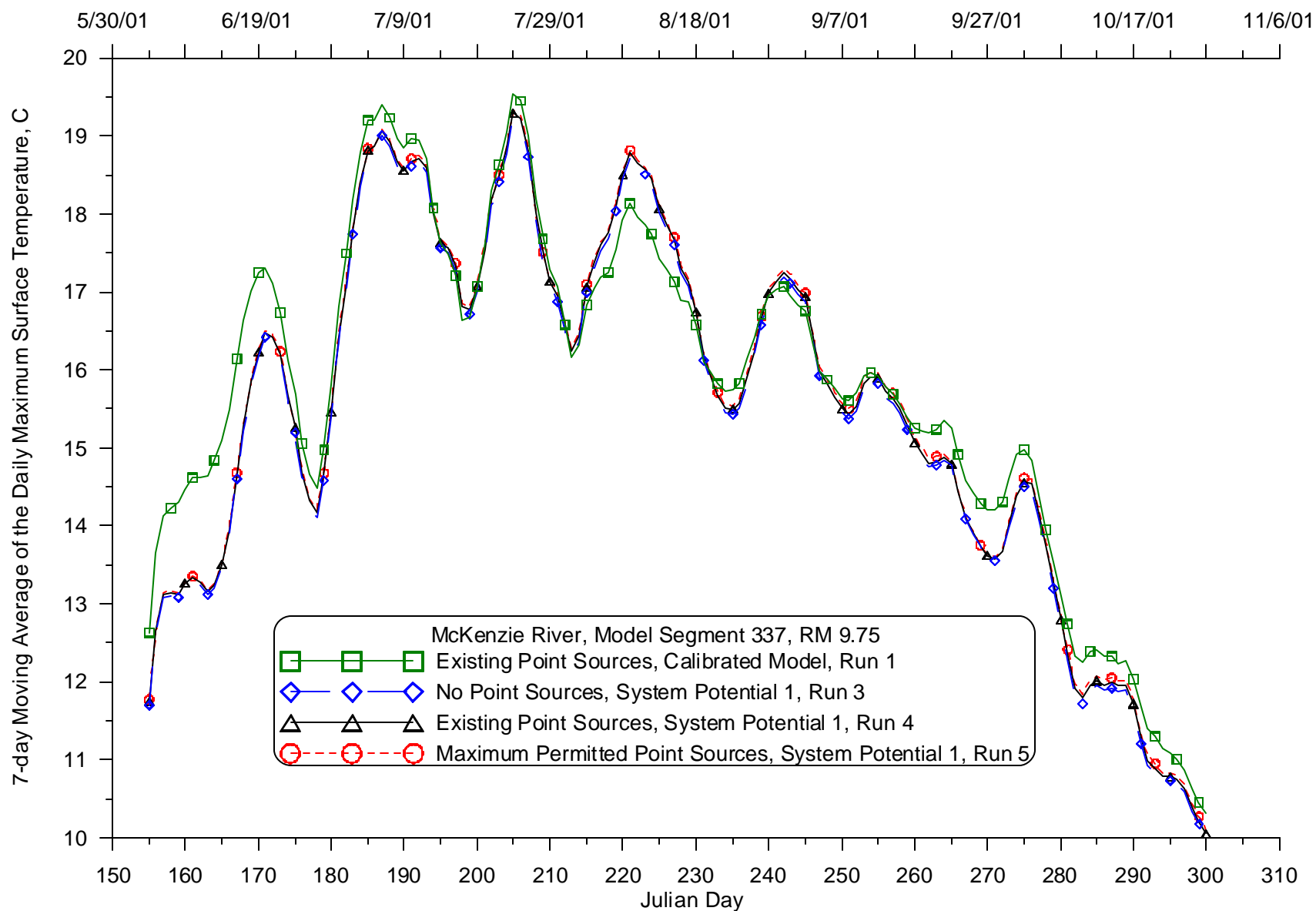
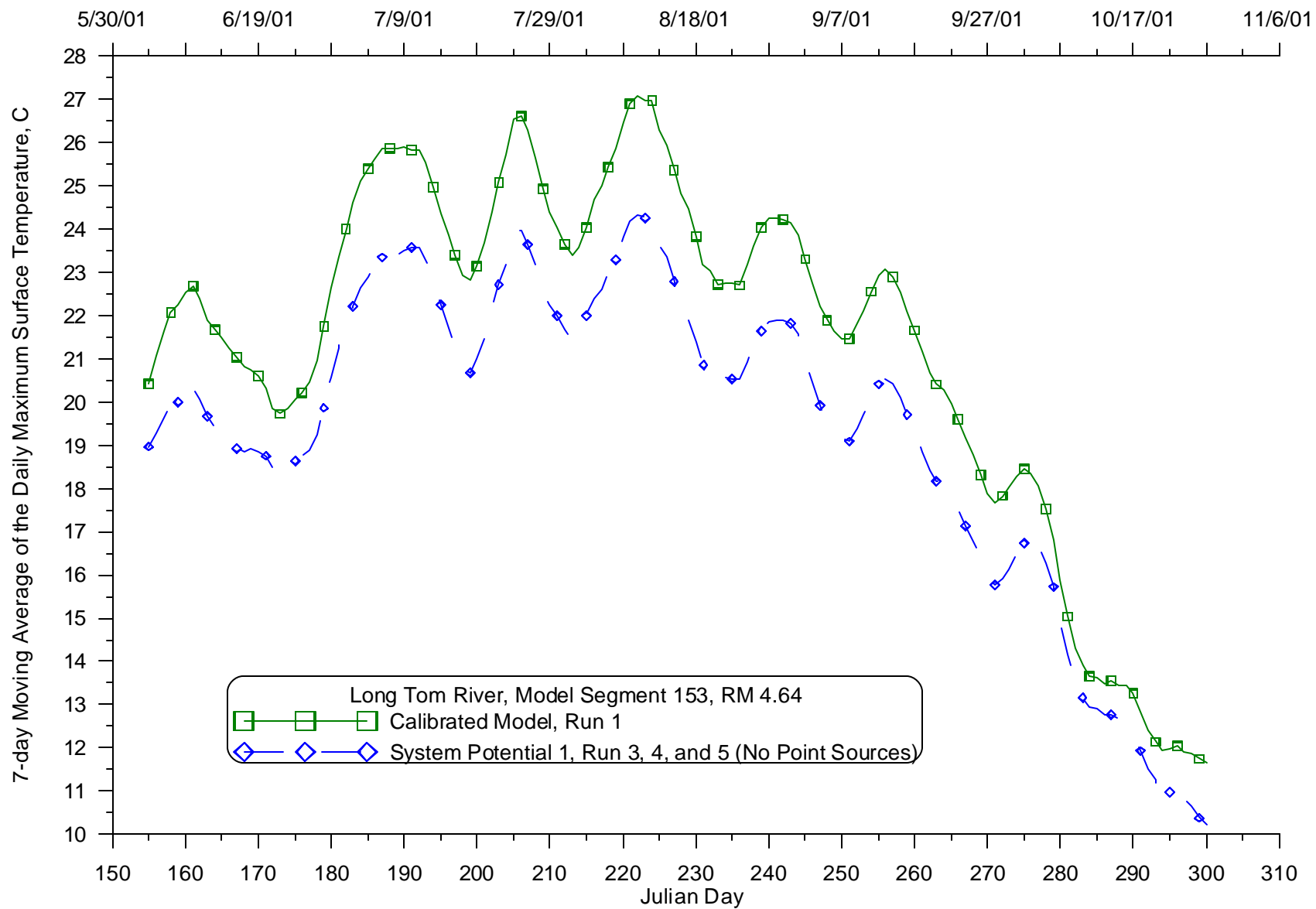
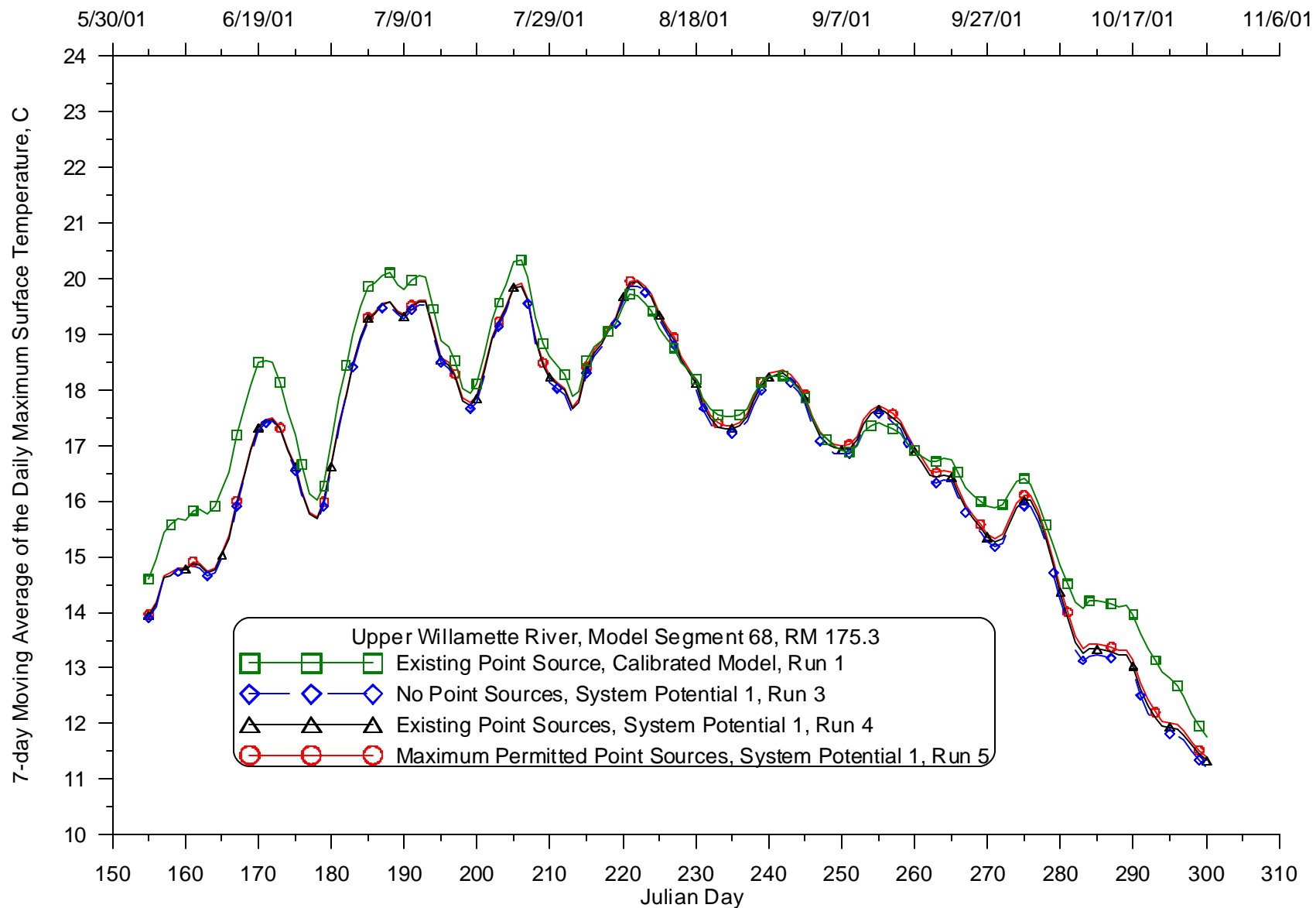


Figure 65: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the McKenzie River at RM 9.75

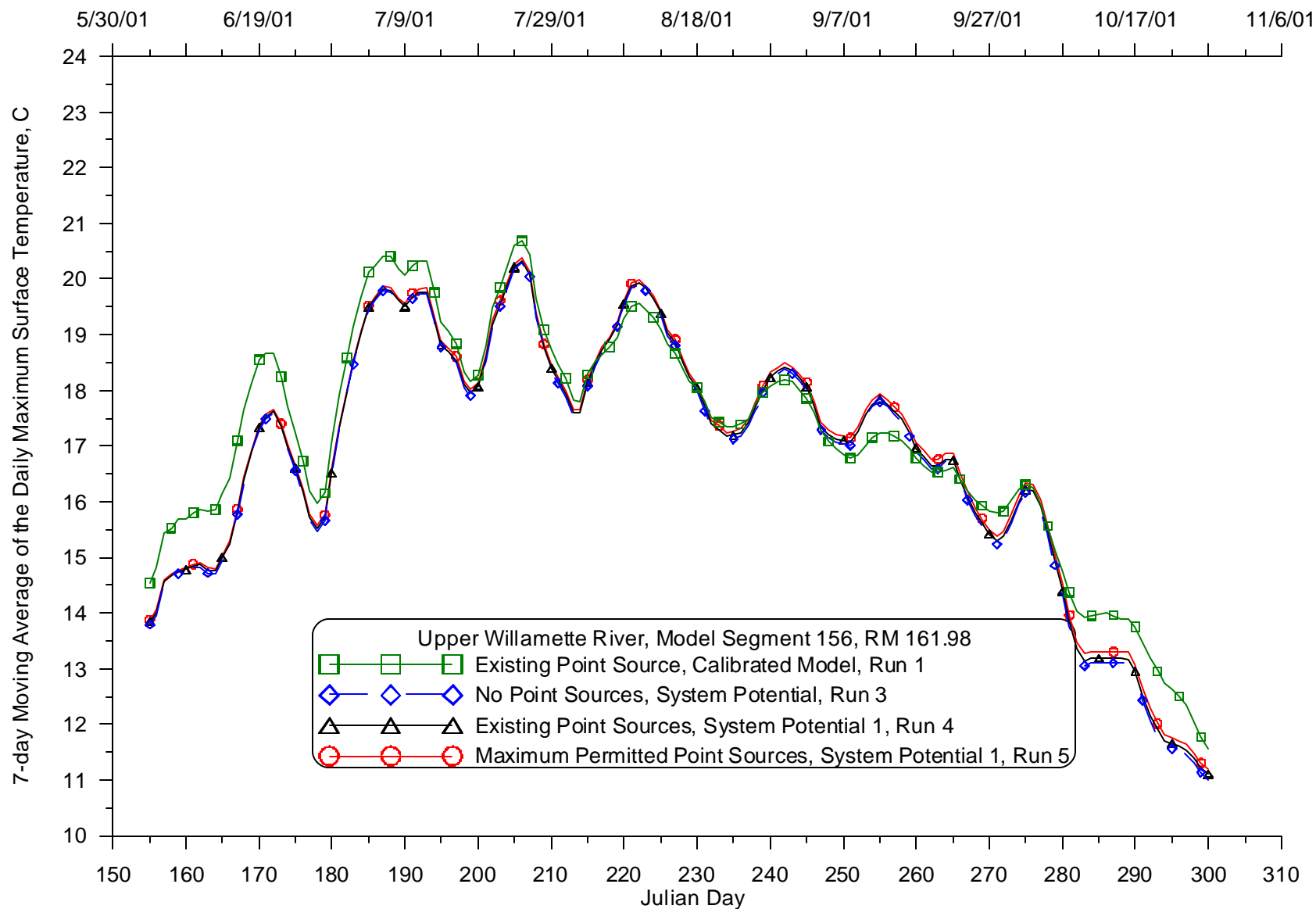


**Figure 66: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Long Tom River at RM 4.64**

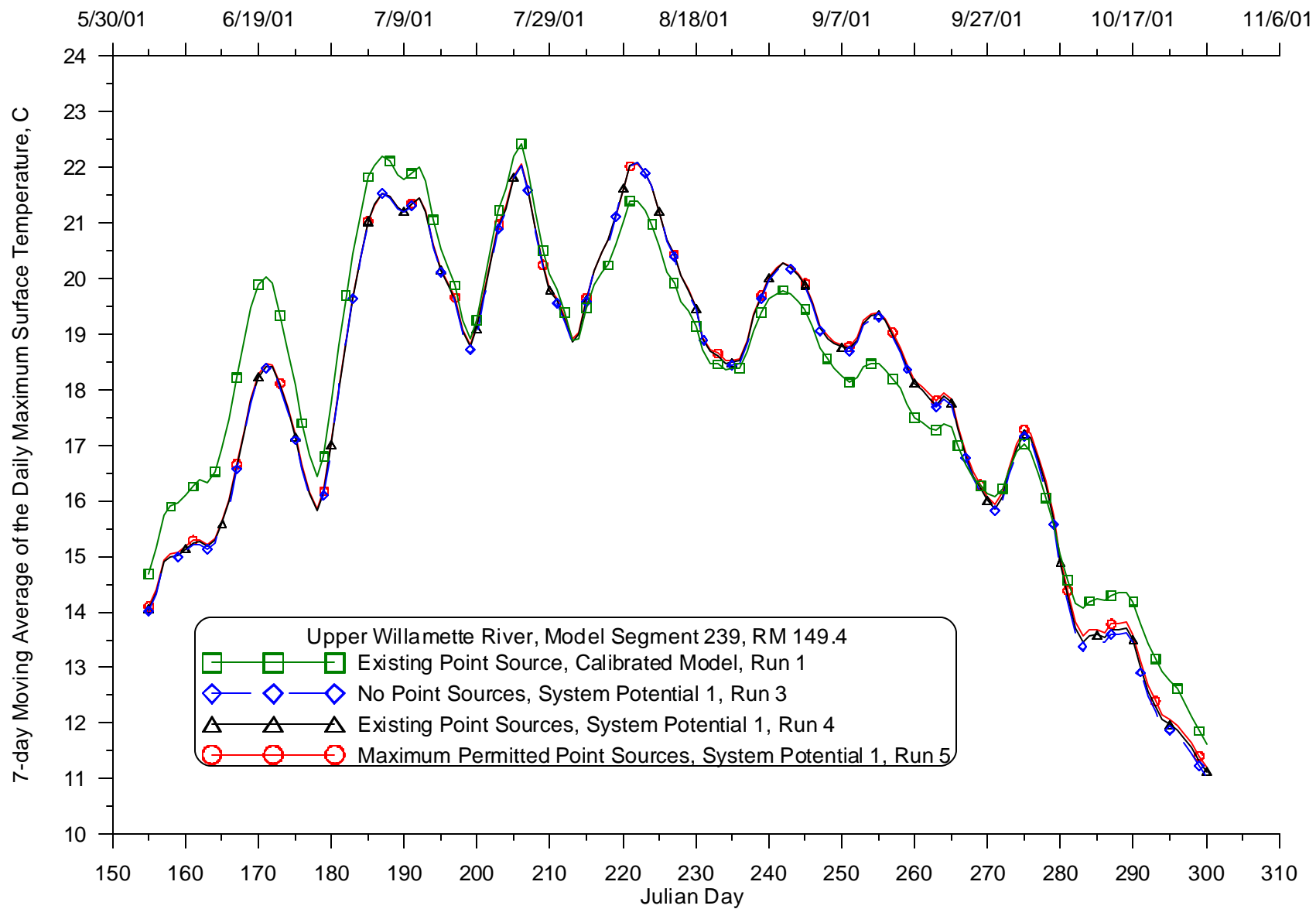




**Figure 67: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 175.3**



**Figure 68: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 161.98**



**Figure 69: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 149.4**

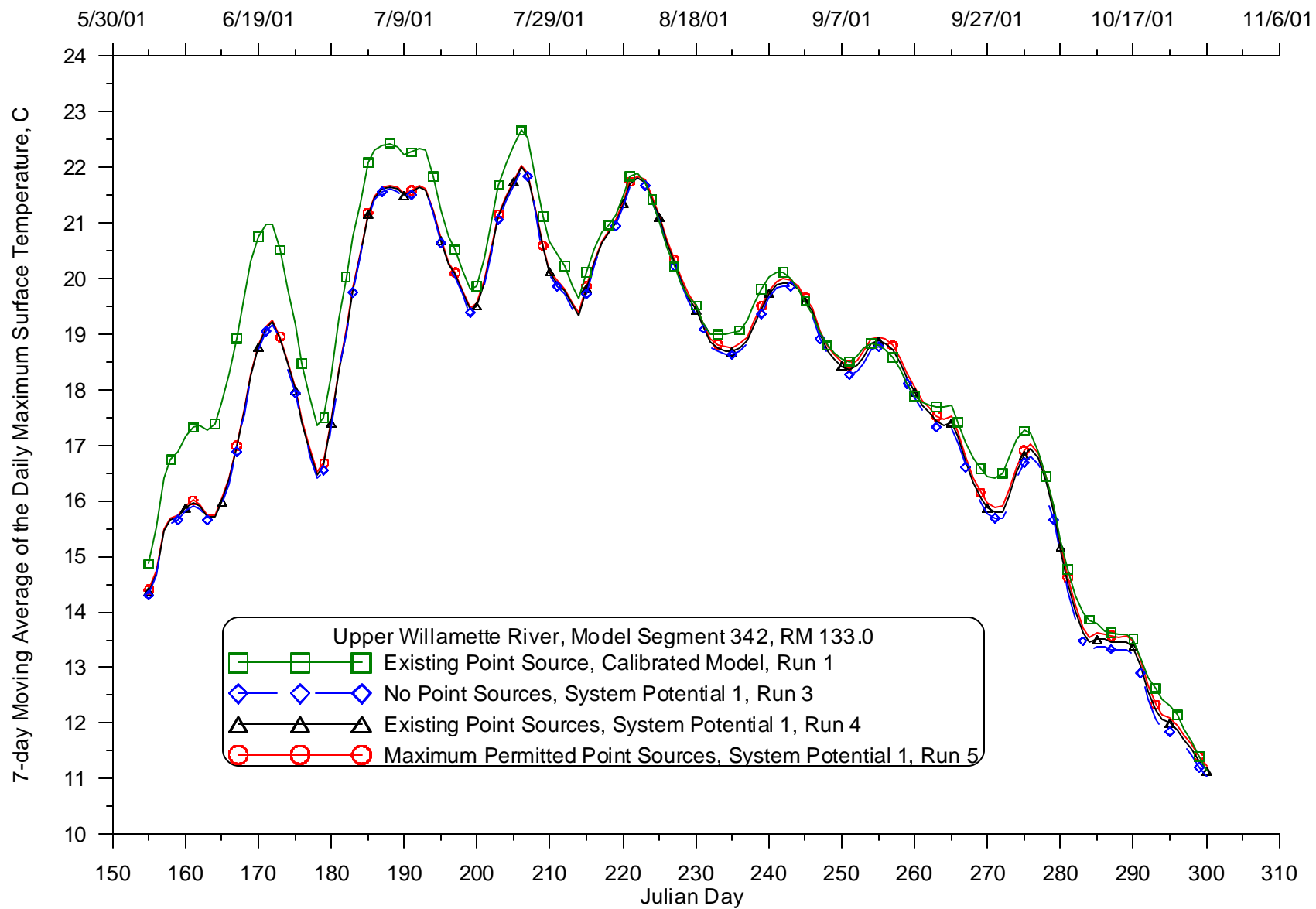


Figure 70: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 133.0

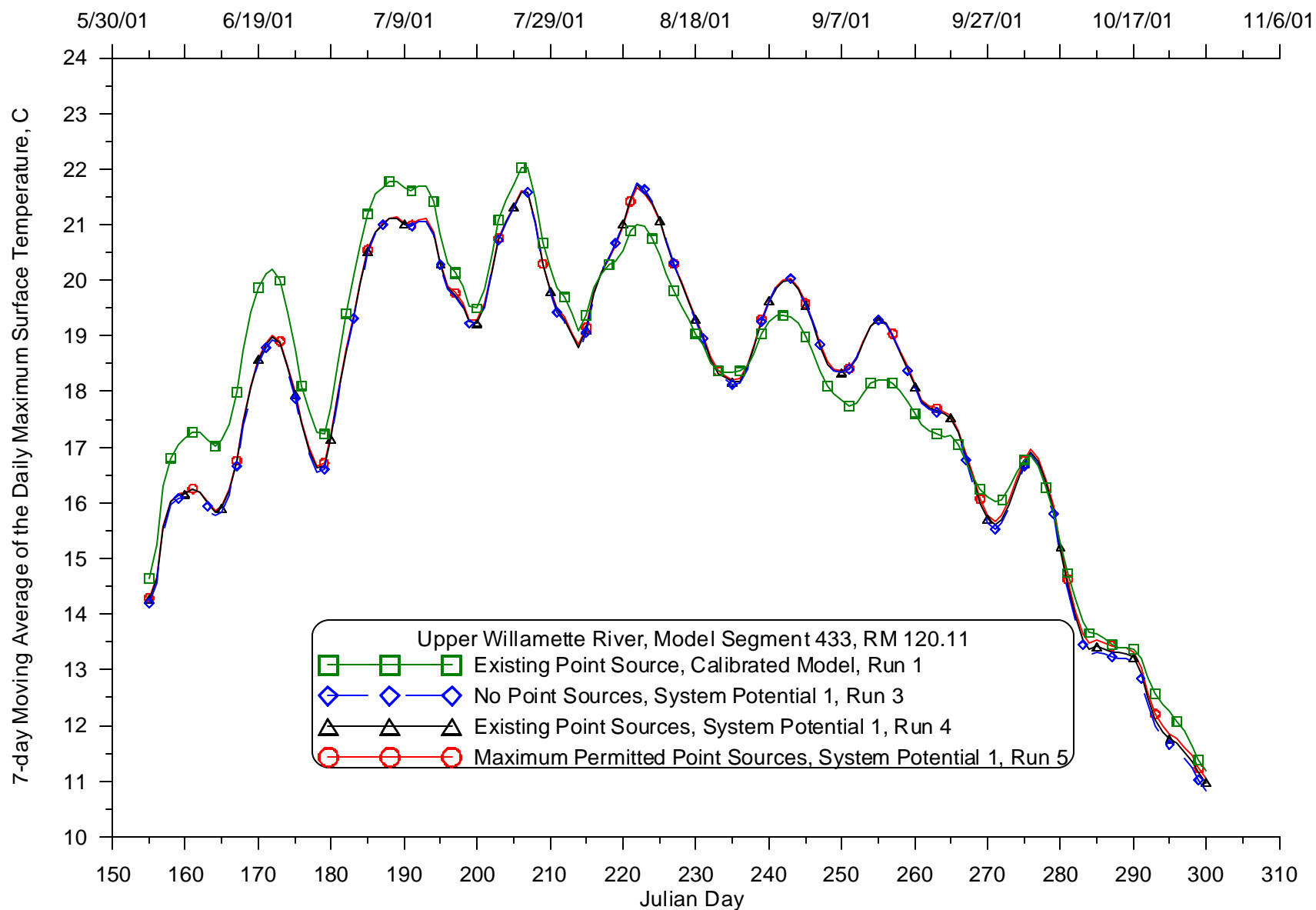


Figure 71: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 120.11

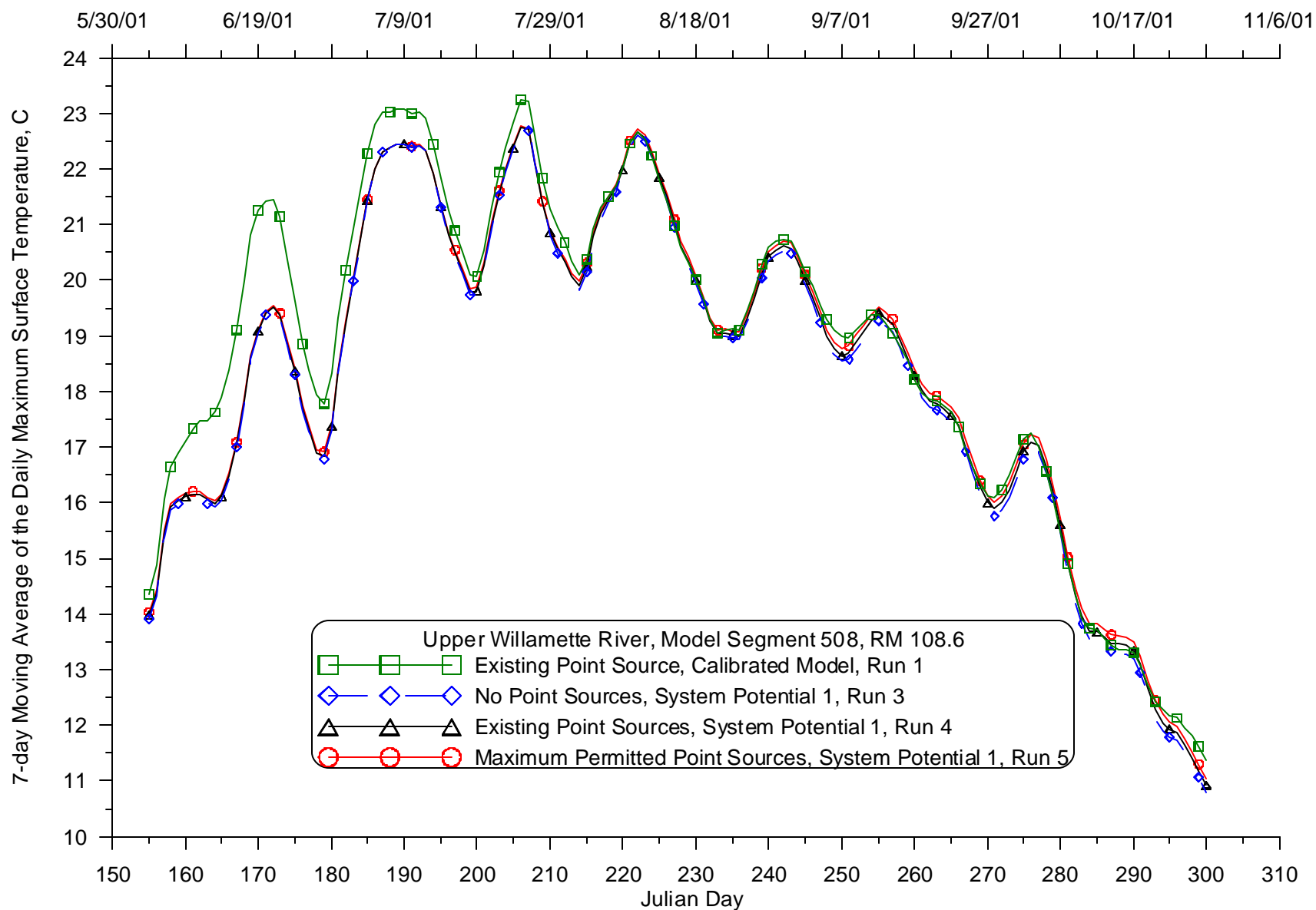
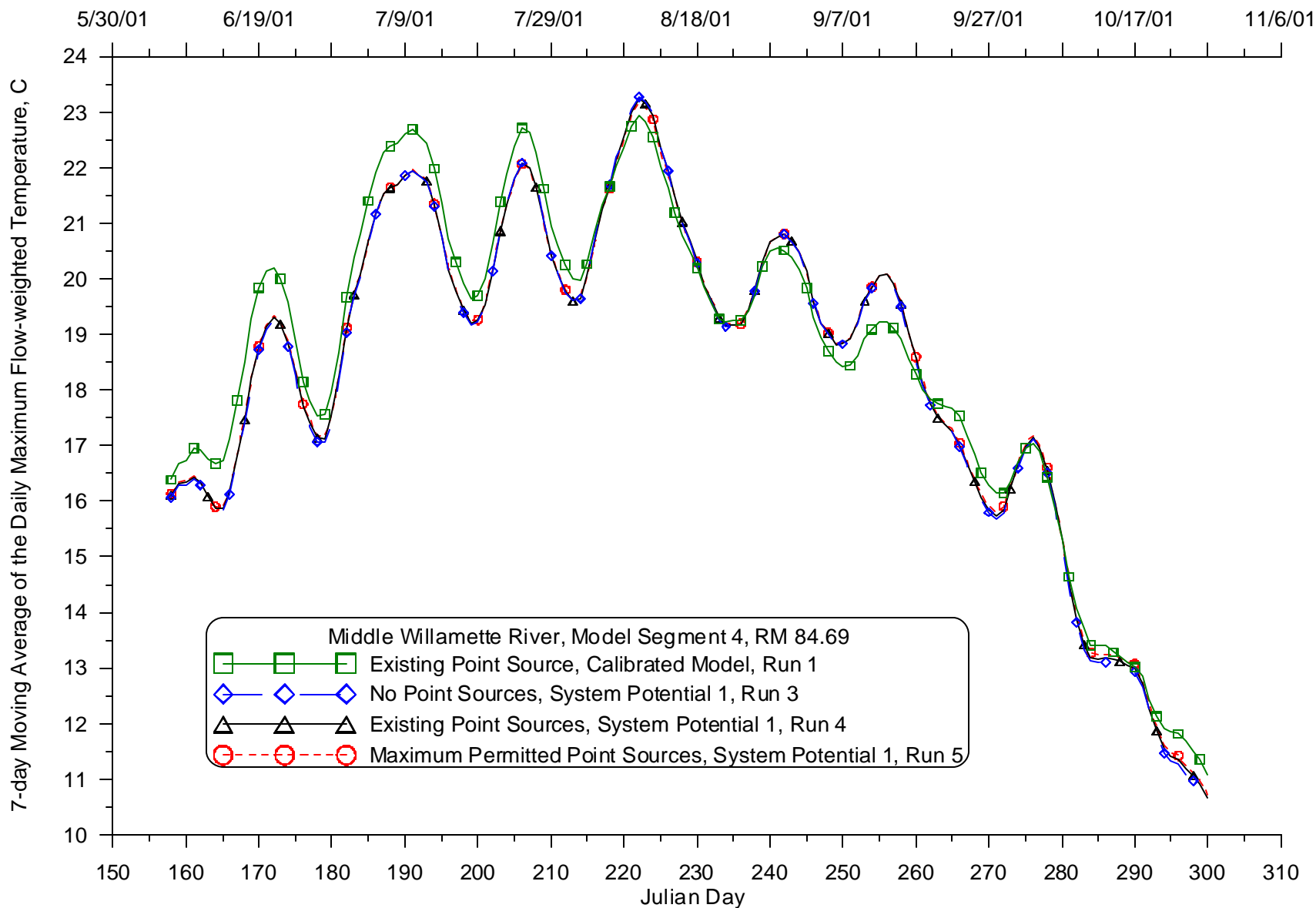


Figure 72: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 108.6



**Figure 73: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 84.69**

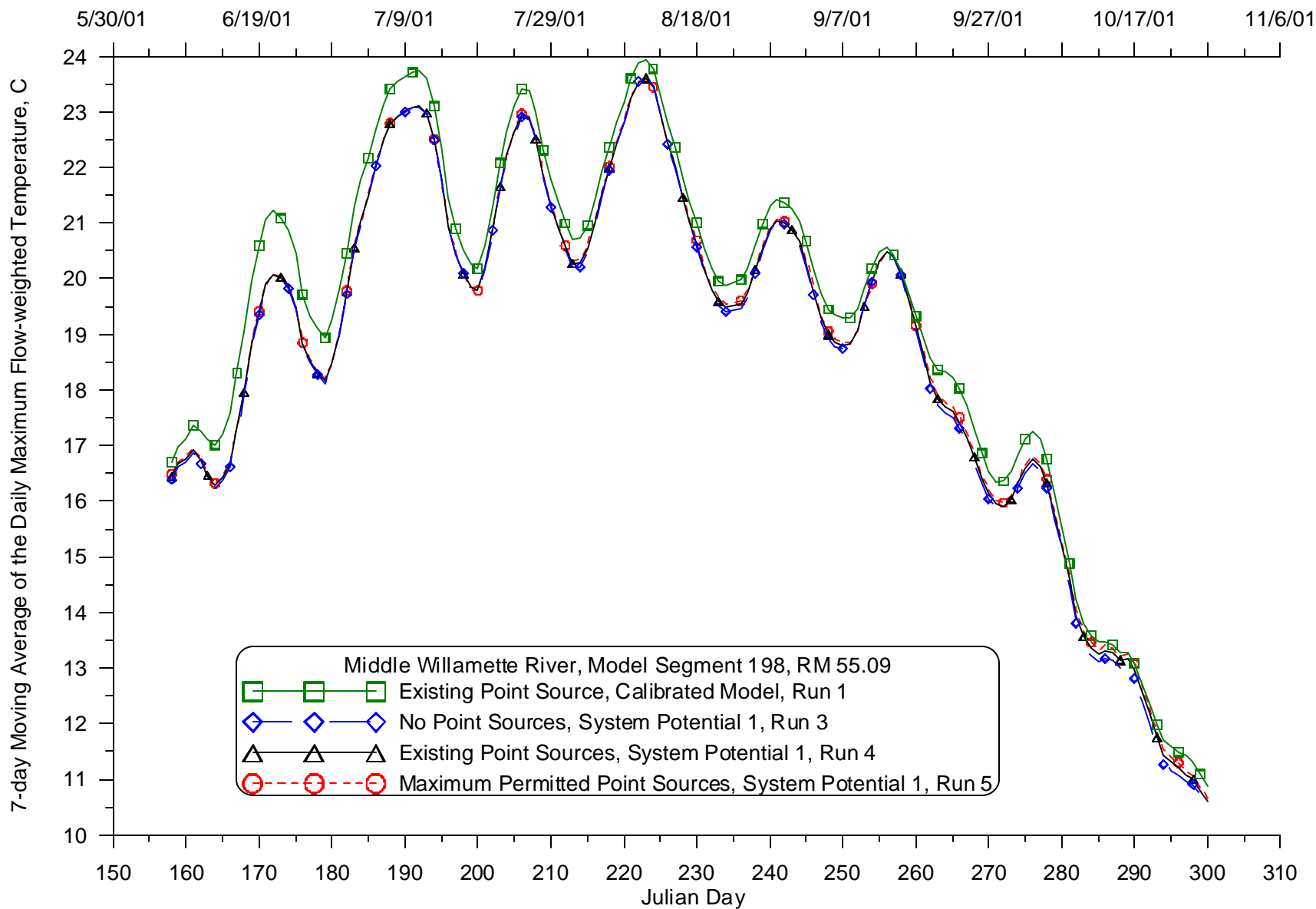
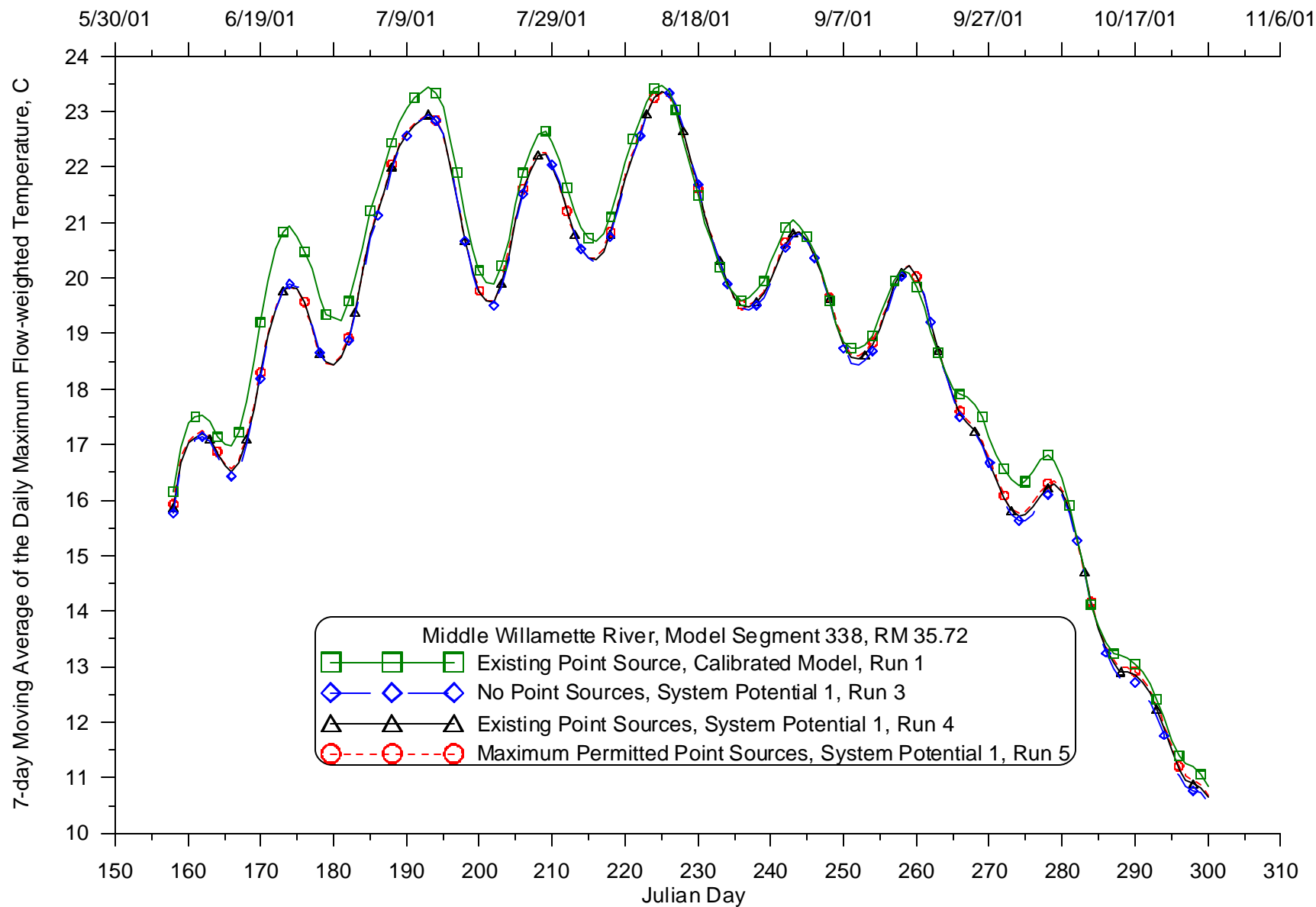
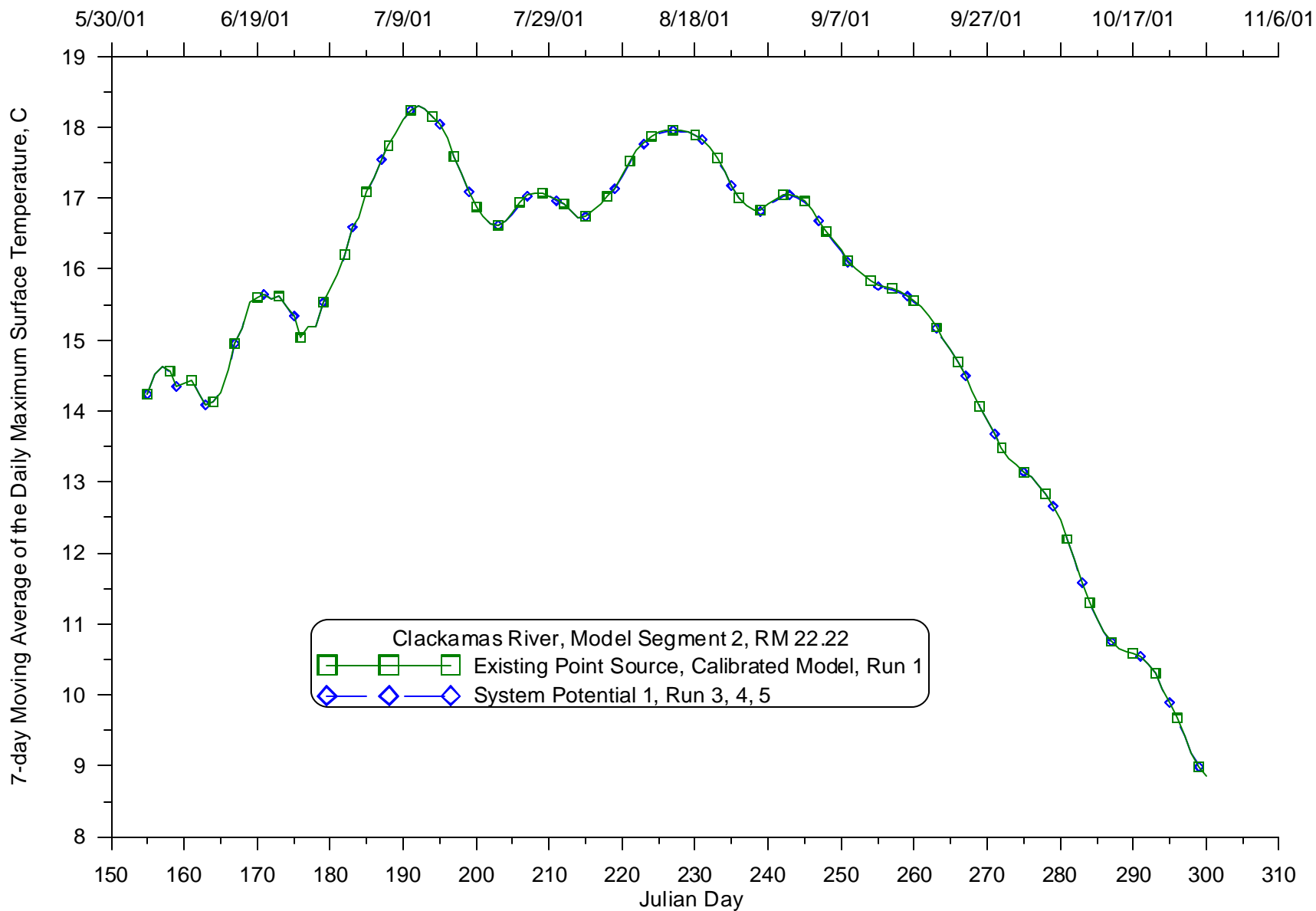


Figure 74: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 55.09

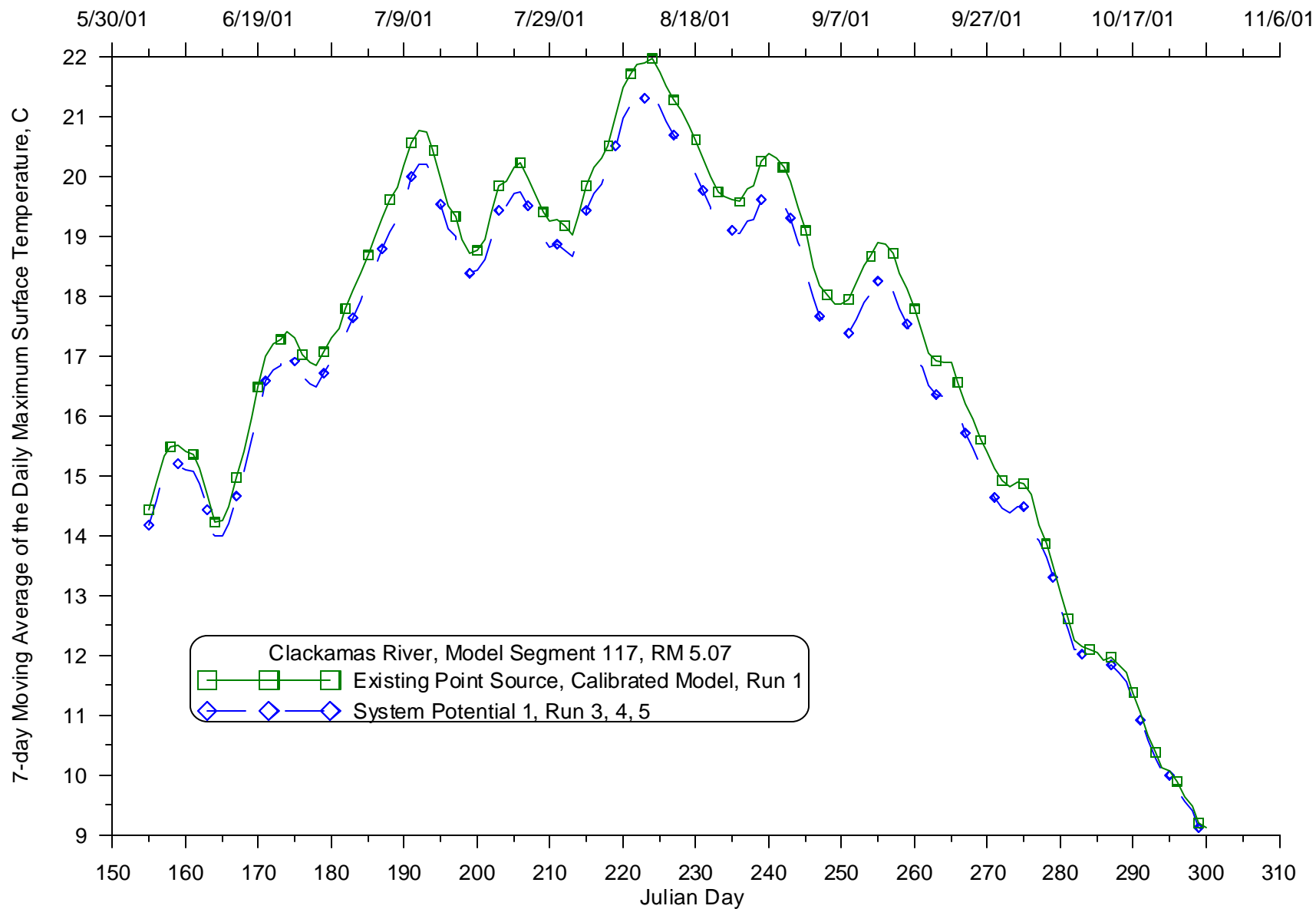




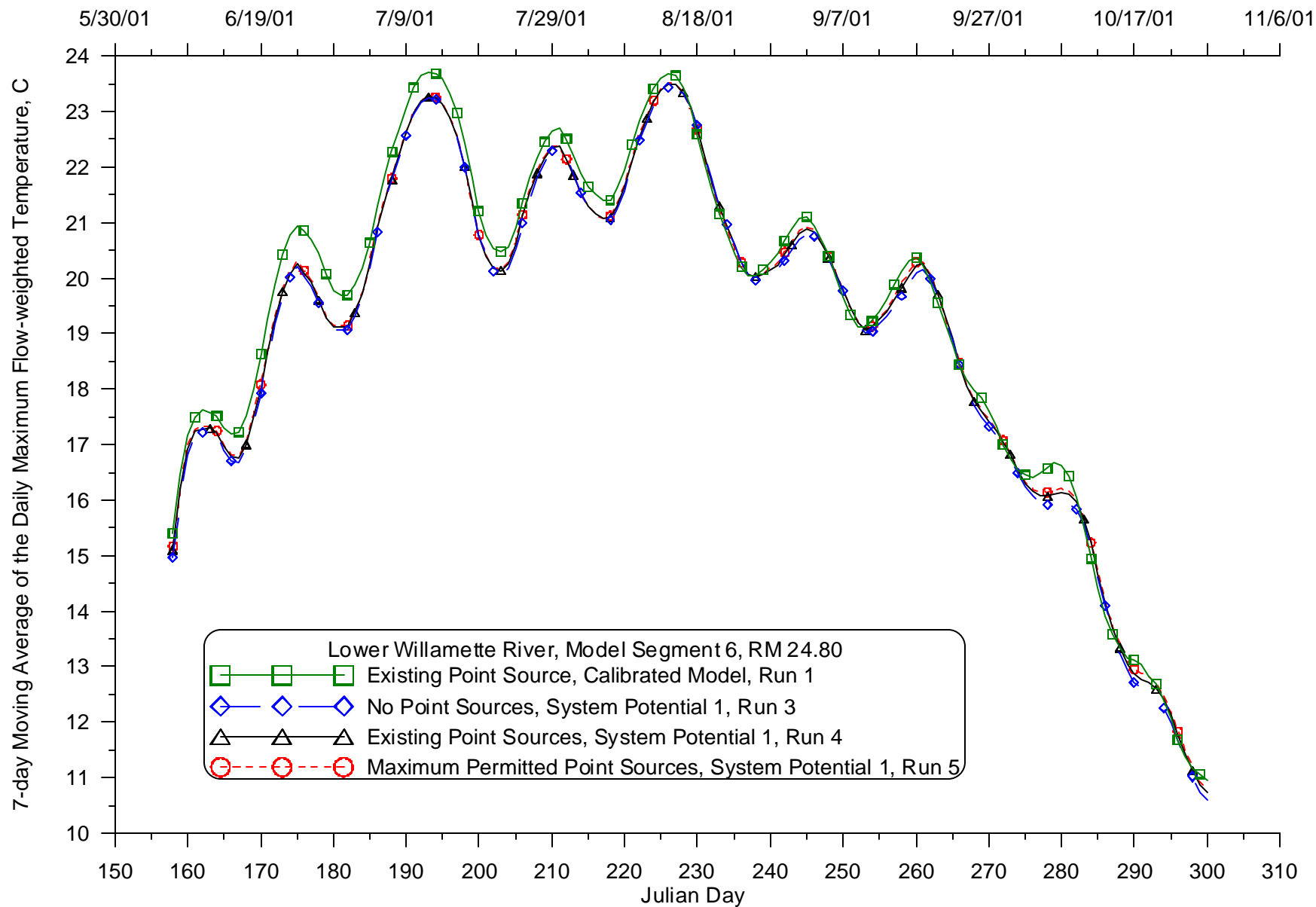
**Figure 75: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 35.72**



**Figure 76: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Clackamas River at RM 22.22**



**Figure 77: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Clackamas River at RM 5.07**



**Figure 78: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 24.80**

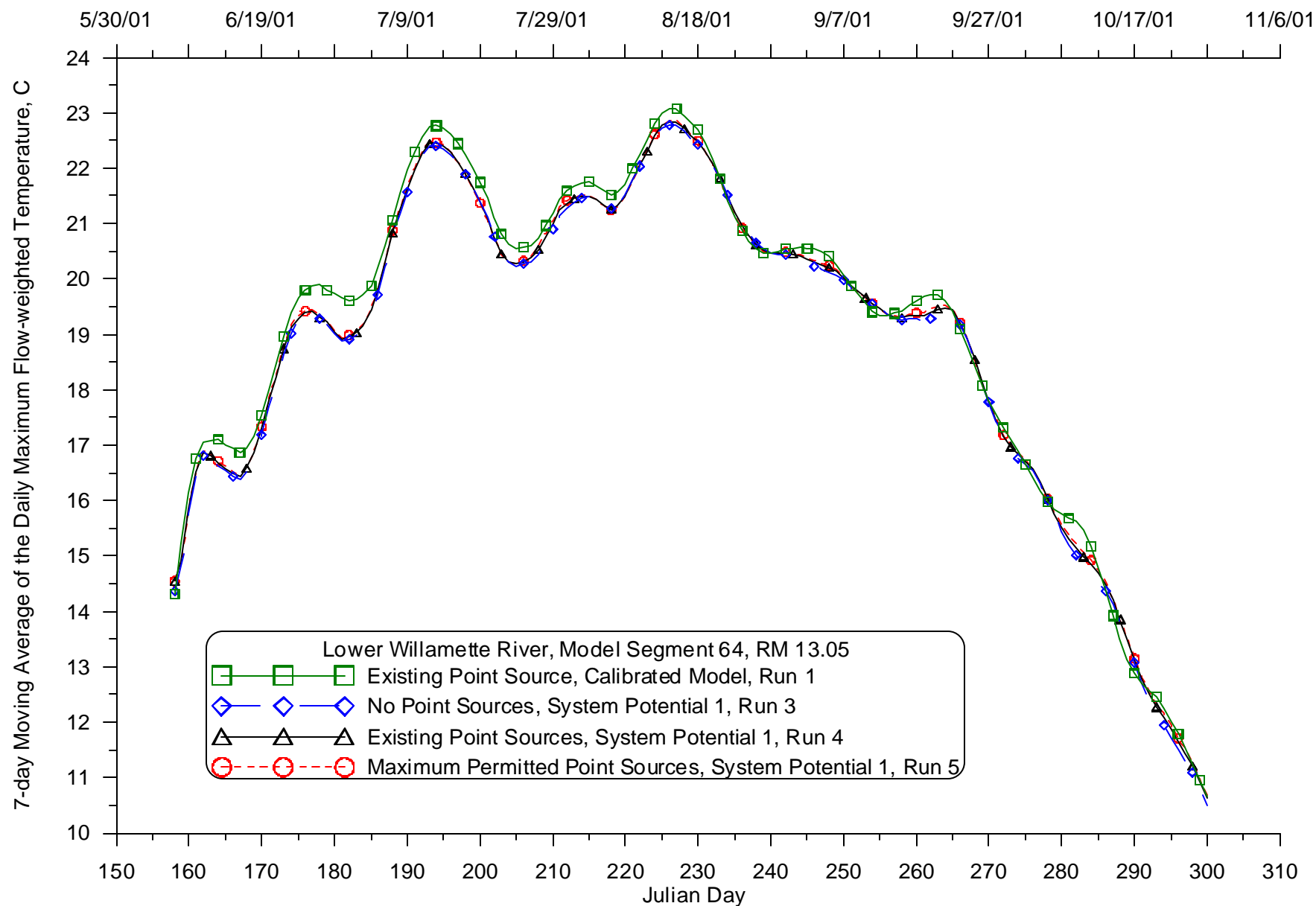


Figure 79: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 13.05

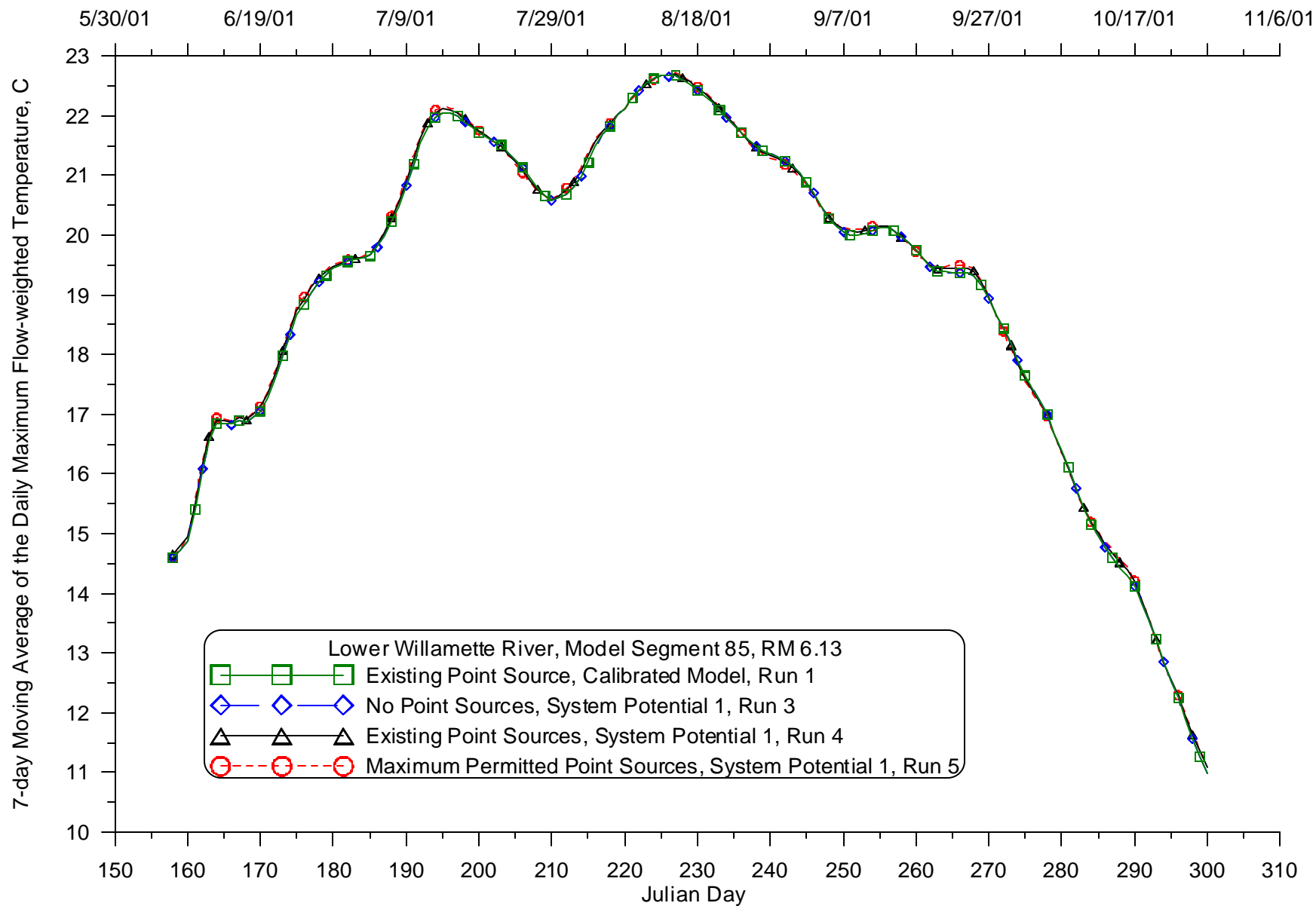


Figure 80: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 6.13

## Daily seven day average flow

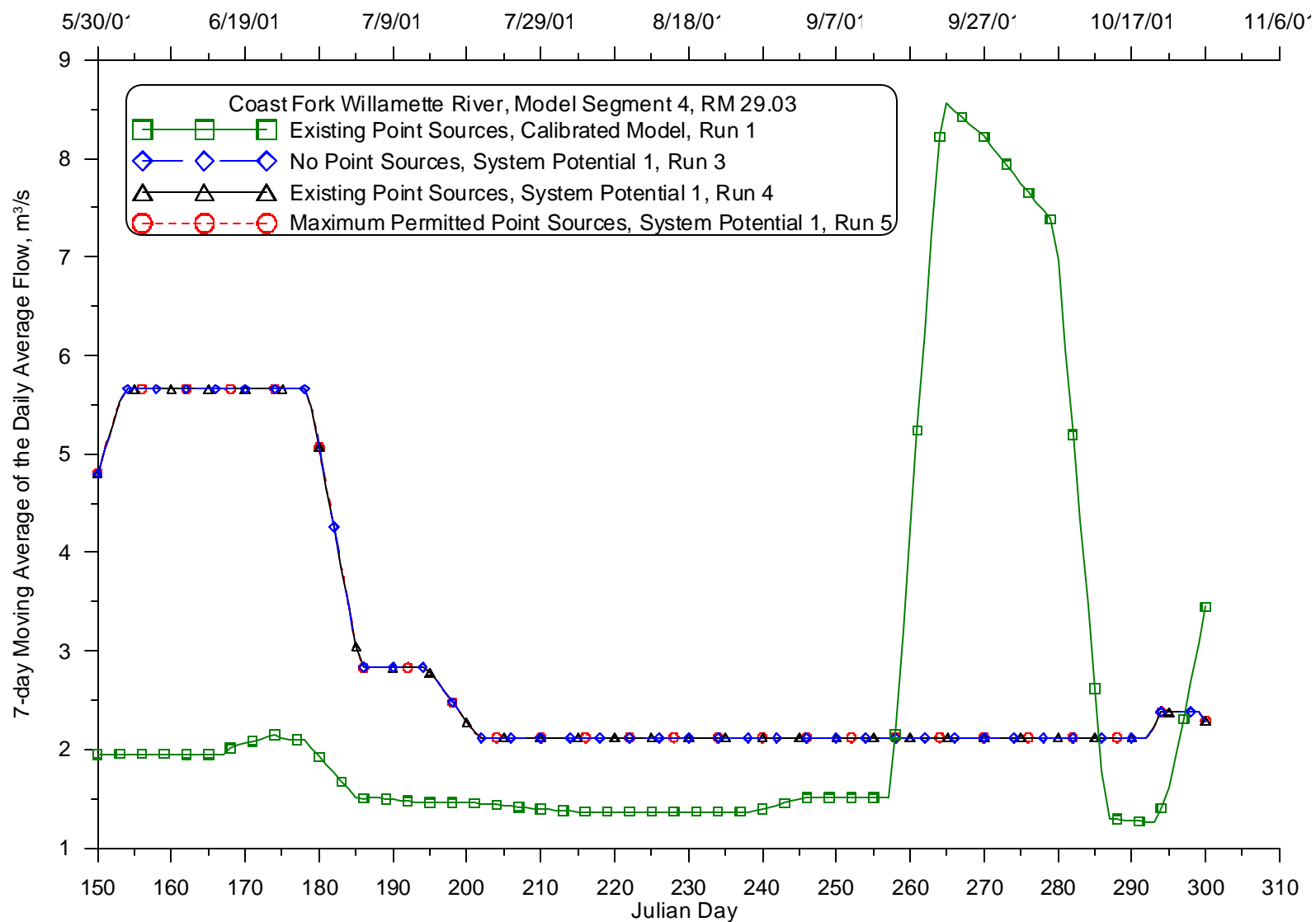


Figure 81: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Coast Fork Willamette River at RM 29.03

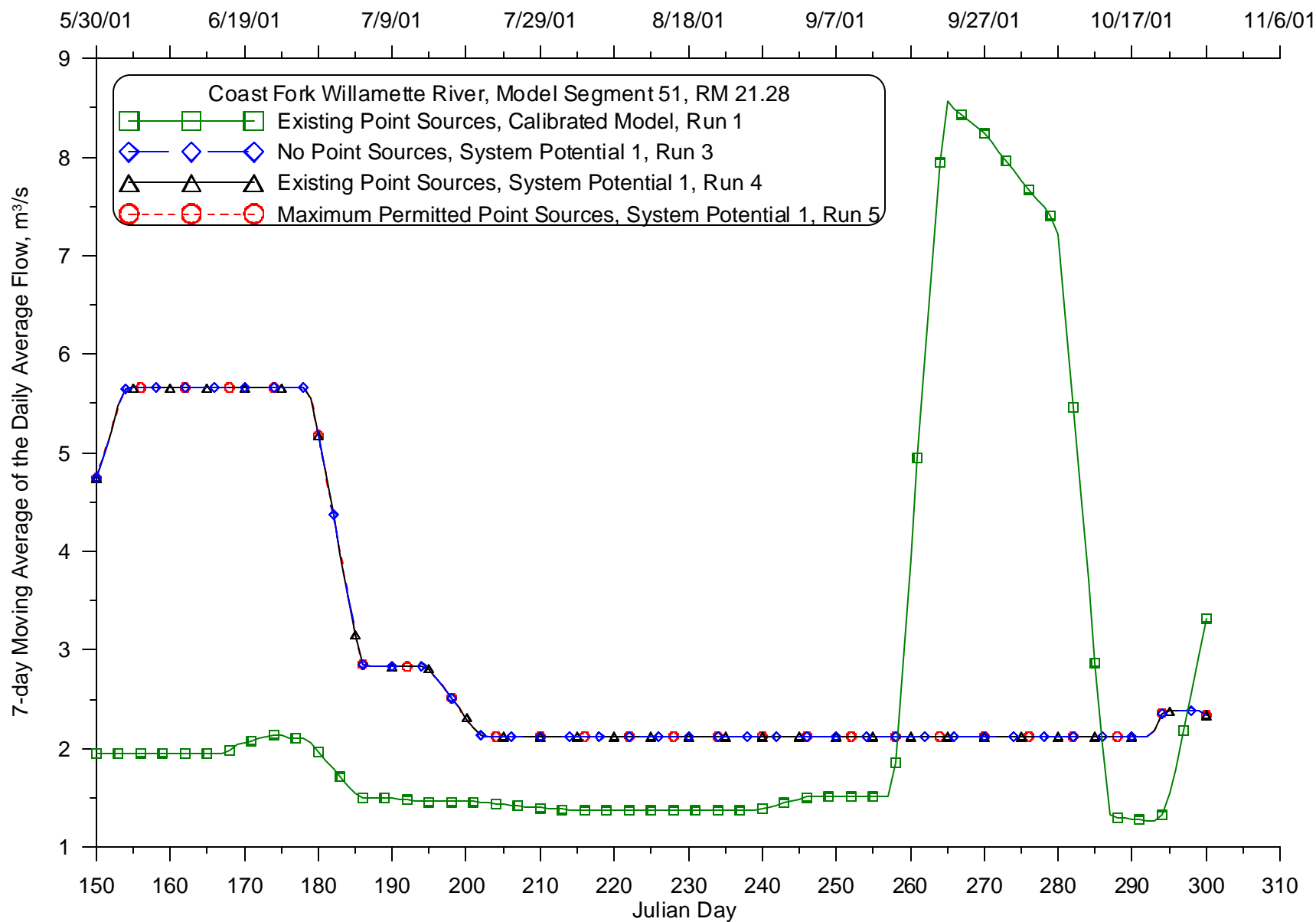
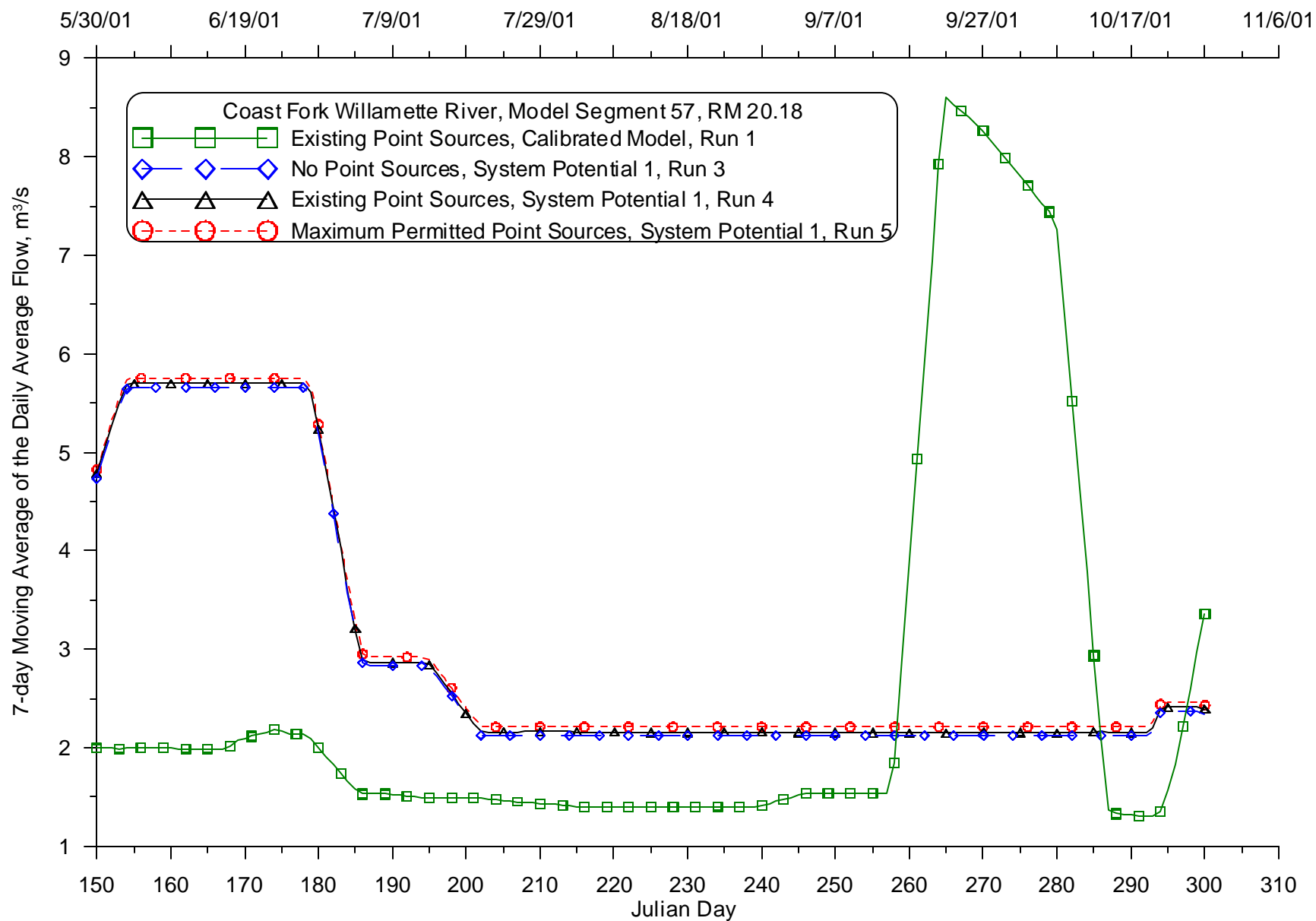
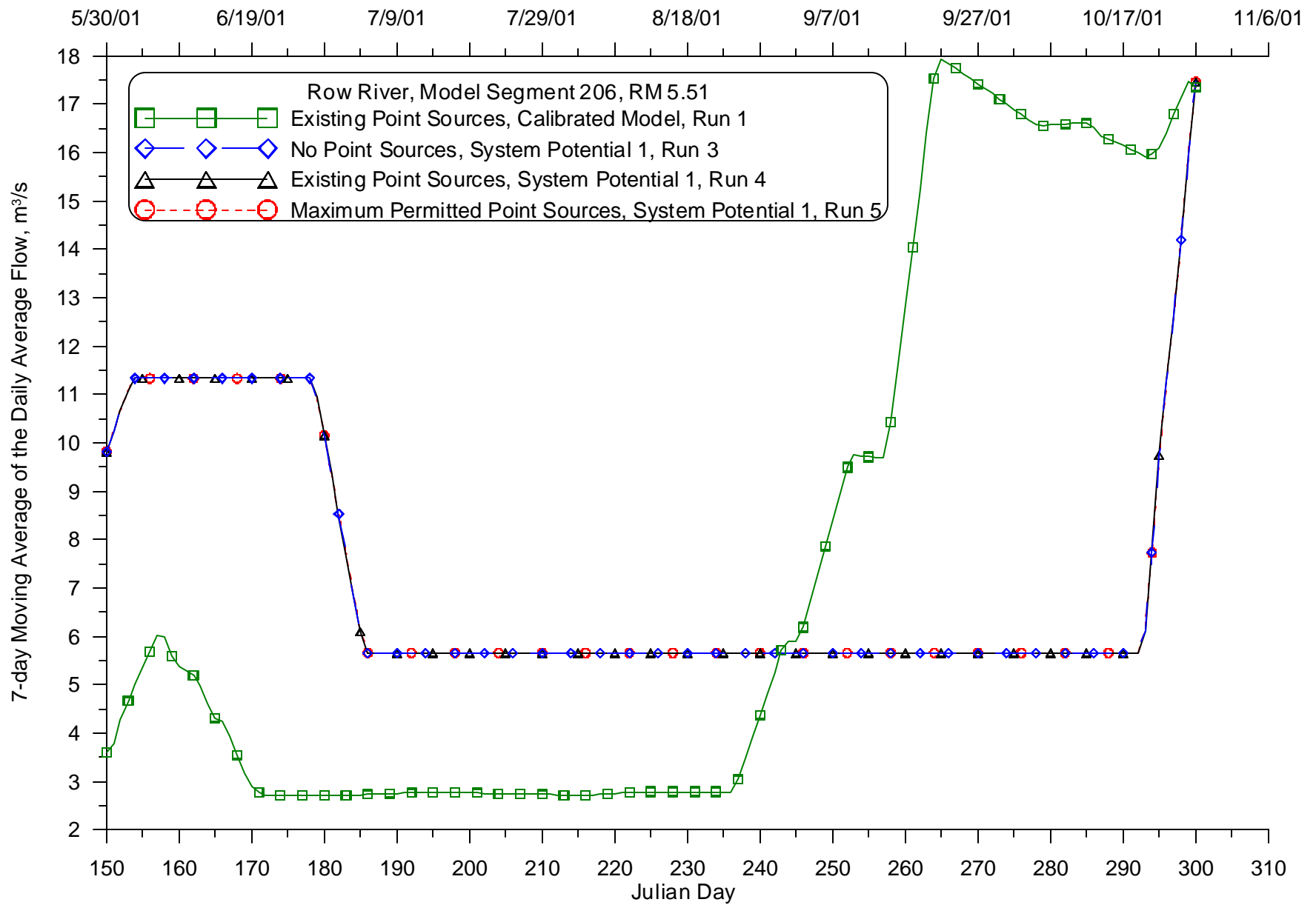


Figure 82: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Coast Fork Willamette River at RM 21.28





**Figure 83: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Coast Fork Willamette River at RM 20.18**



**Figure 84: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Row River at RM 5.51**

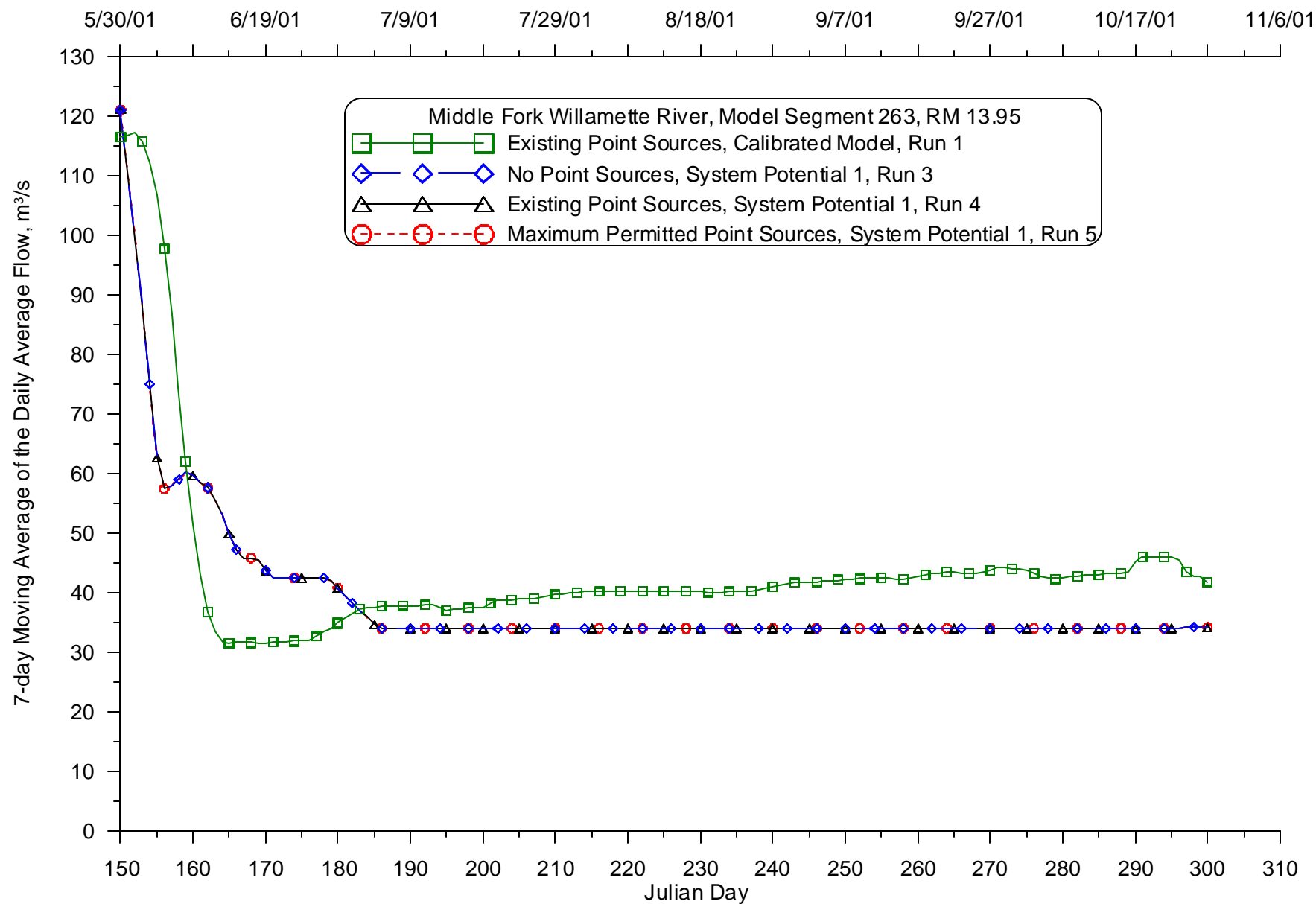
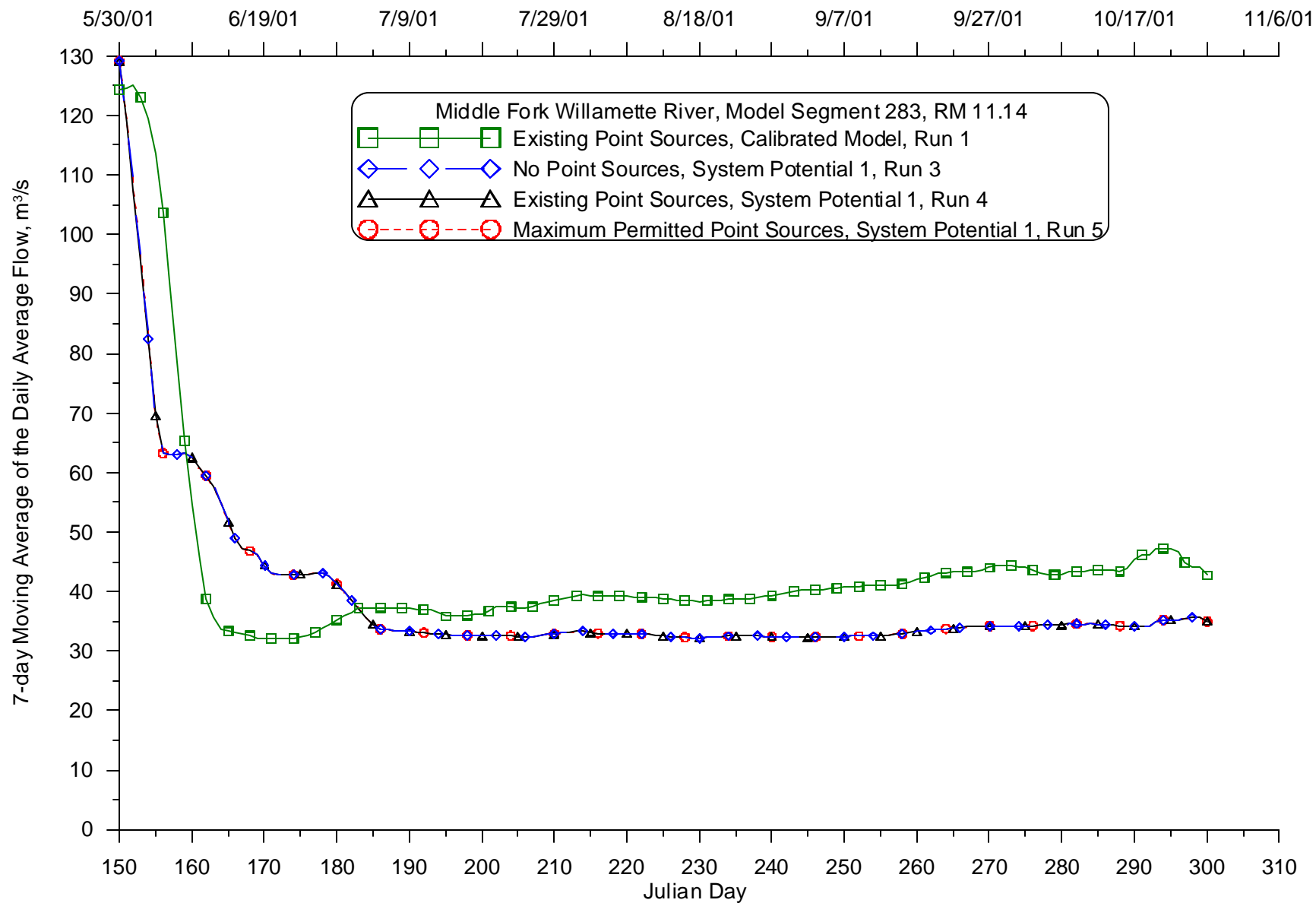


Figure 85: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Middle Fork Willamette River at RM 13.95



**Figure 86: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Middle Fork Willamette River at RM 11.14**

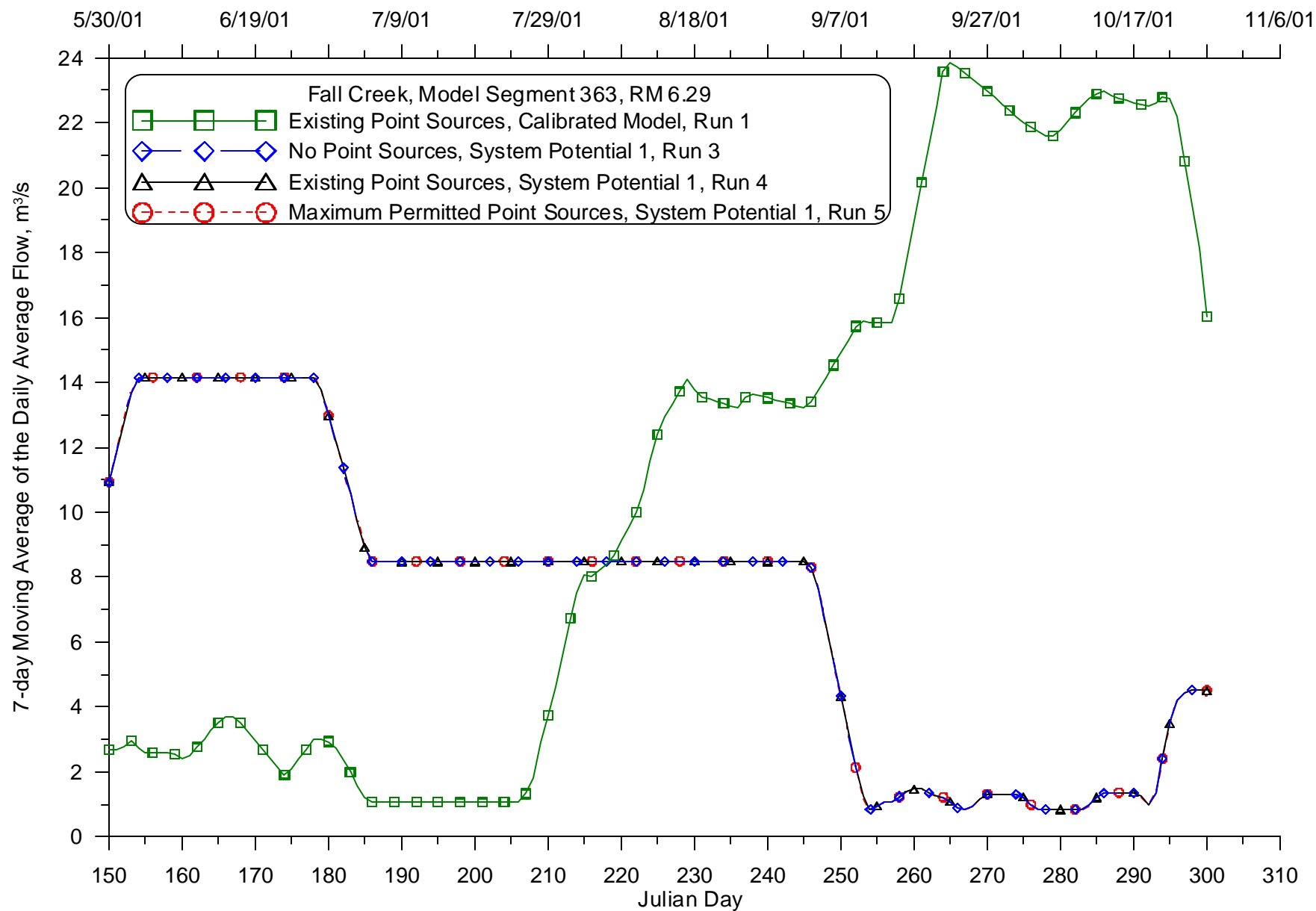
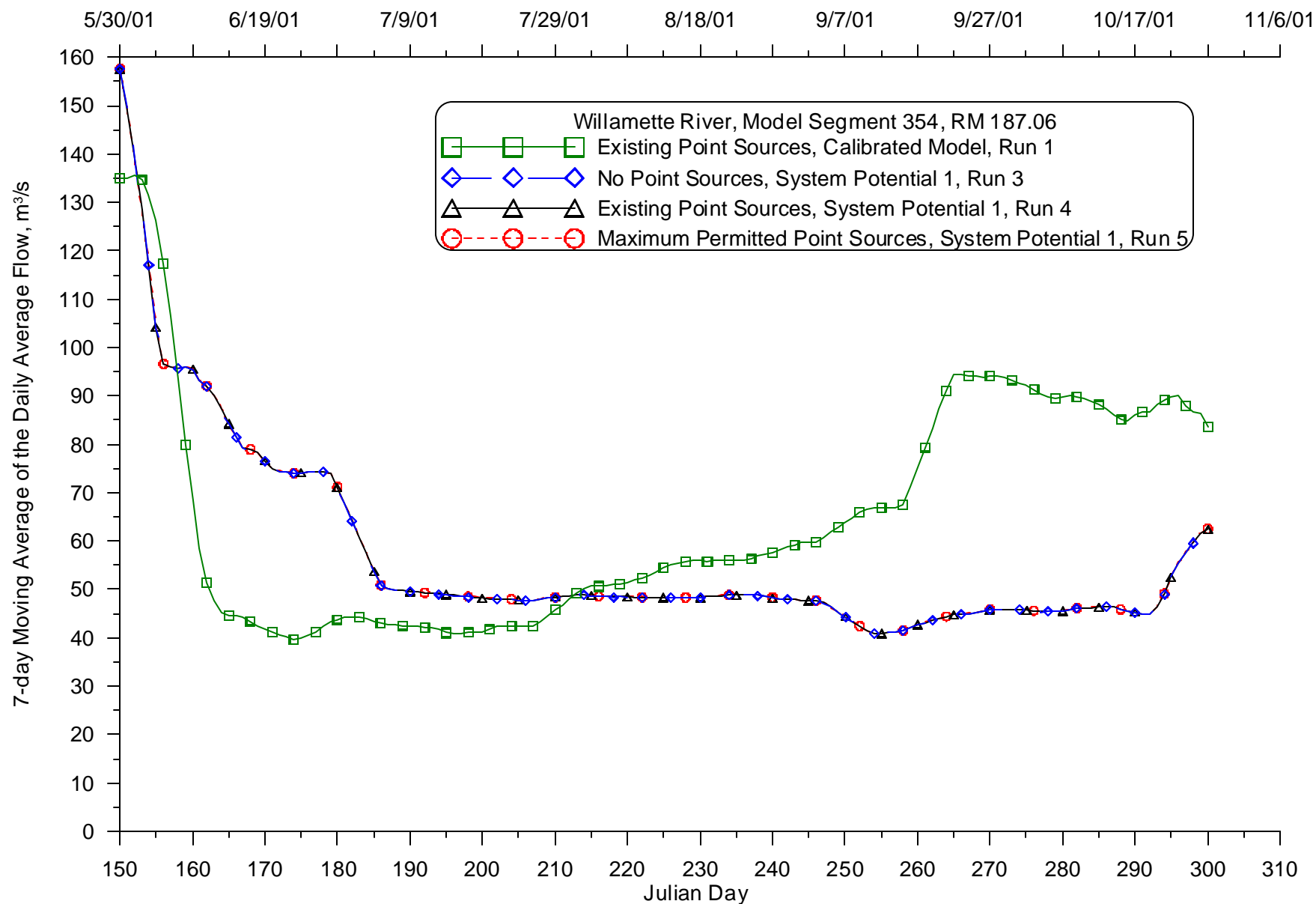


Figure 87: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Fall Creek at RM 6.29



**Figure 88: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 187.06**

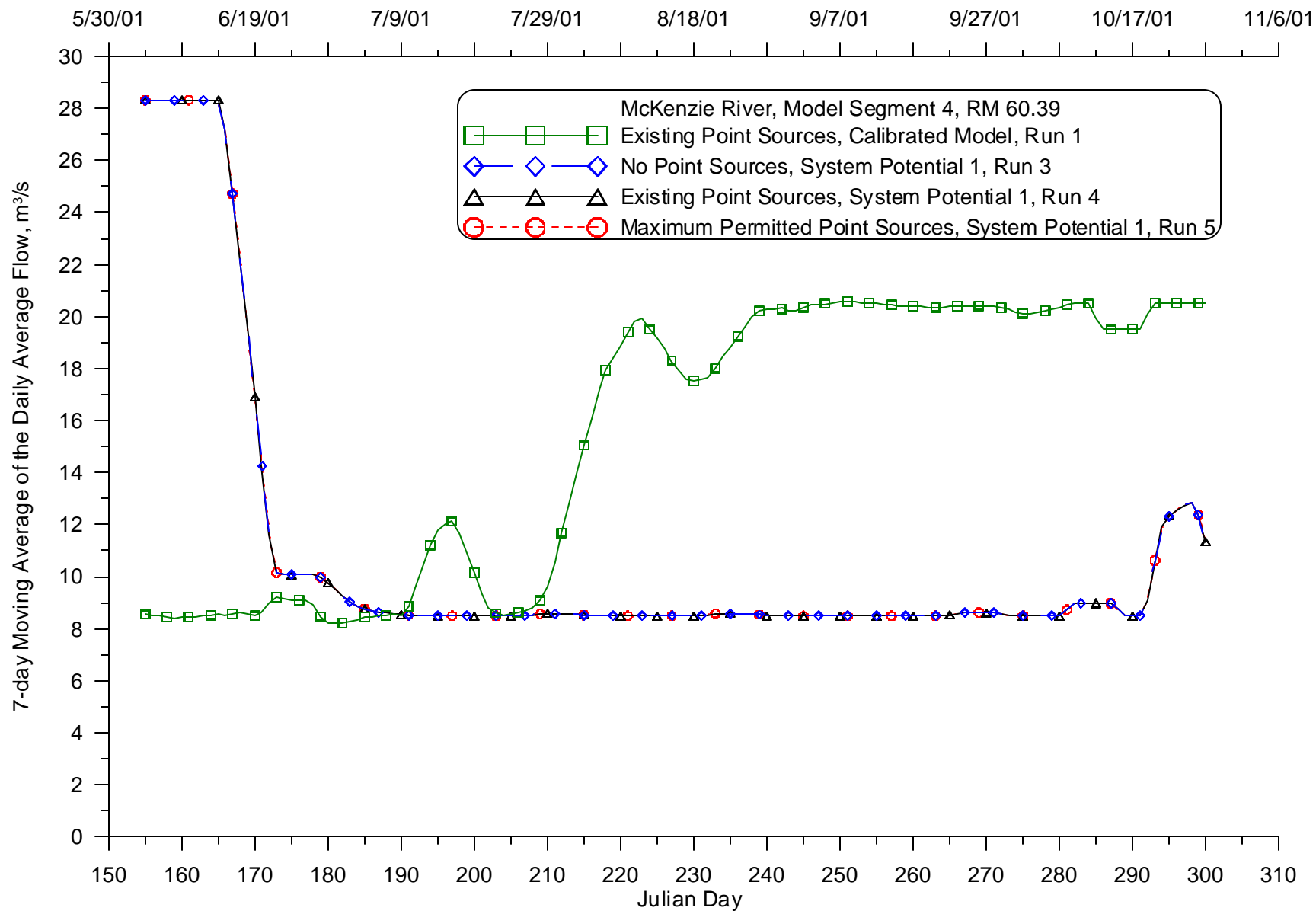
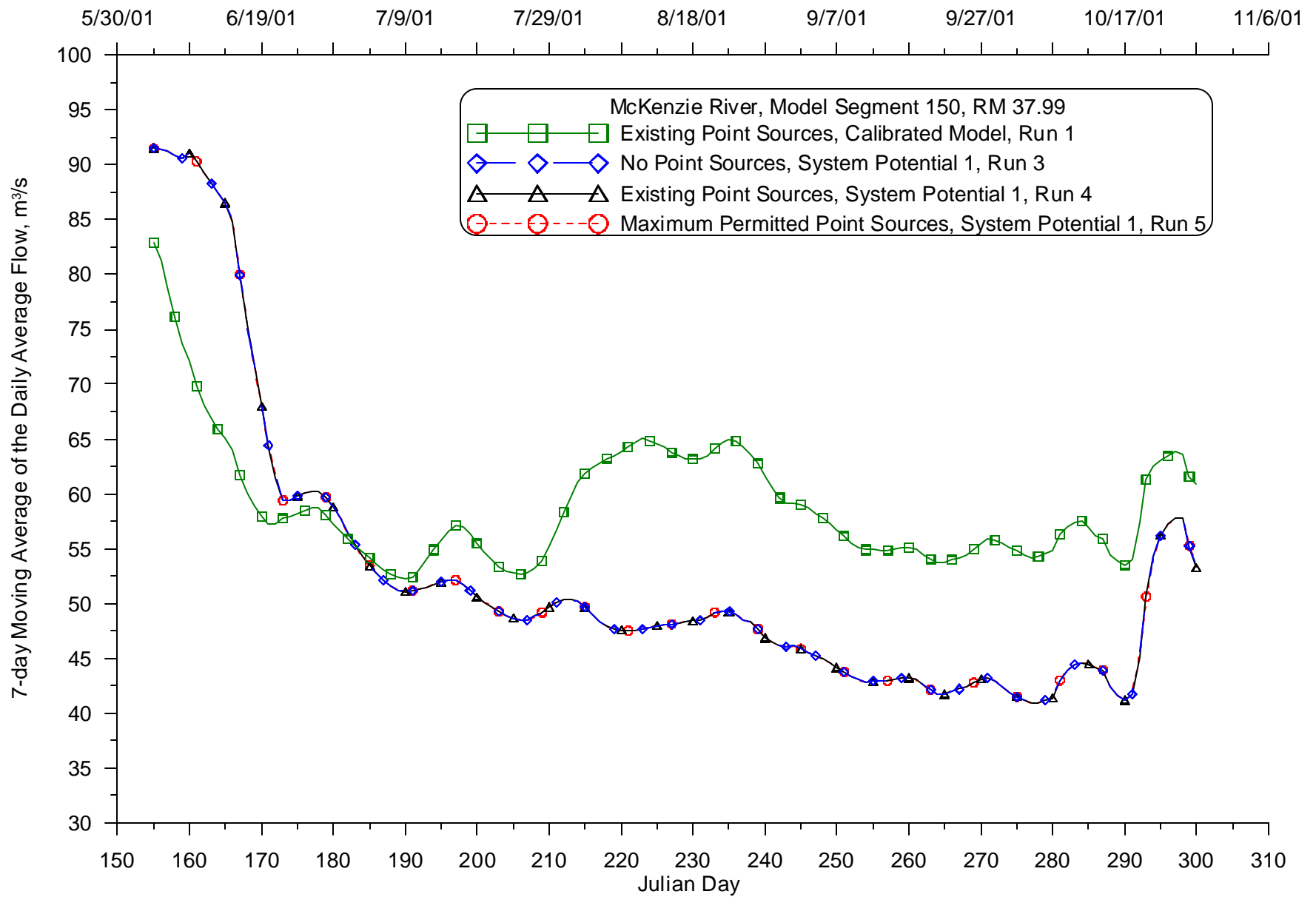
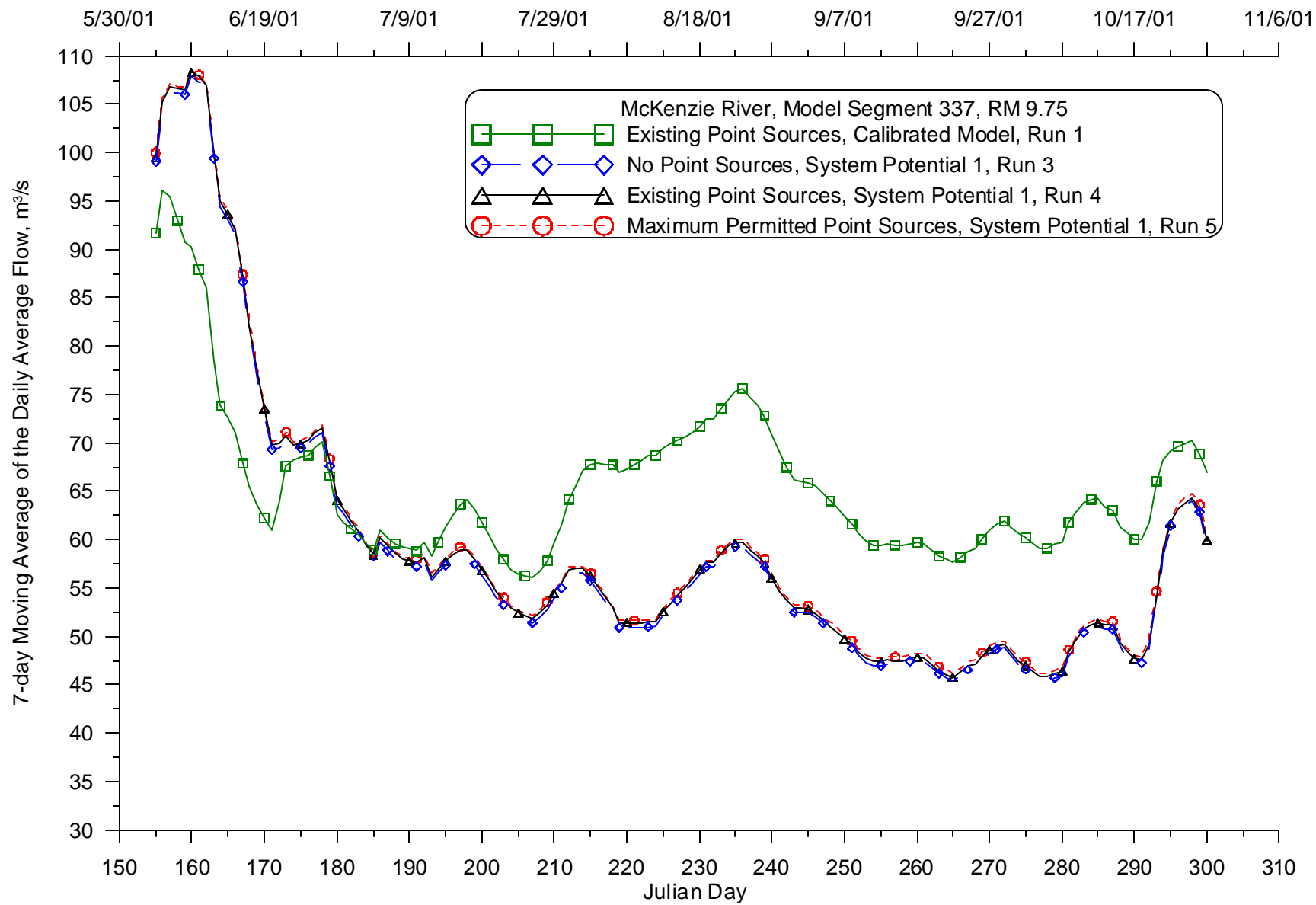


Figure 89: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the McKenzie River at RM 60.39

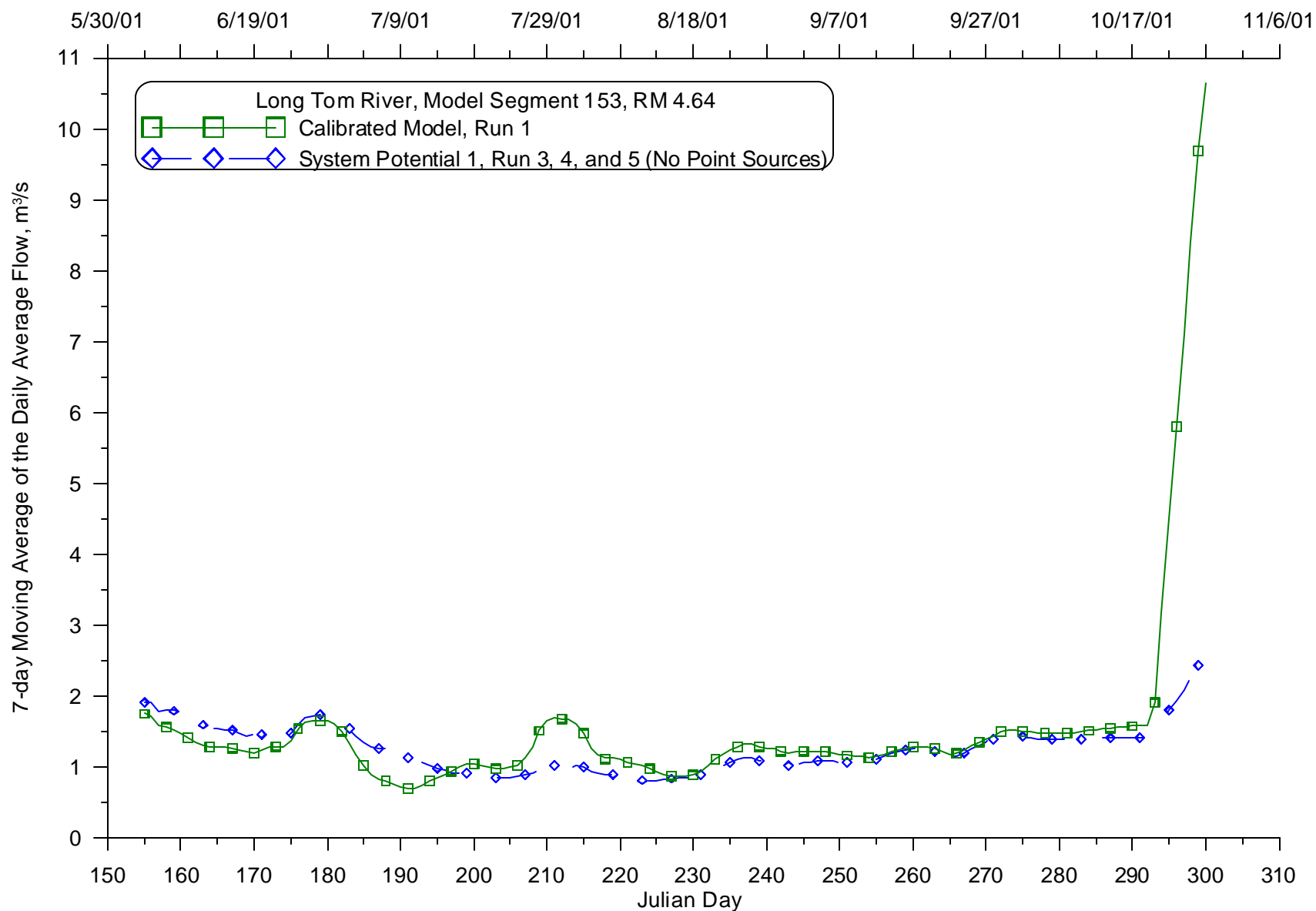


**Figure 90: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the McKenzie River at RM 37.99**





**Figure 91: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the McKenzie River at RM 9.75**



**Figure 92: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Long Tom River at RM 4.64**

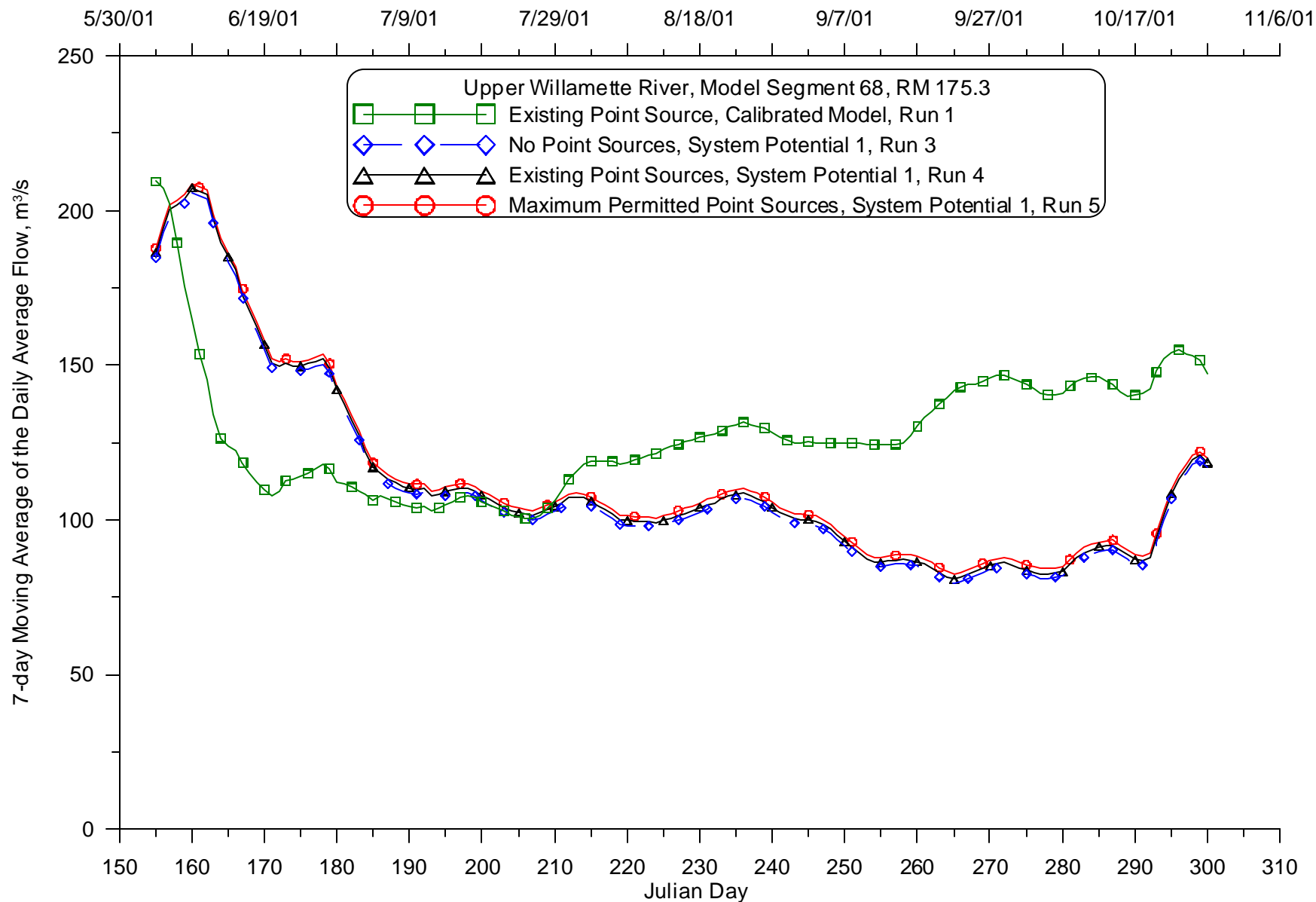
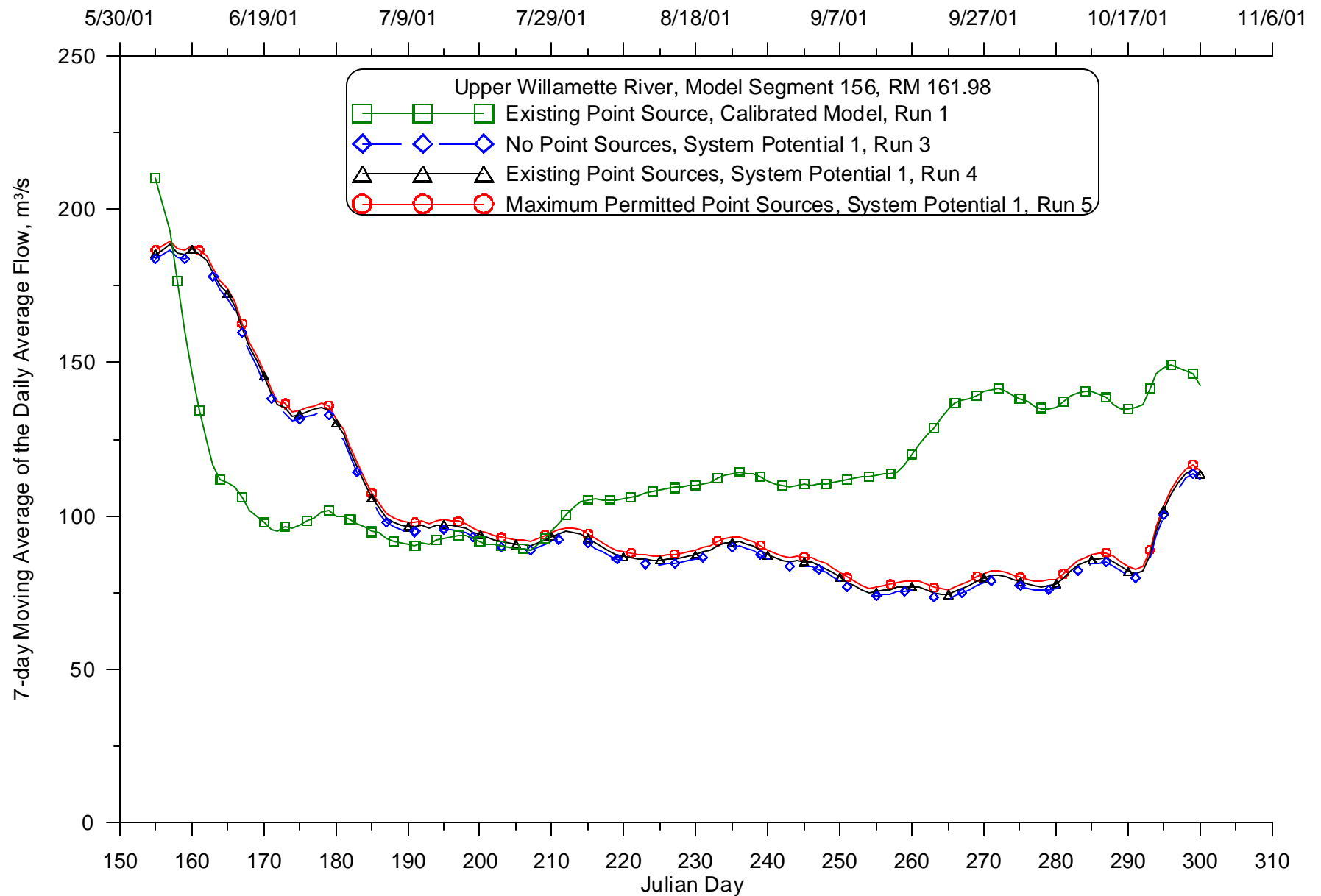
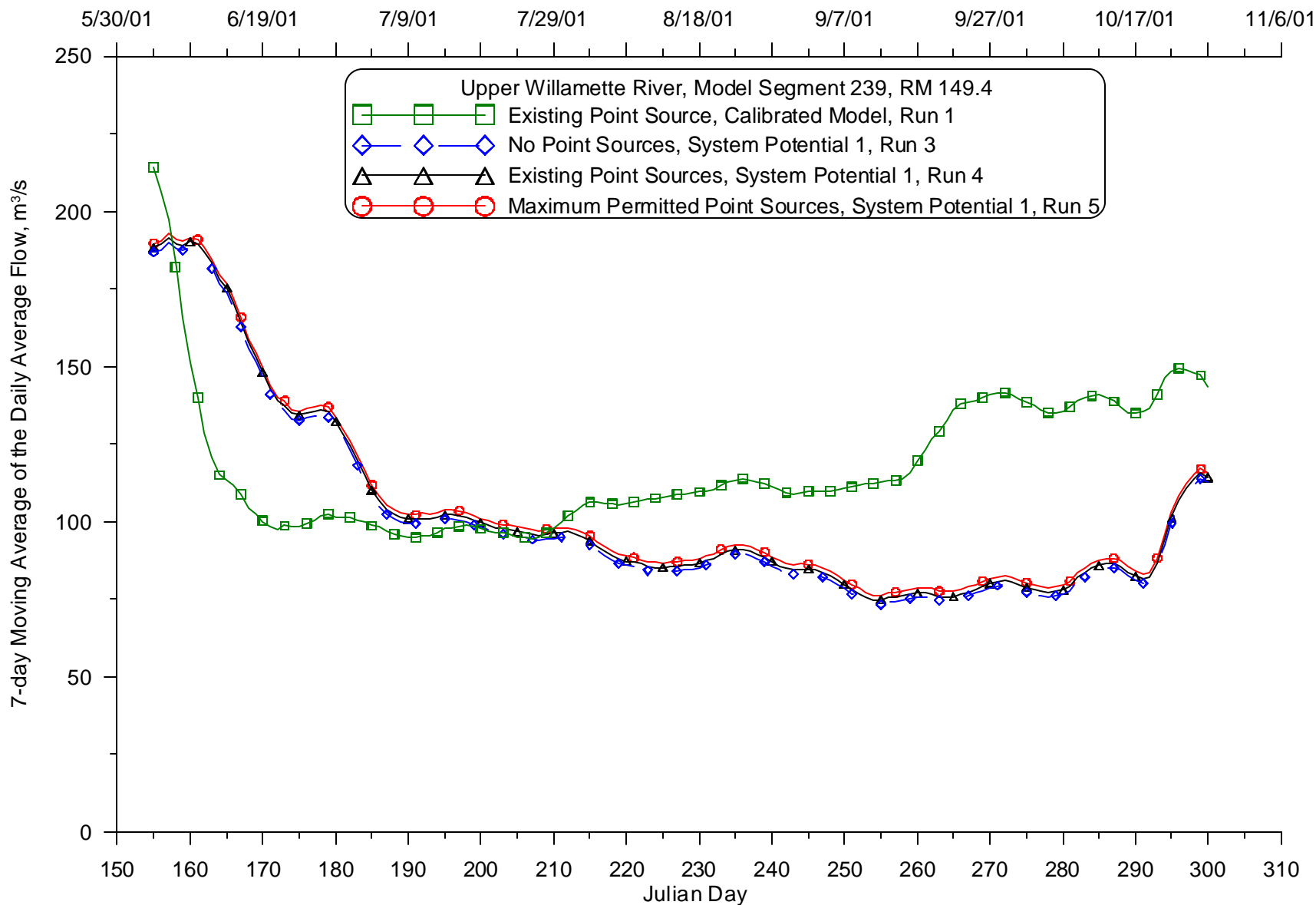


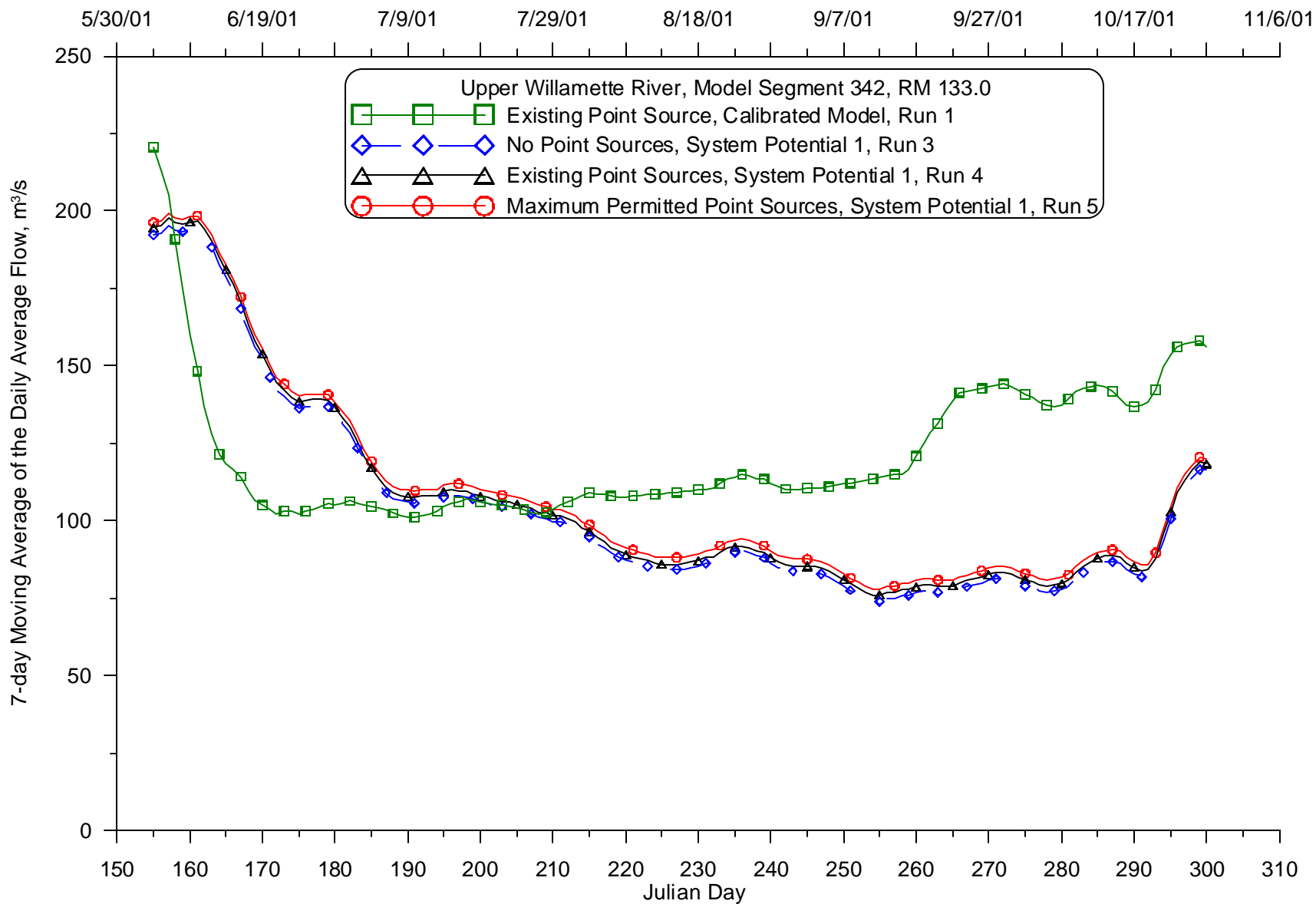
Figure 93: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 175.3



**Figure 94: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 161.98**



**Figure 95: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 149.4**



**Figure 96: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 133.0**

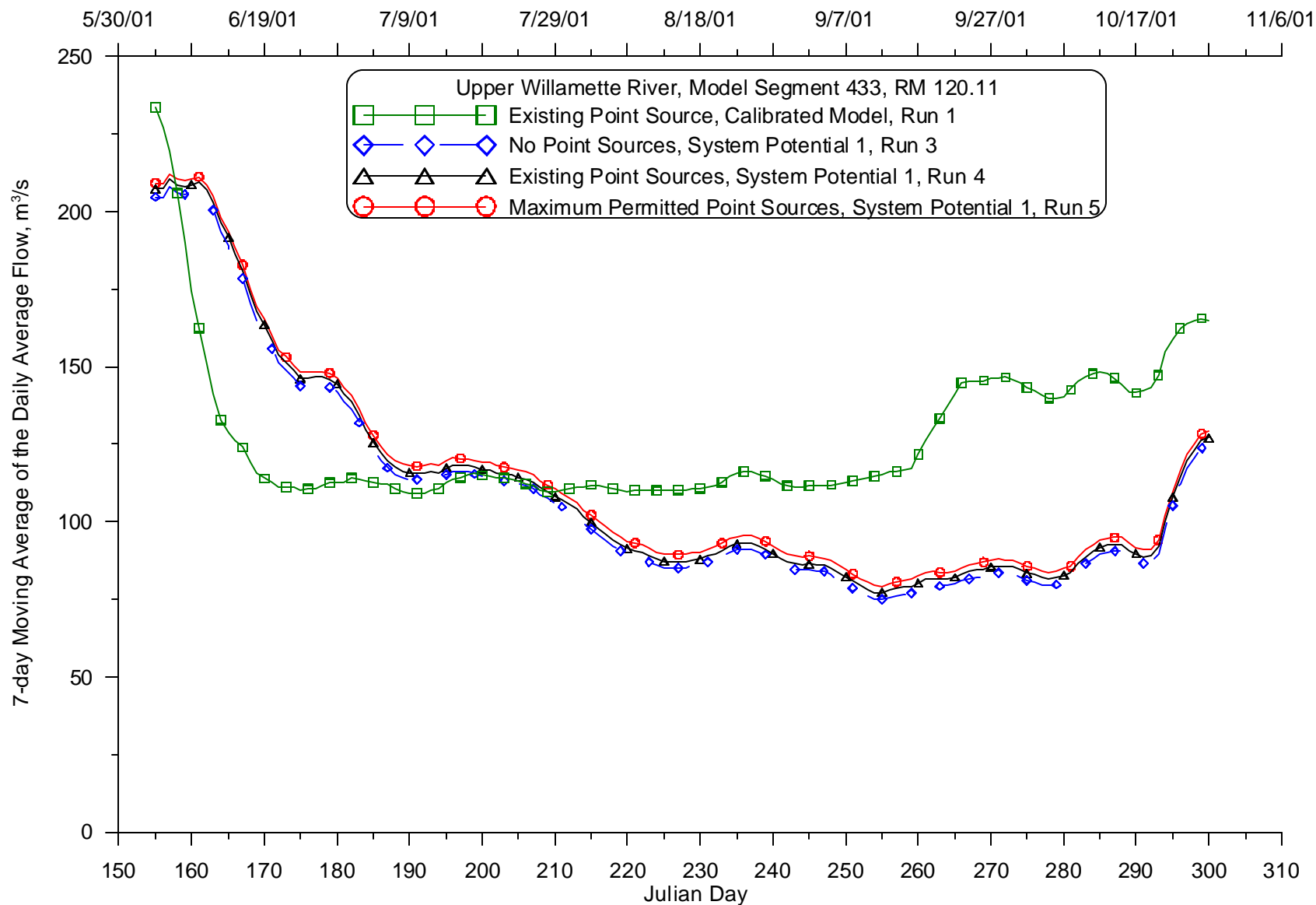
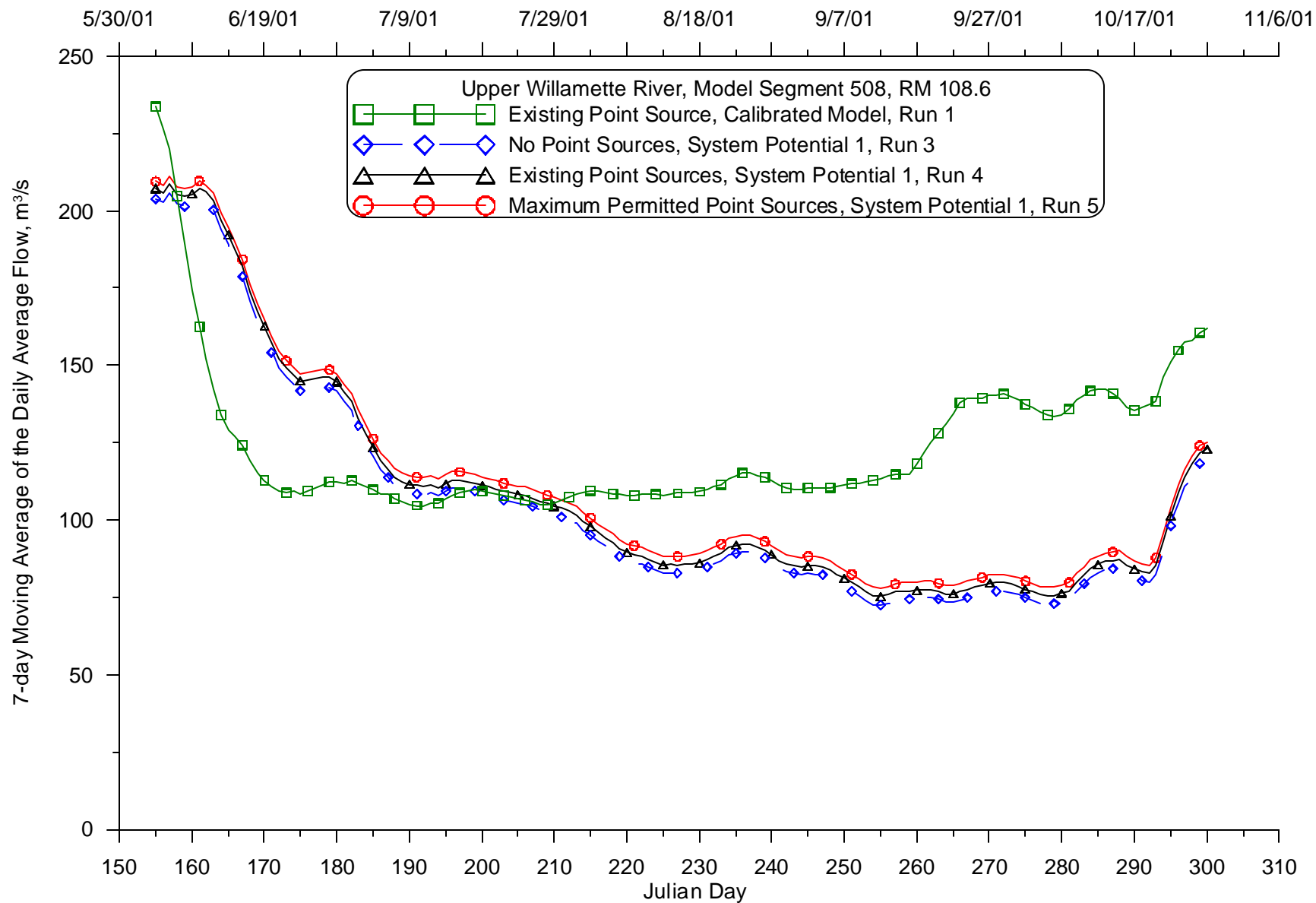
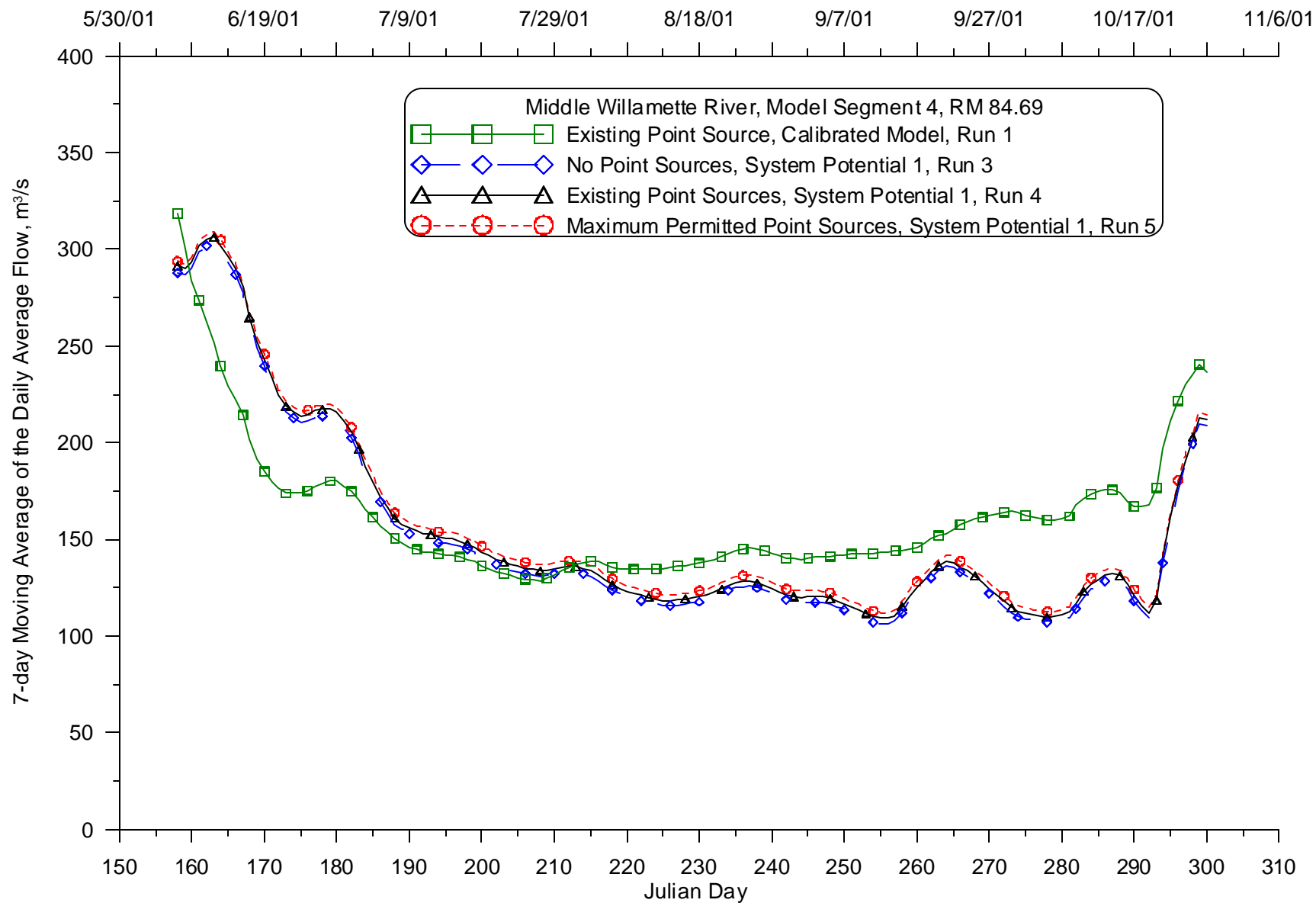


Figure 97: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 120.11

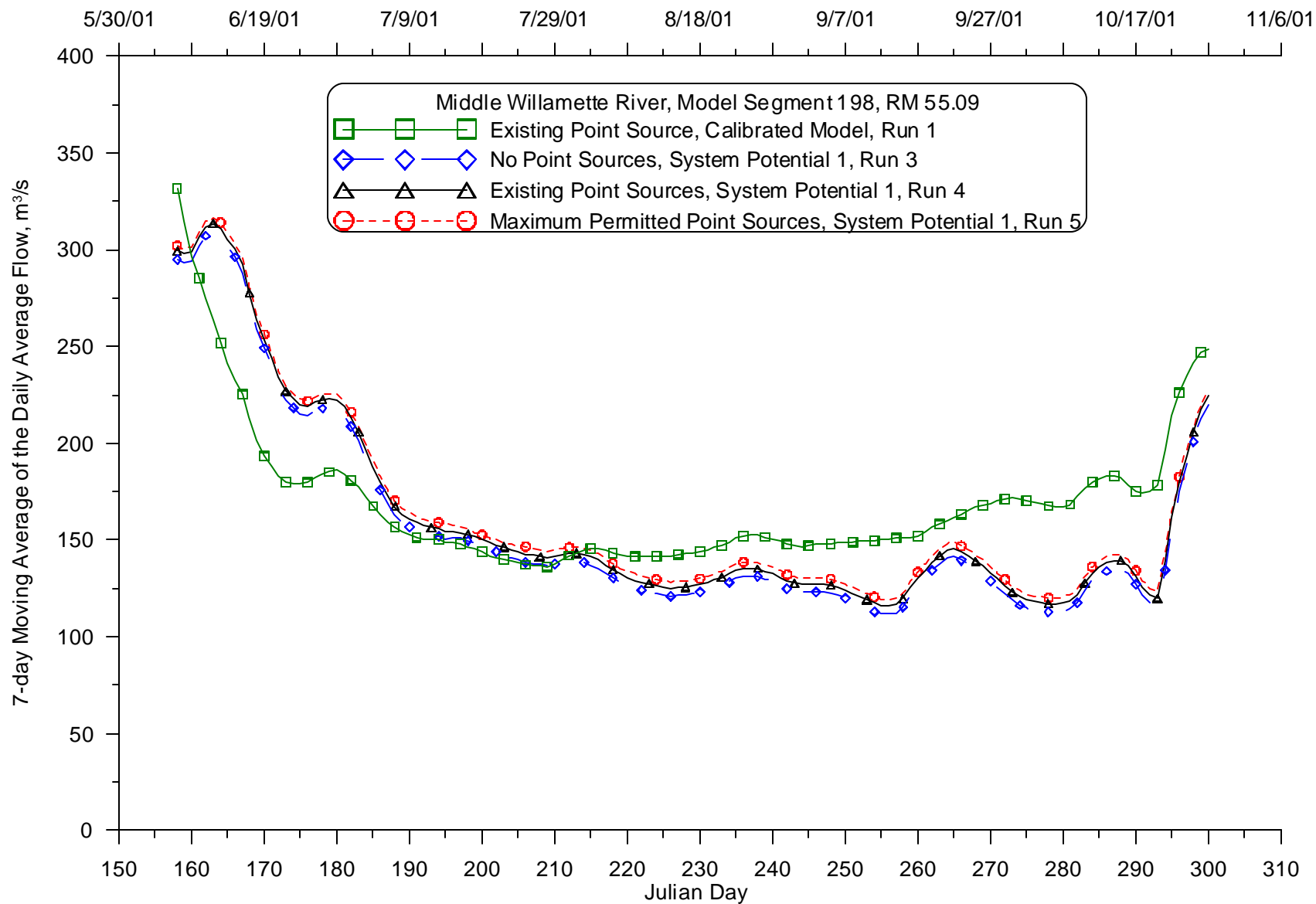


**Figure 98: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 108.6**

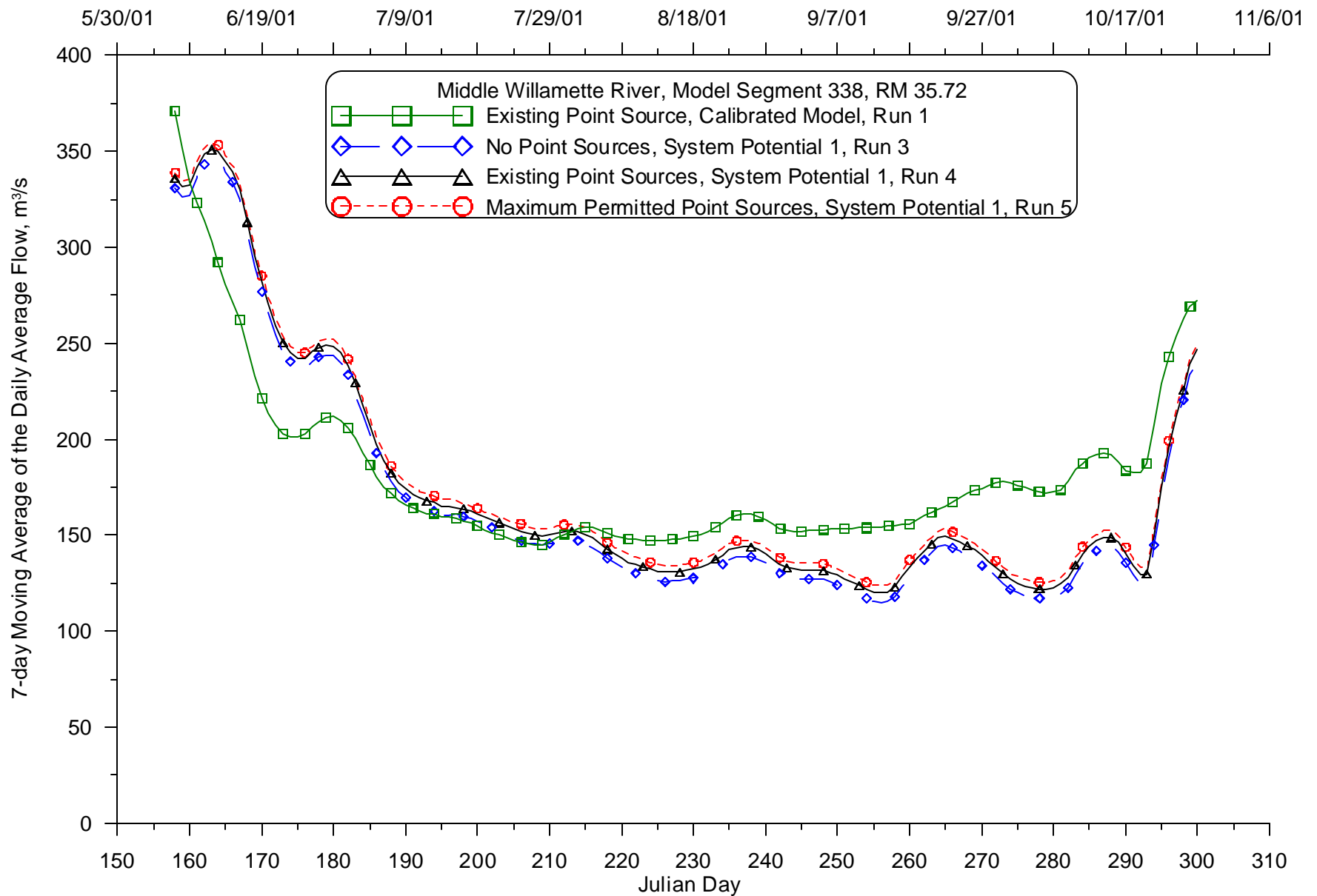




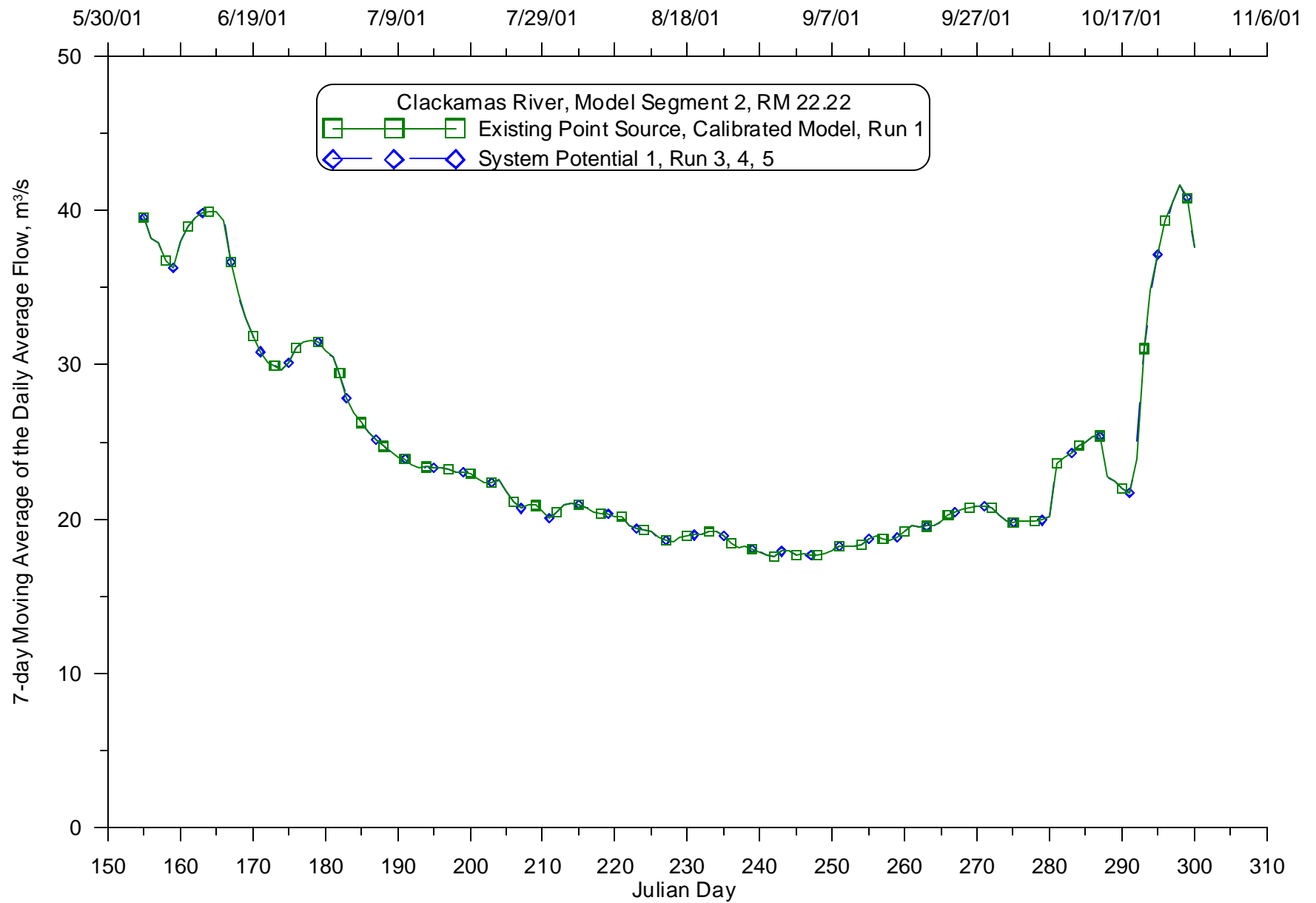
**Figure 99: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 84.69**



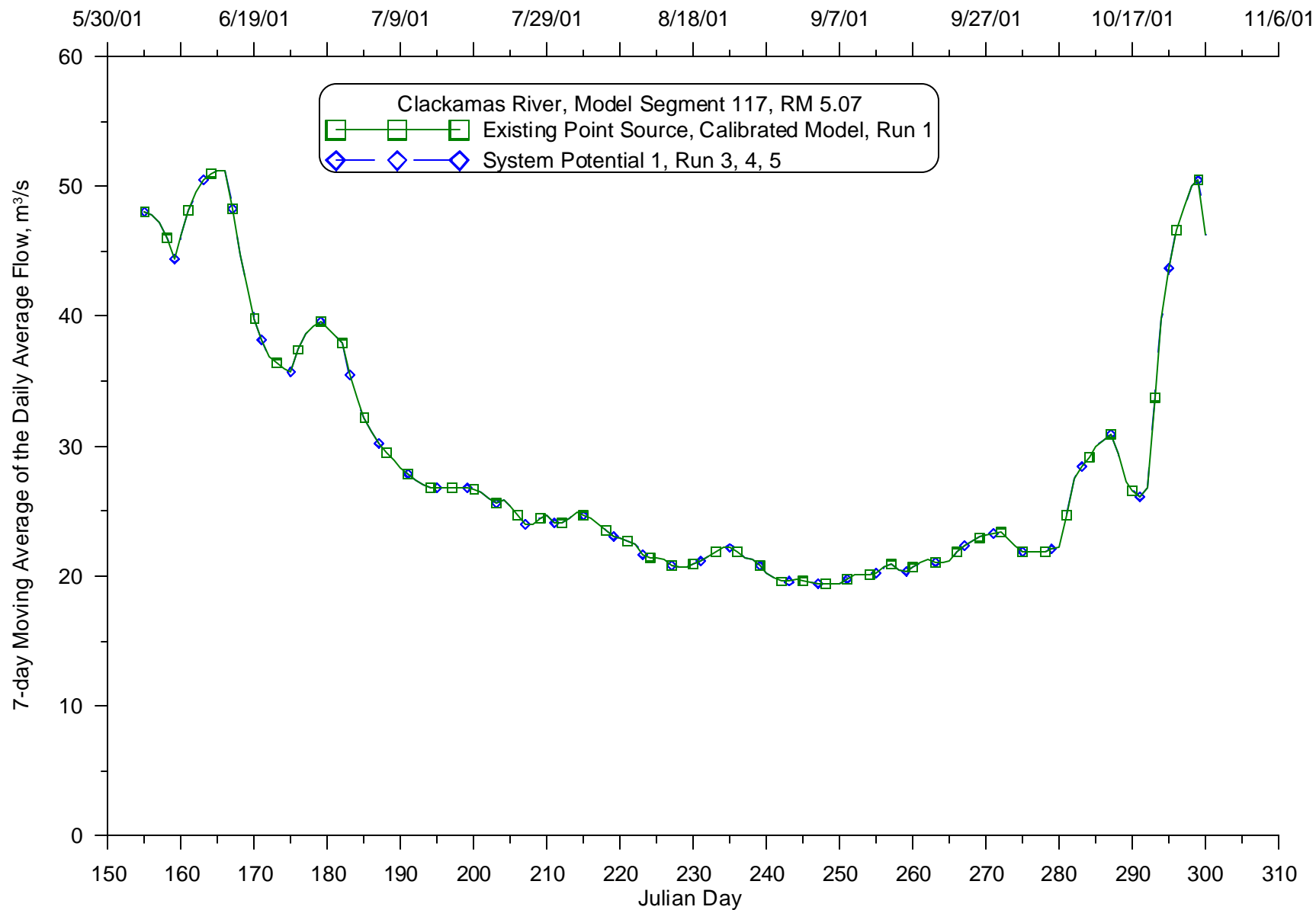
**Figure 100: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 55.09**



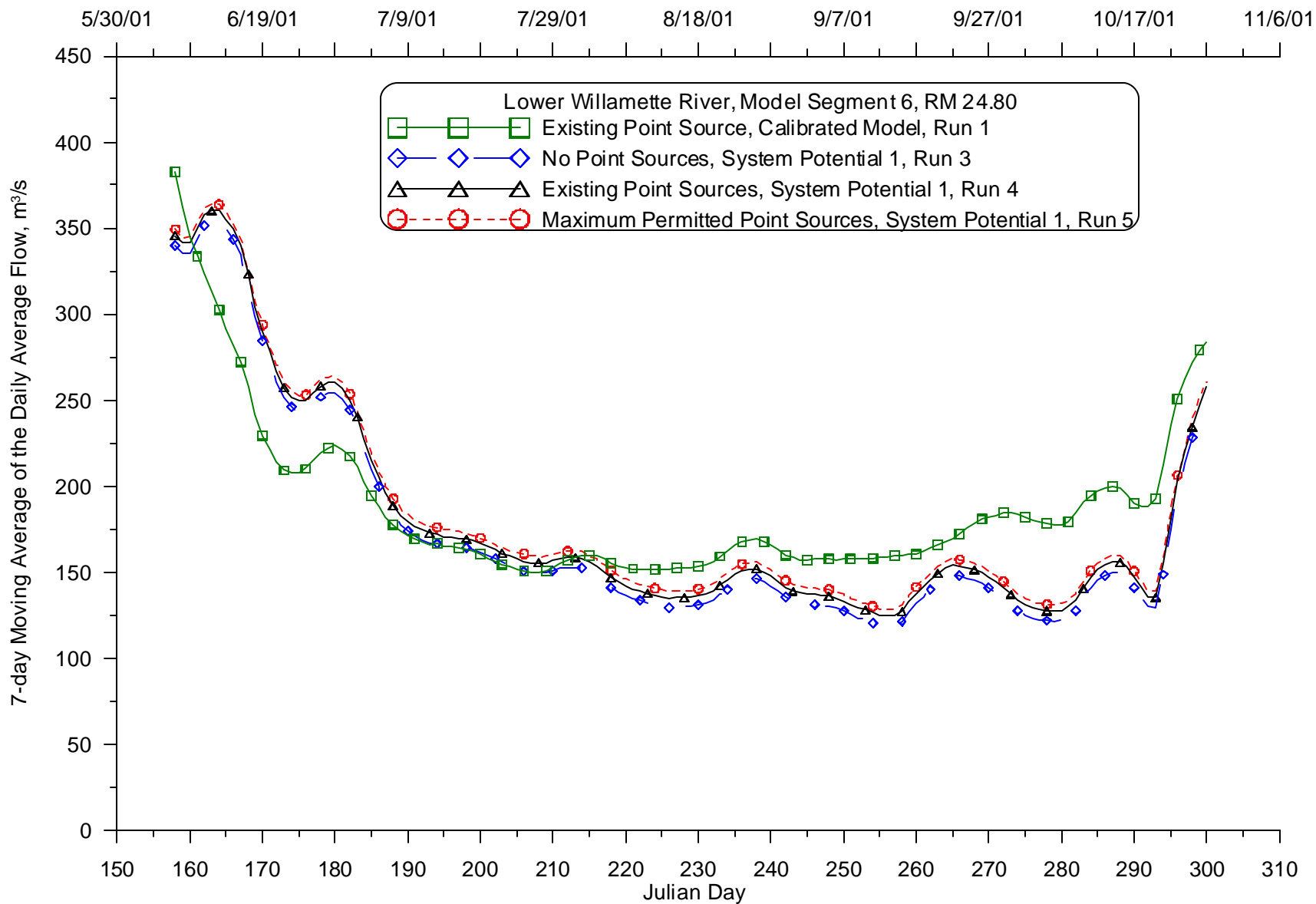
**Figure 101: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 35.72**



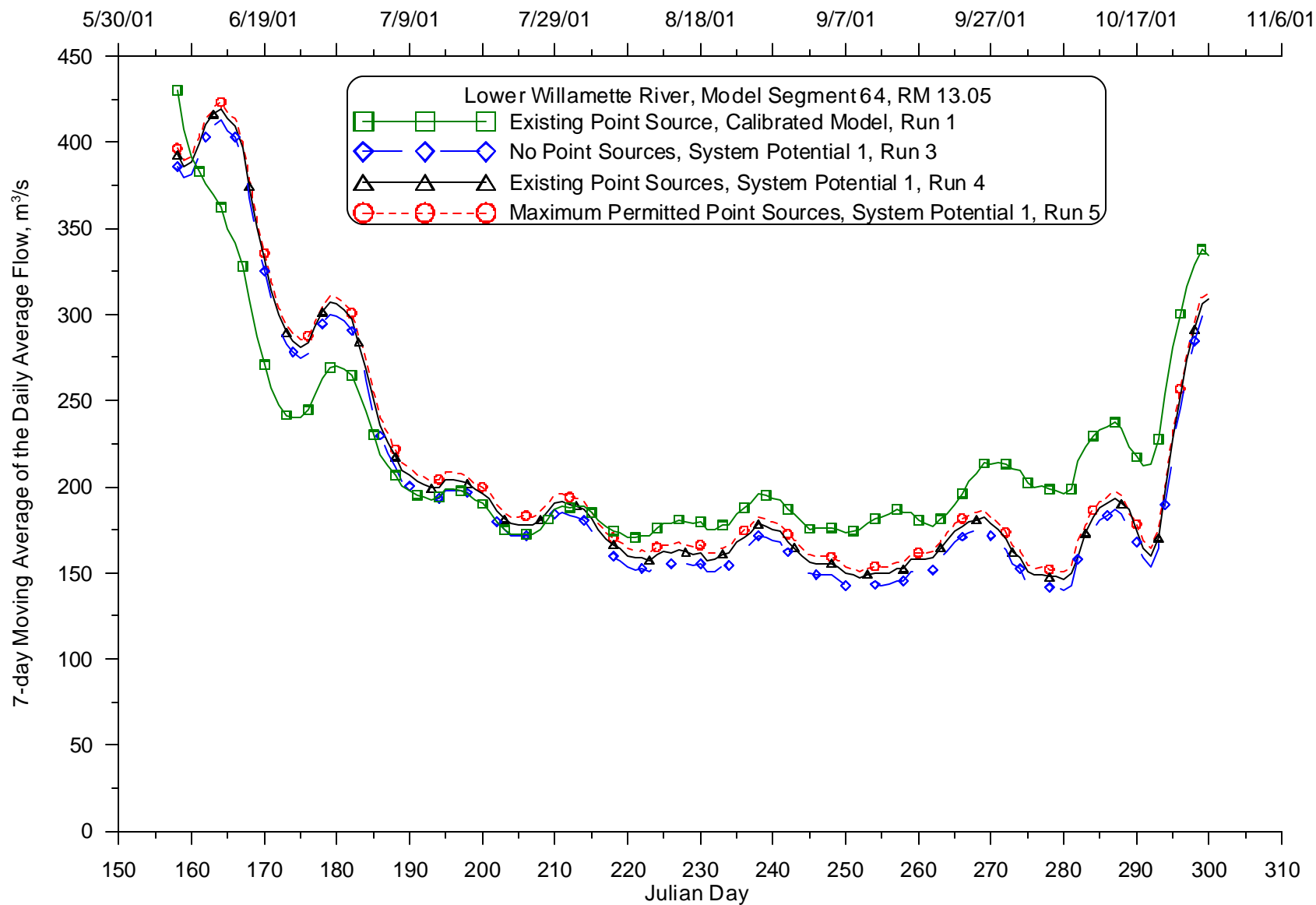
**Figure 102: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Clackamas River at RM 22.22**



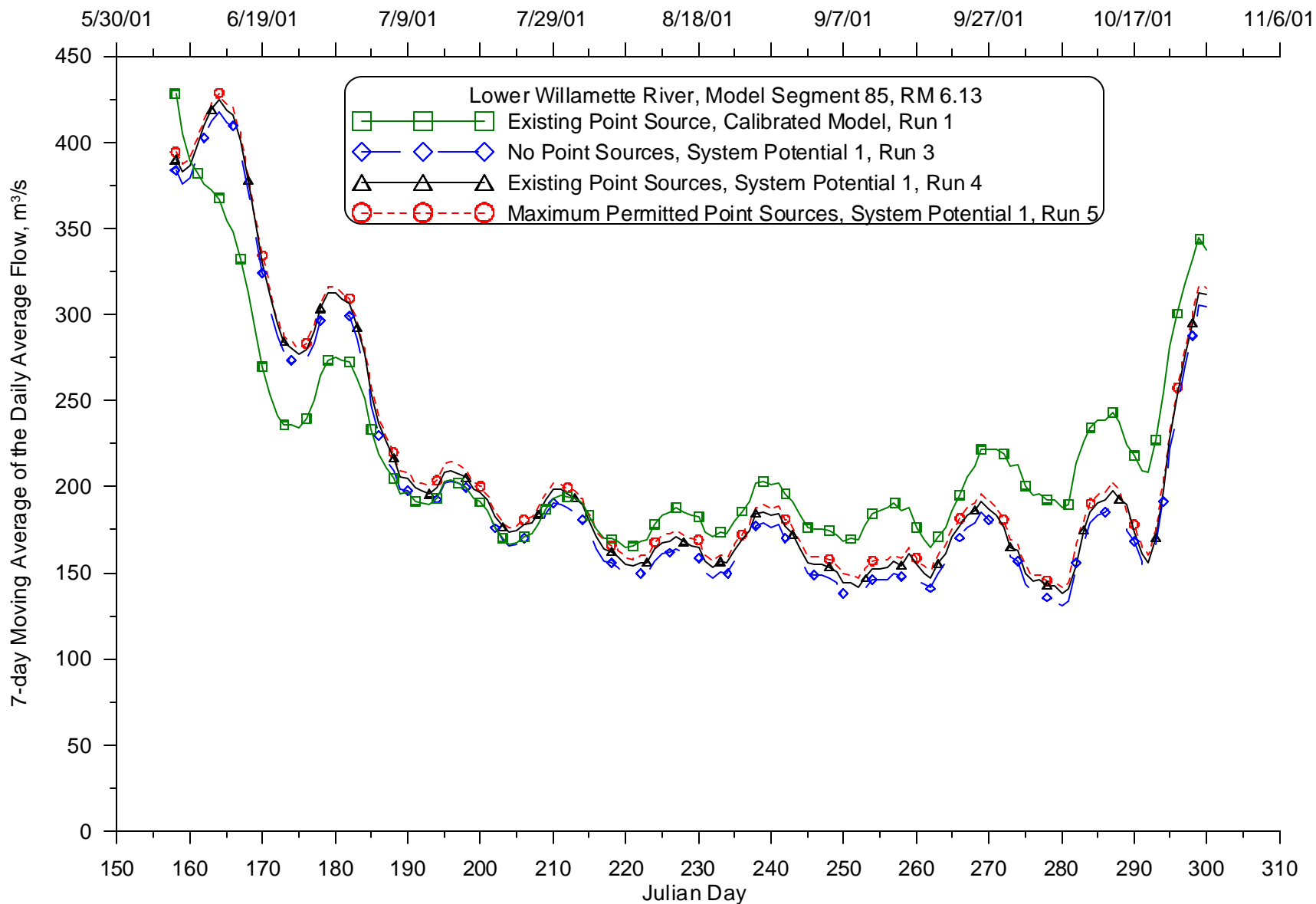
**Figure 103: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Clackamas River at RM 5.07**



**Figure 104: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 24.80**



**Figure 105: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 13.05**



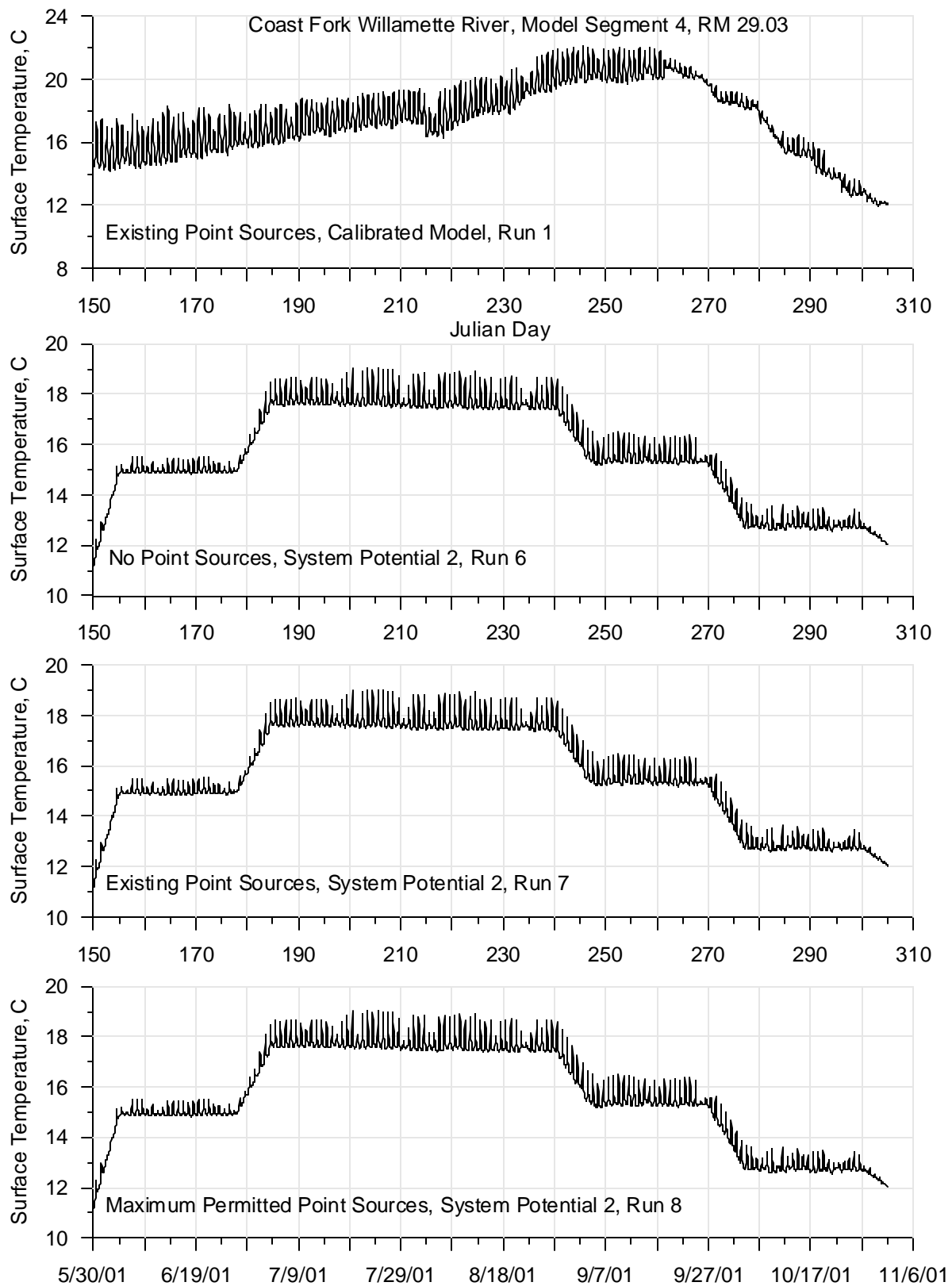
**Figure 106: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 6.13**



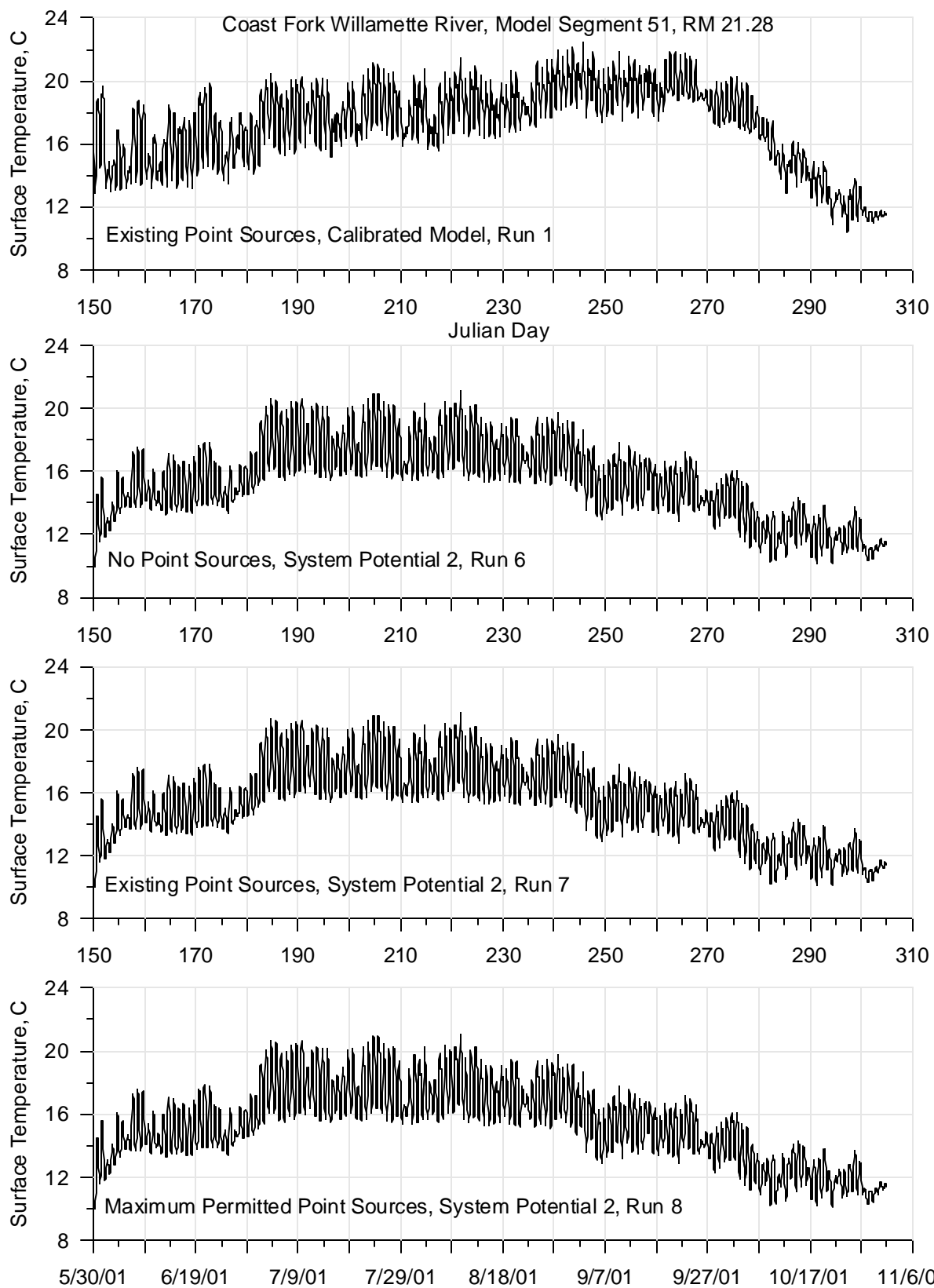
## ***System Potential 2, 2001***

System Potential 2 (ODEQ, 2003) was run for the summer of 2001 for three scenarios with varying discharges from the large point sources in the Willamette River system. The point sources were simulated as having no discharge, their current discharge in 2001, and their maximum permitted discharge. These results were then compared with the results of the calibrated model in a series of time series plots. There are four types of time series output for each of the 21 locations identified above in Table 2: continuous temperature, continuous flow, the seven-day moving average of the daily maximum temperature, and the seven-day average of daily average flow.

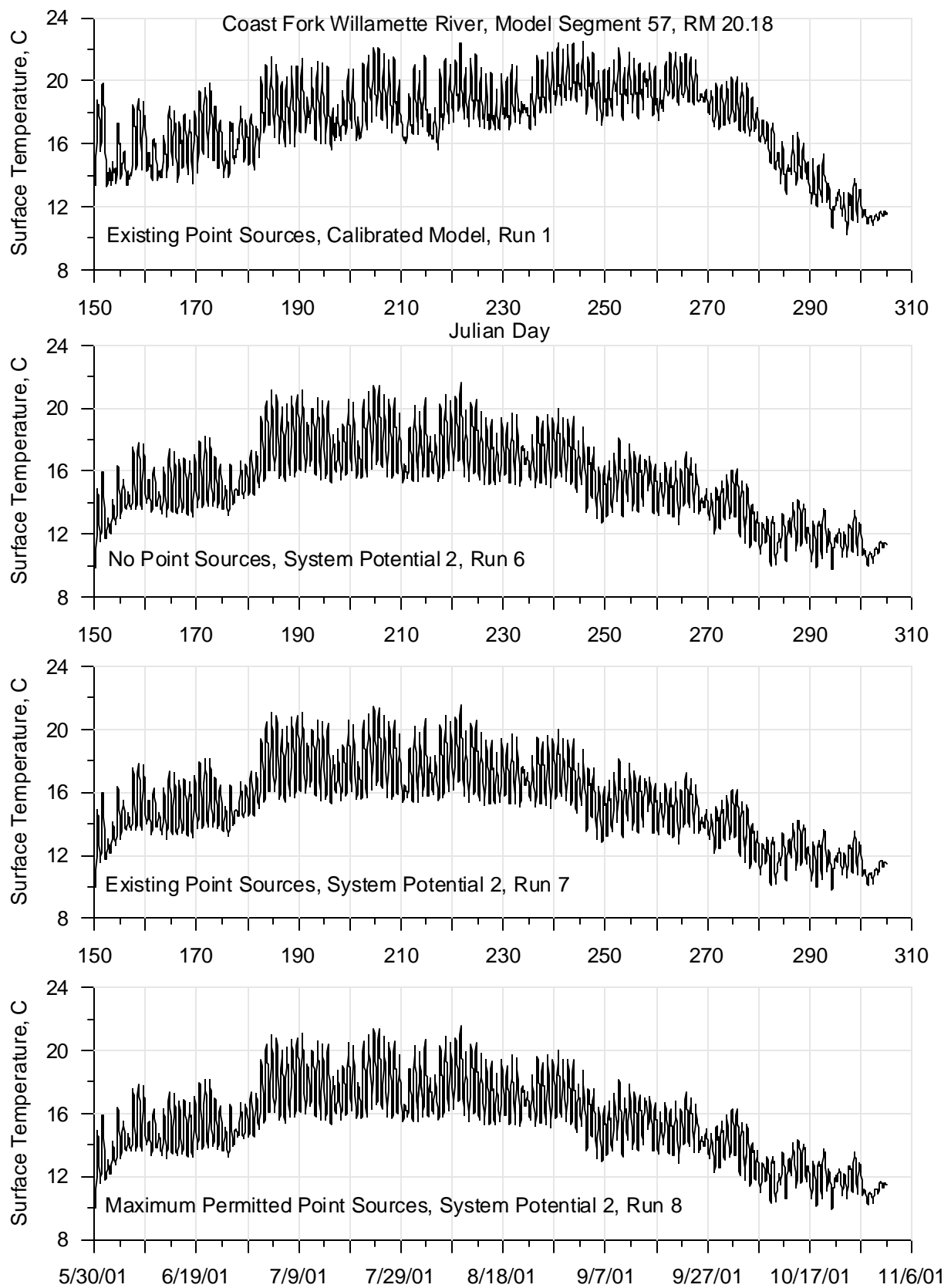
### **Continuous Temperature**



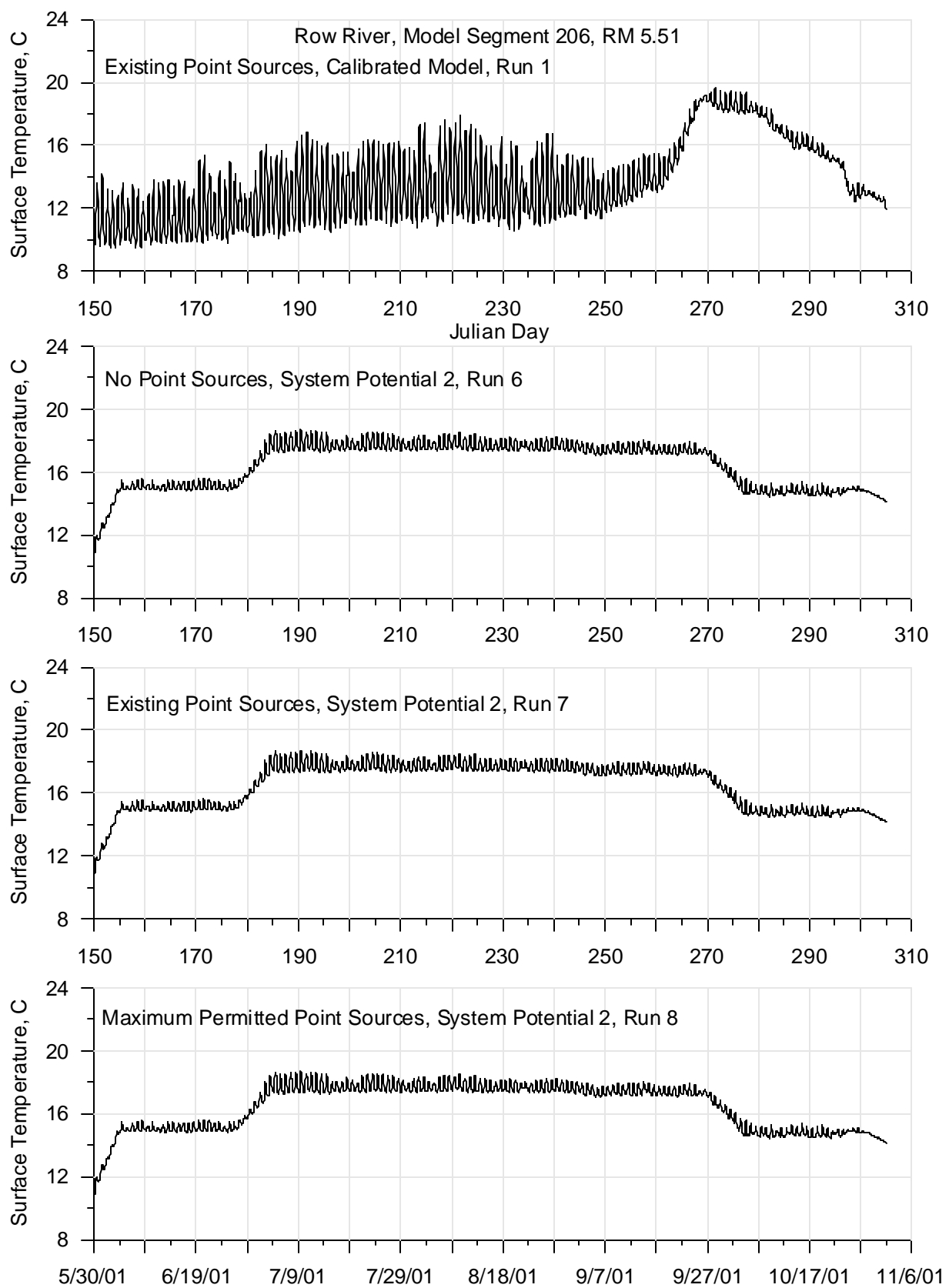
**Figure 107: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Coast Fork Willamette River at RM 29.03**



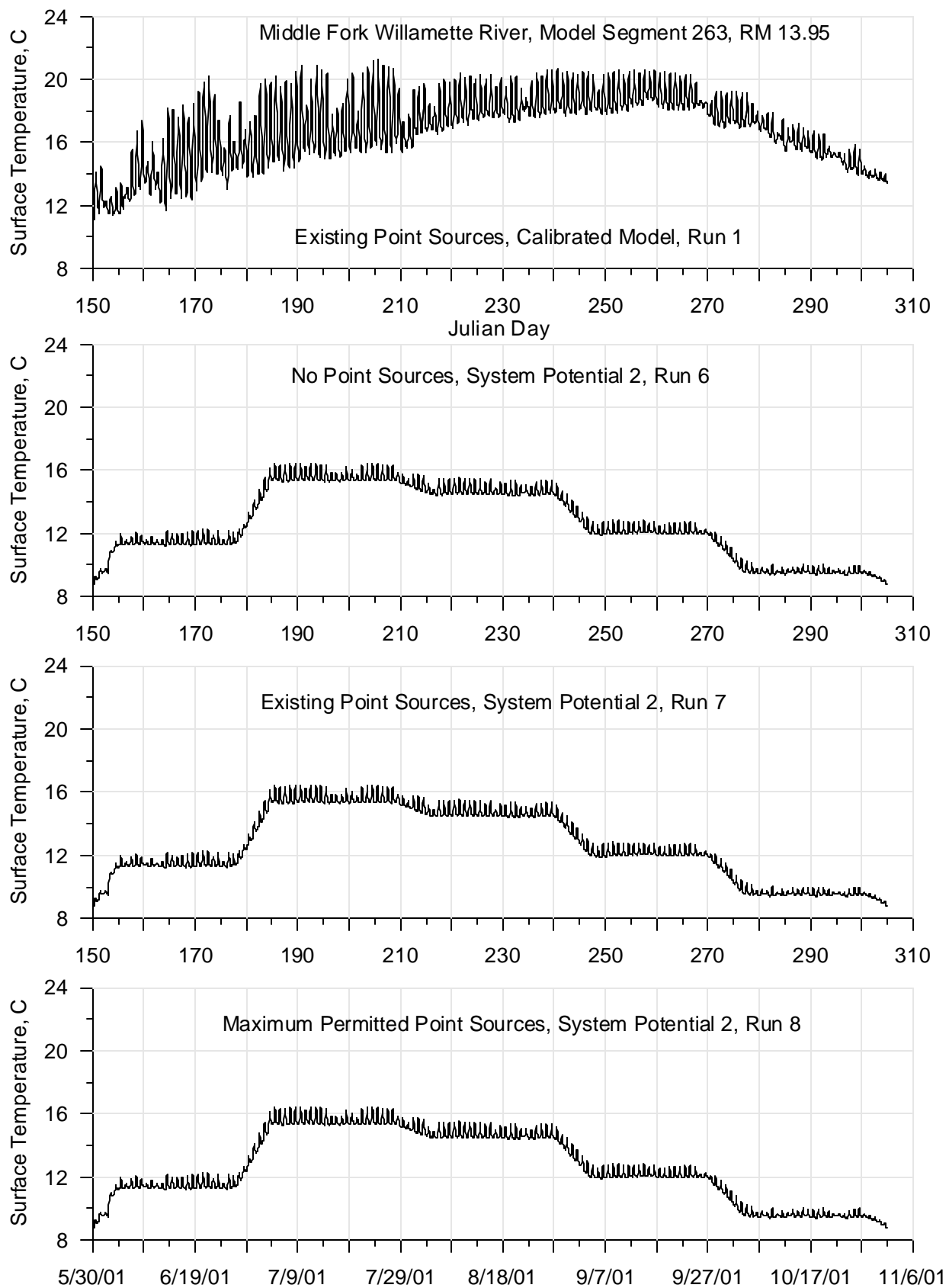
**Figure 108: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Coast Fork Willamette River at RM 21.28**



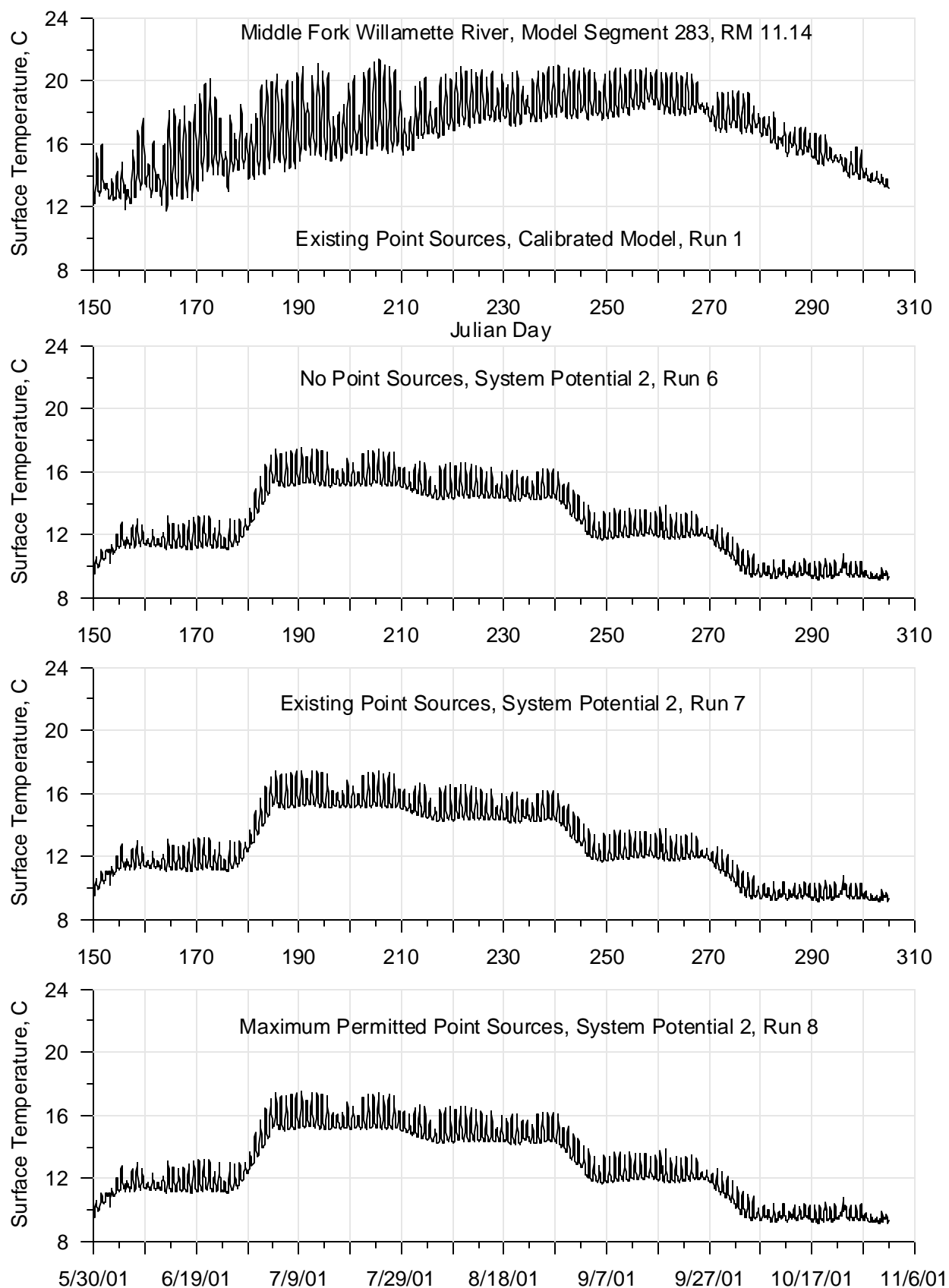
**Figure 109: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Coast Fork Willamette River at RM 20.18**



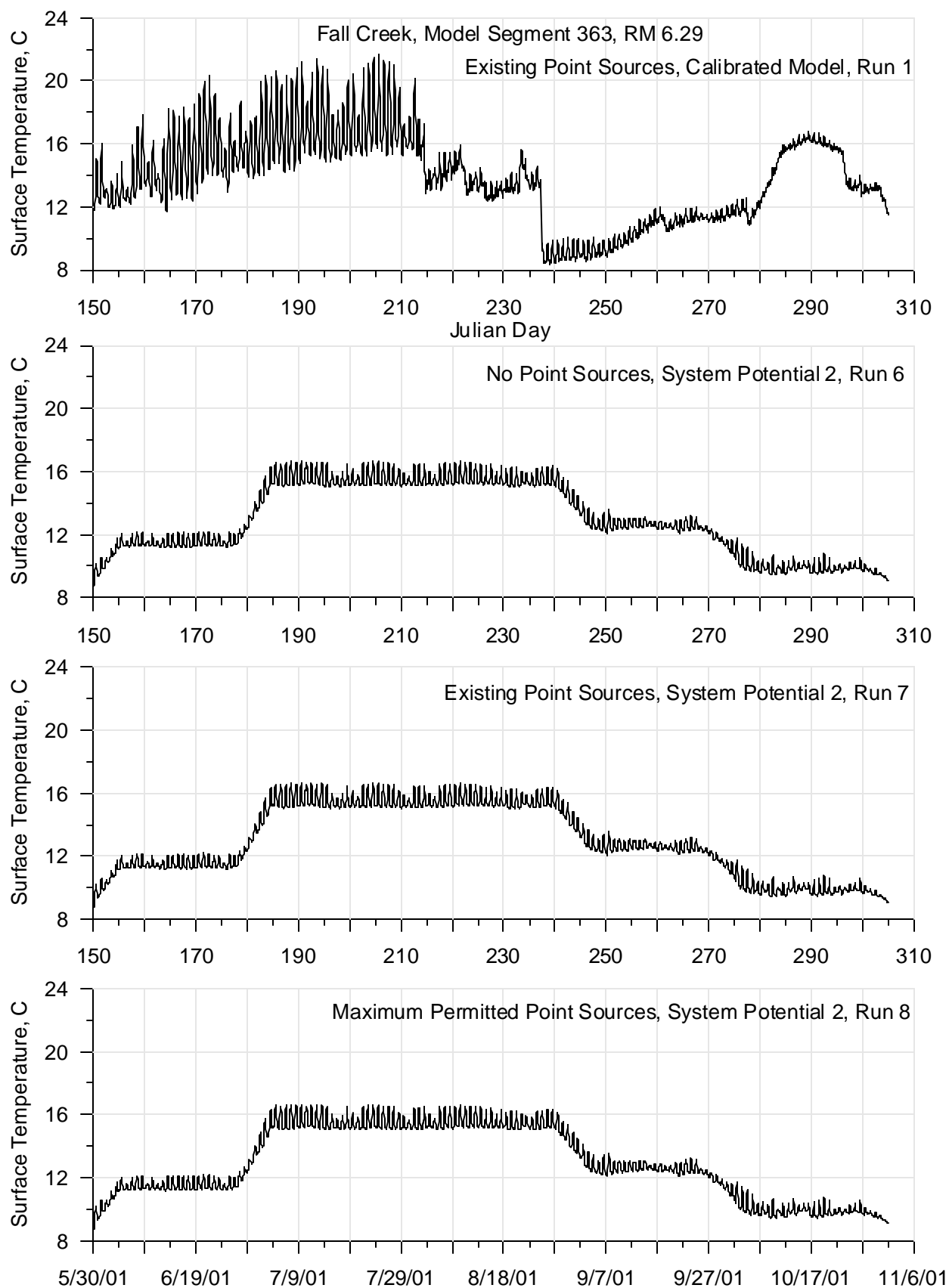
**Figure 110: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Row River at RM 5.51**



**Figure 111: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Middle Fork Willamette River at RM 13.95**

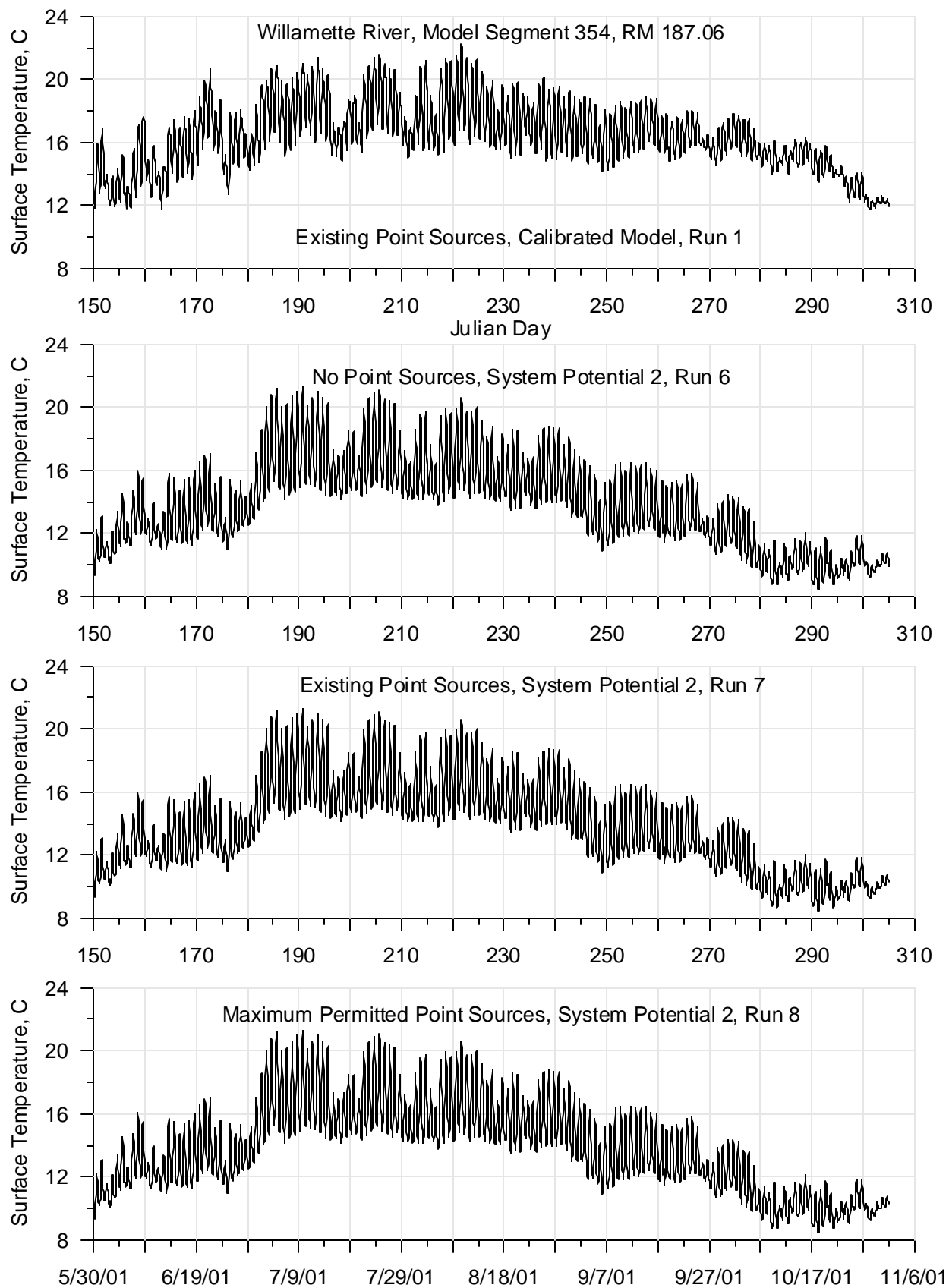


**Figure 112: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Middle Fork Willamette River at RM 11.14**

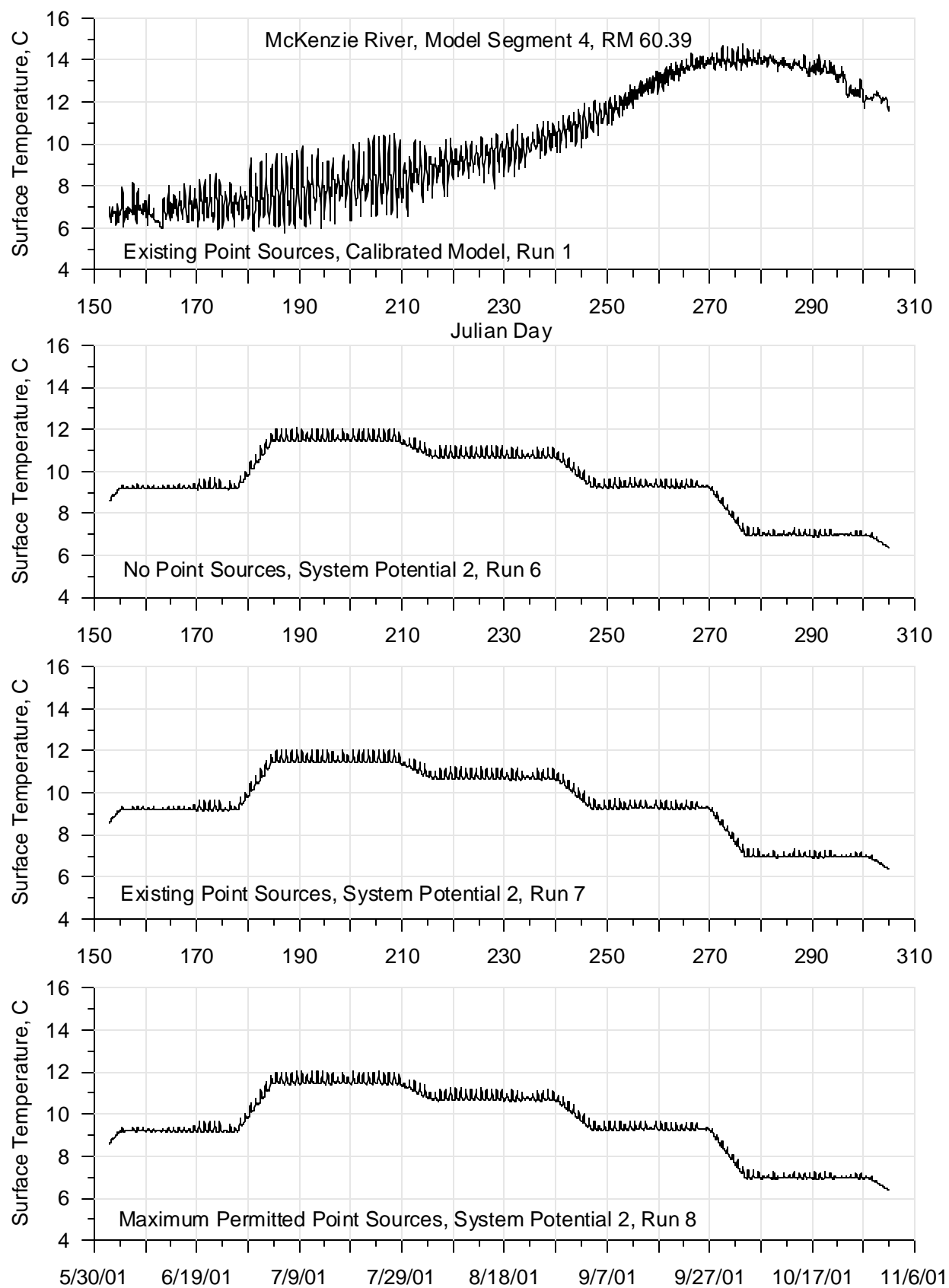


**Figure 113: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Fall Creek at RM 6.29**

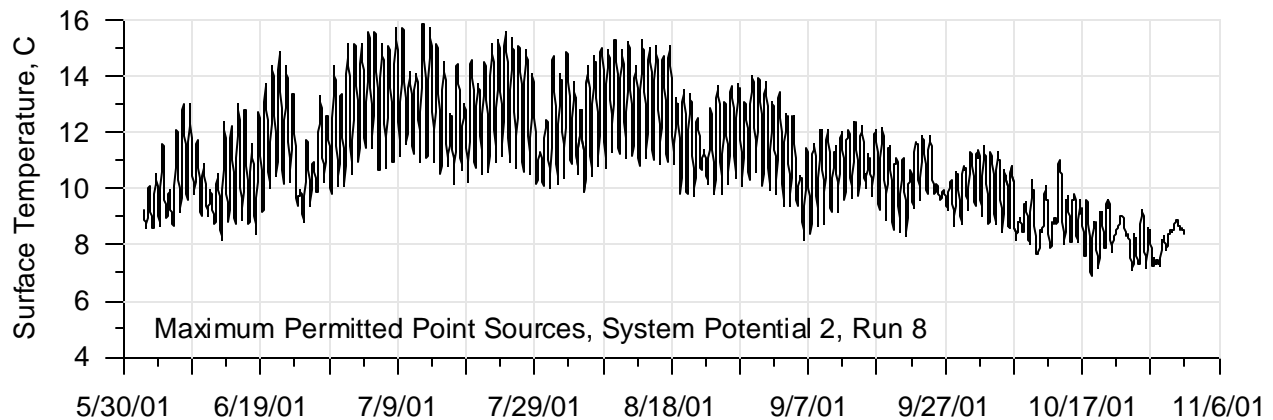
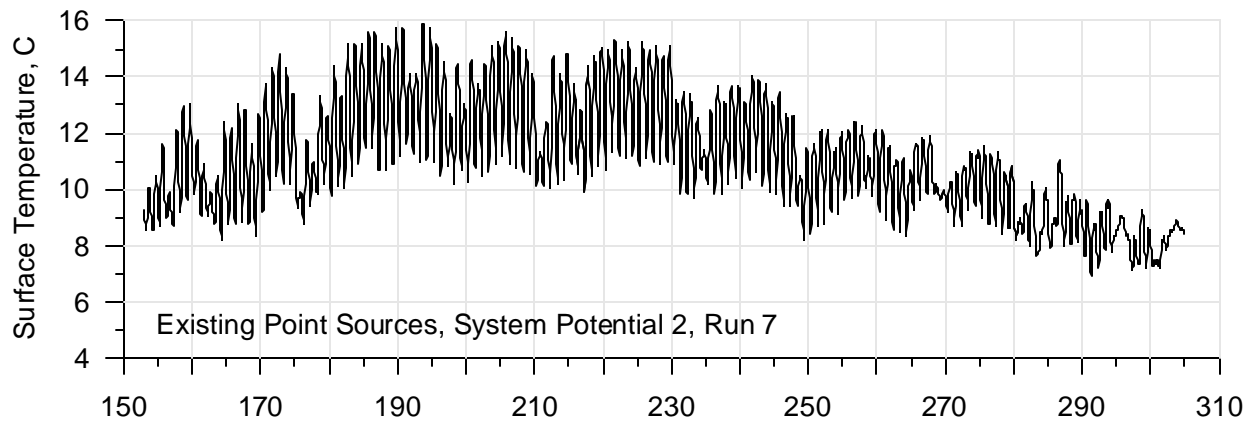
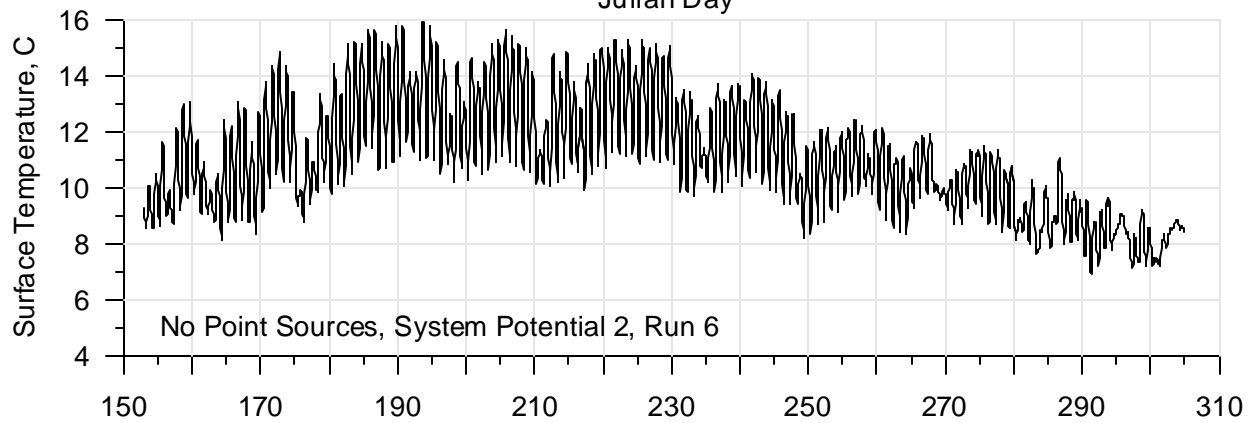
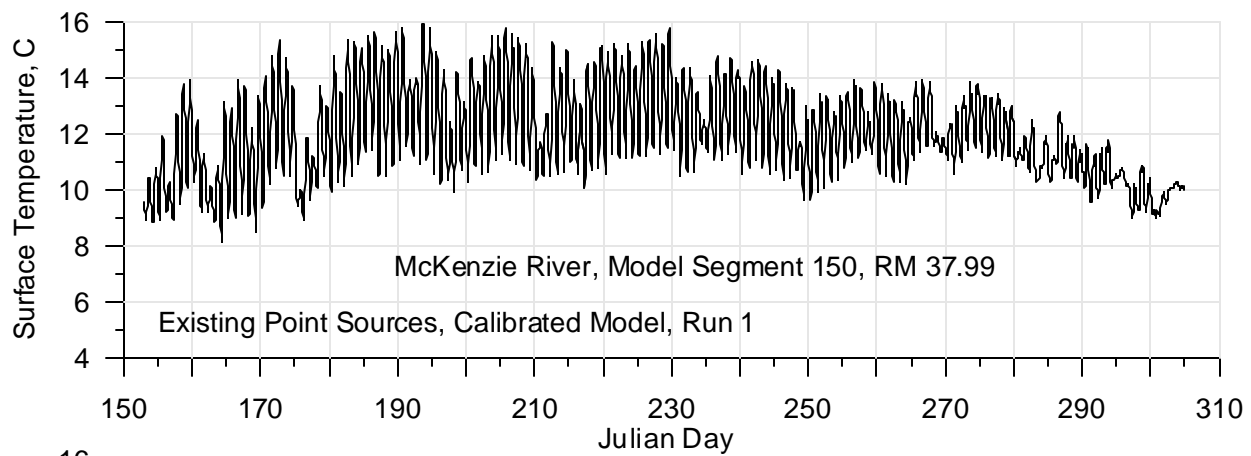




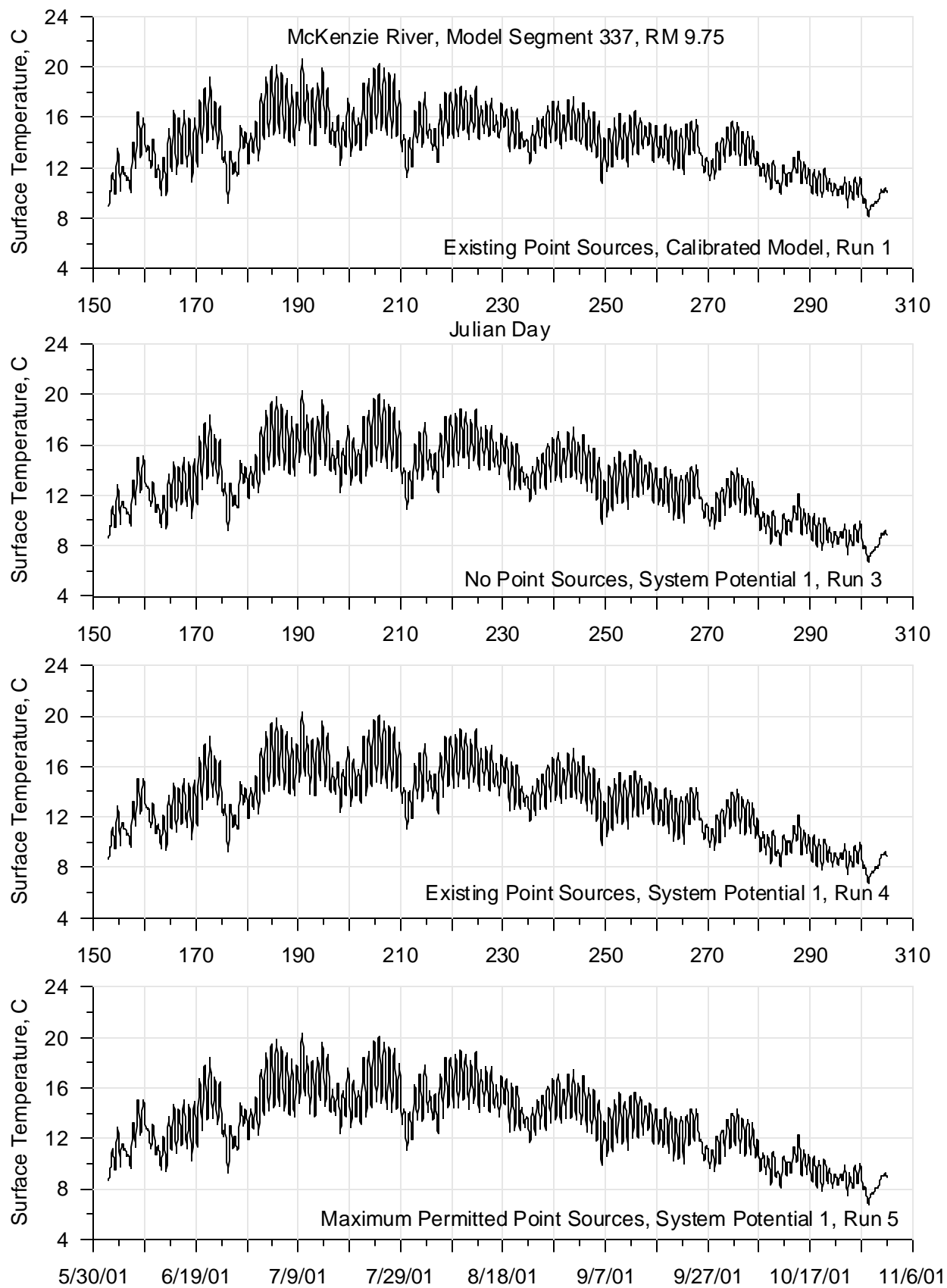
**Figure 114: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 187.06**



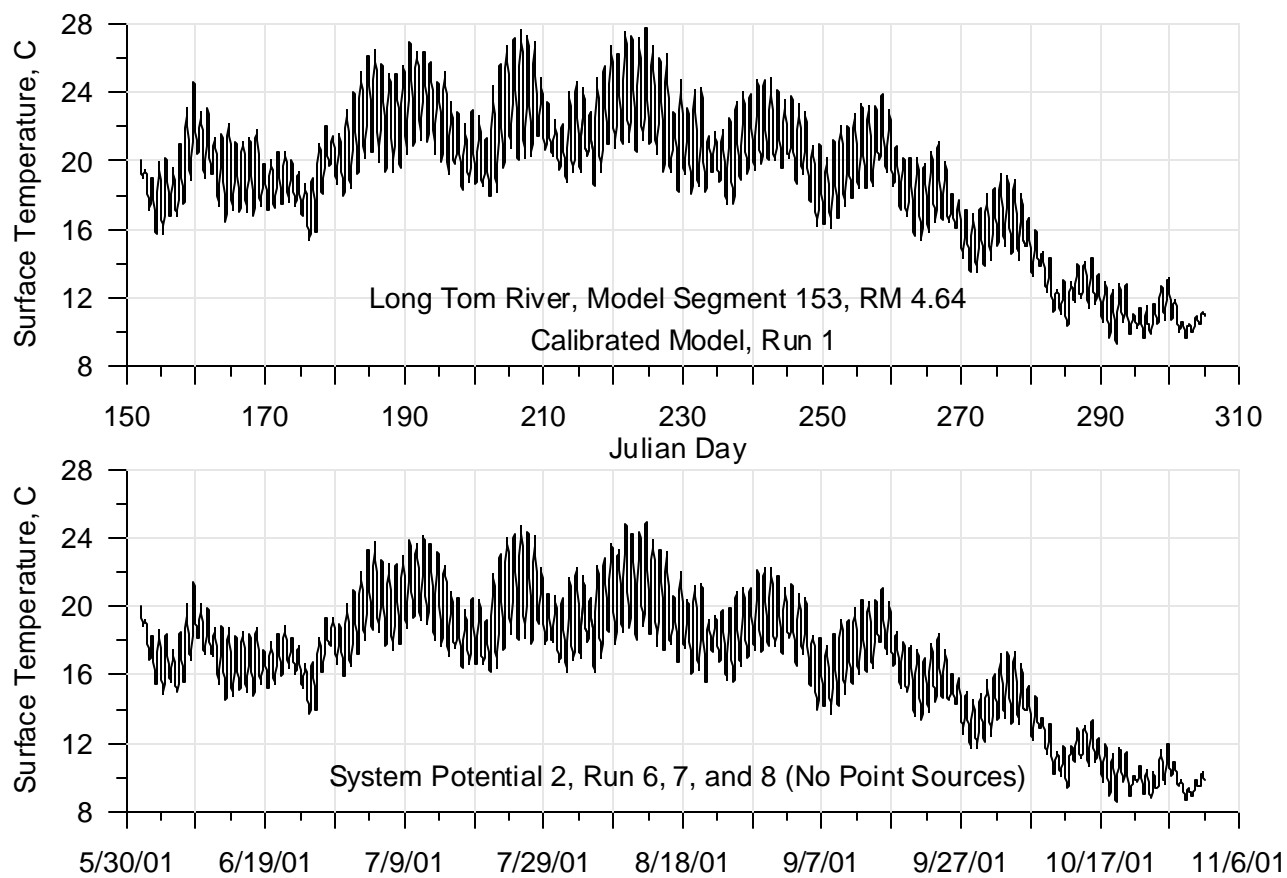
**Figure 115: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the McKenzie River at RM 60.39**



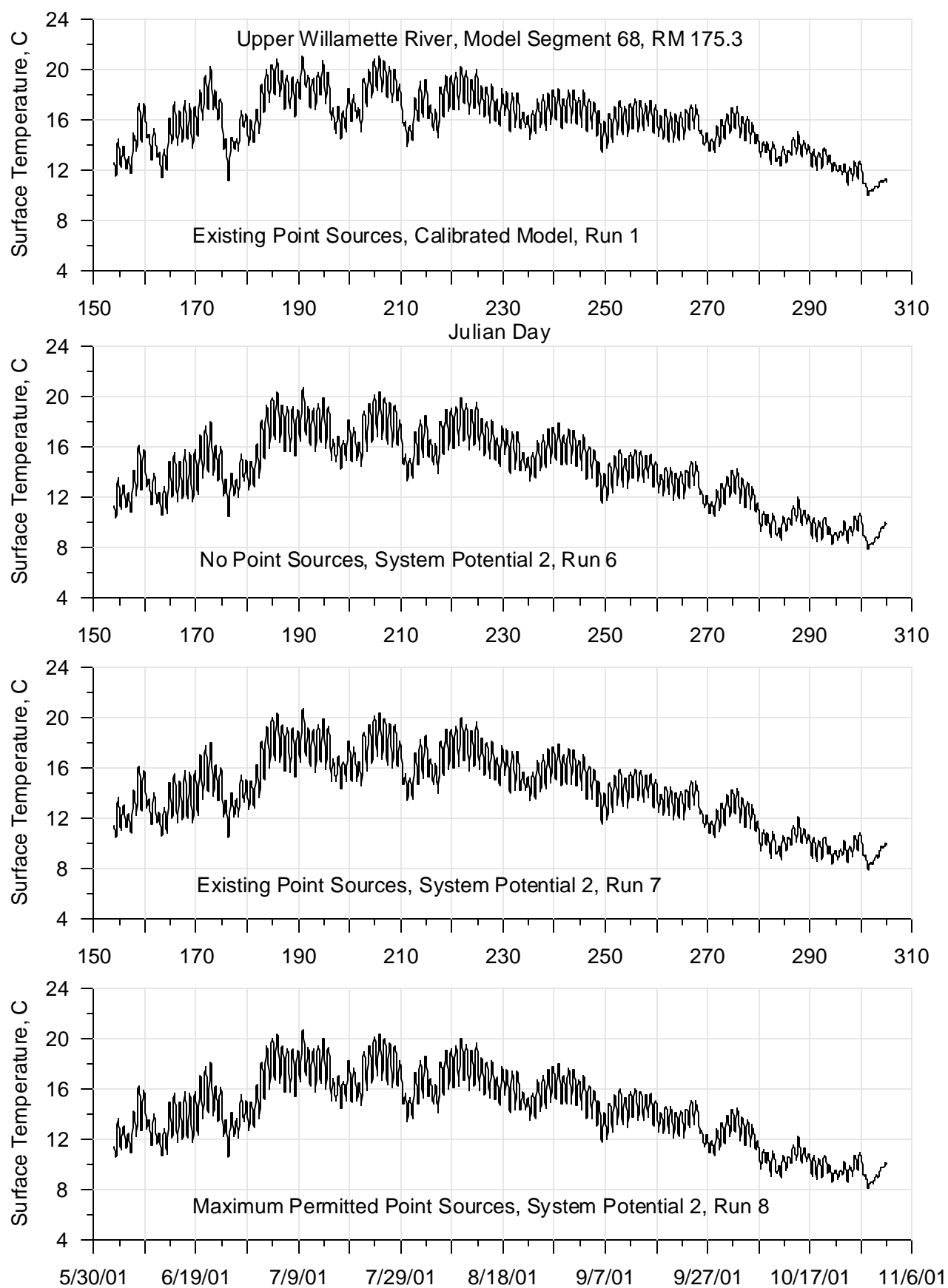
**Figure 116: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the McKenzie River at RM 37.99**



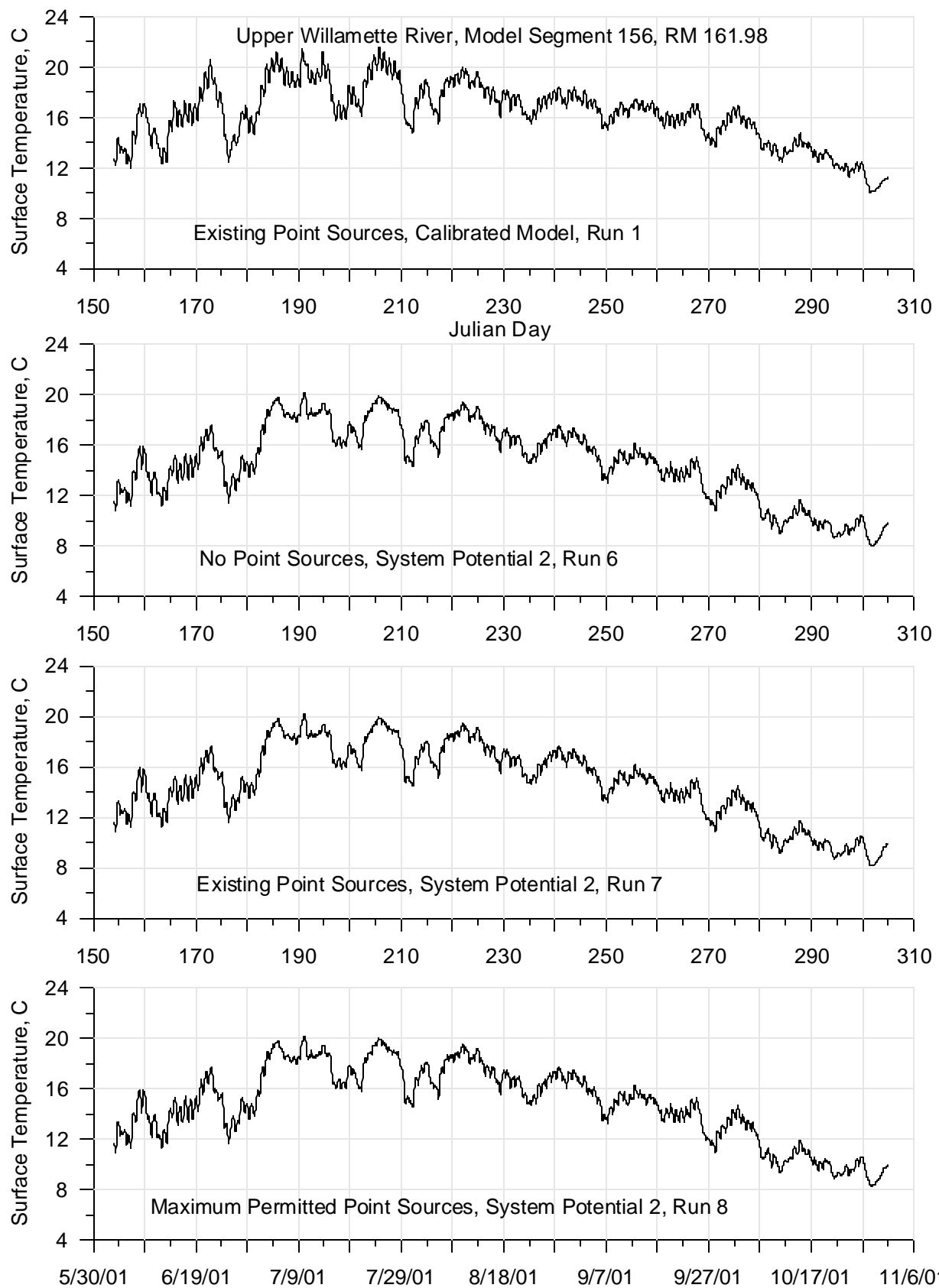
**Figure 117: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the McKenzie River at RM 9.75**



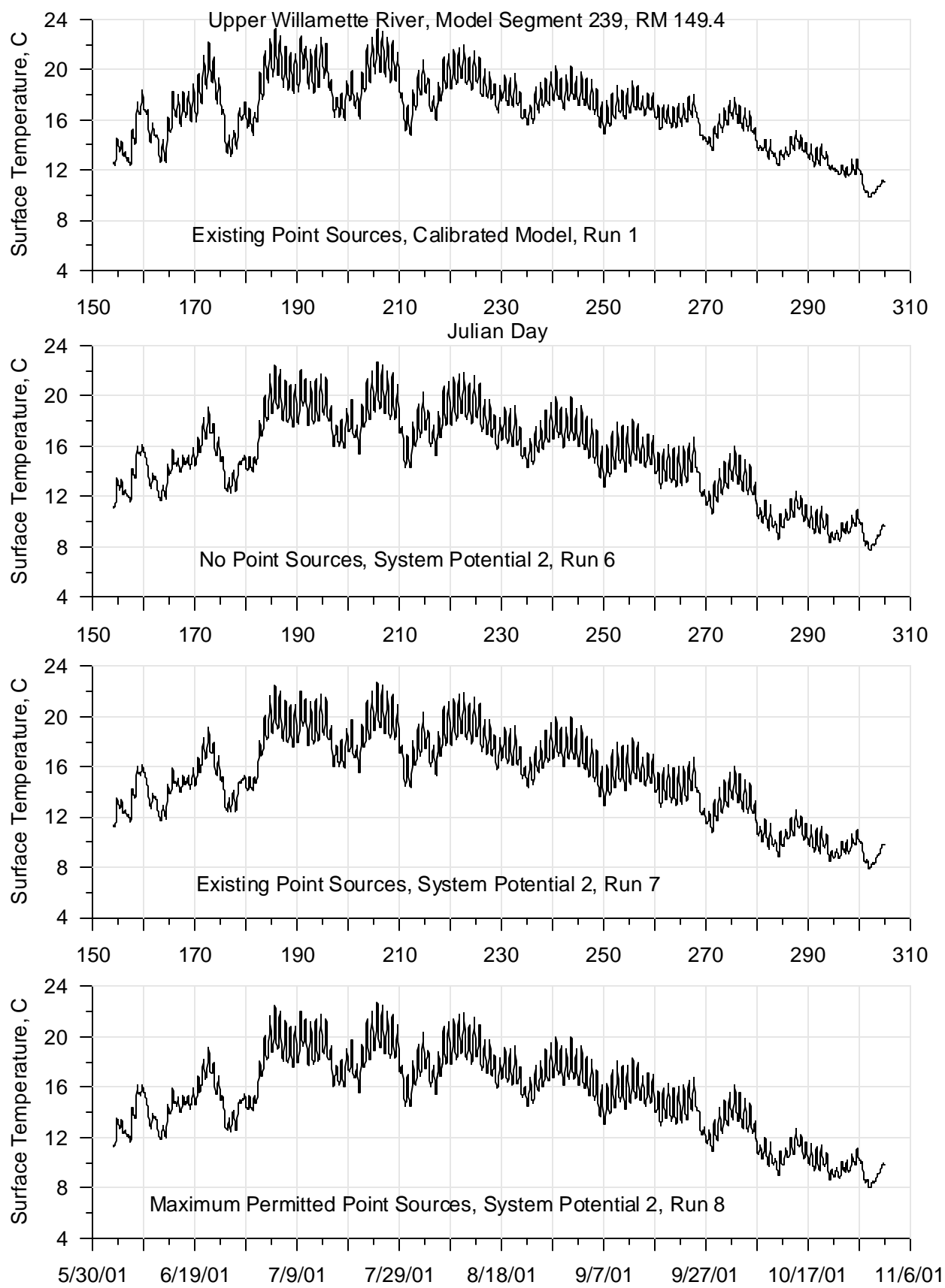
**Figure 118: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Long Tom River at RM 4.64**



**Figure 119: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 175.3**

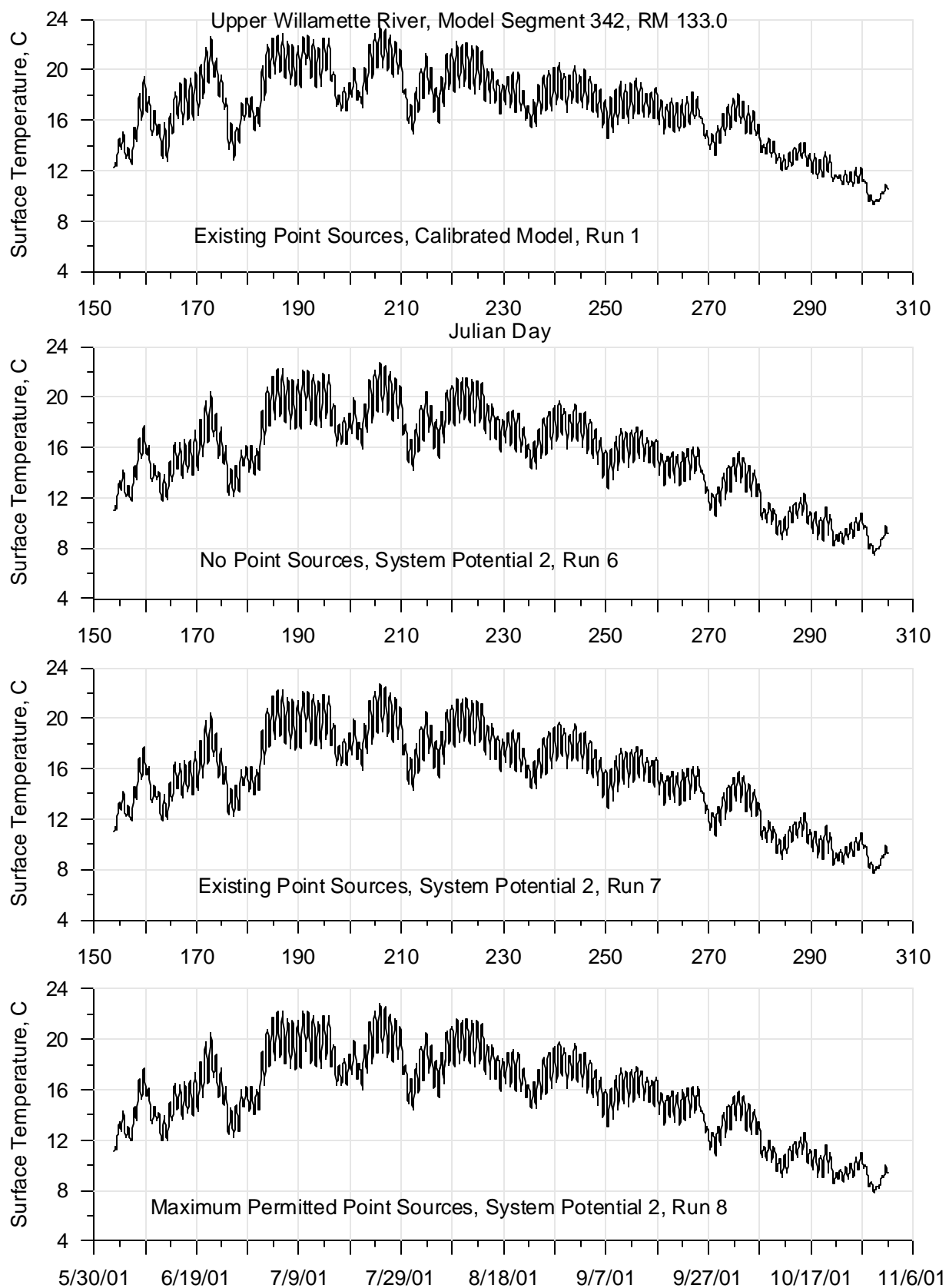


**Figure 120: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 161.98**

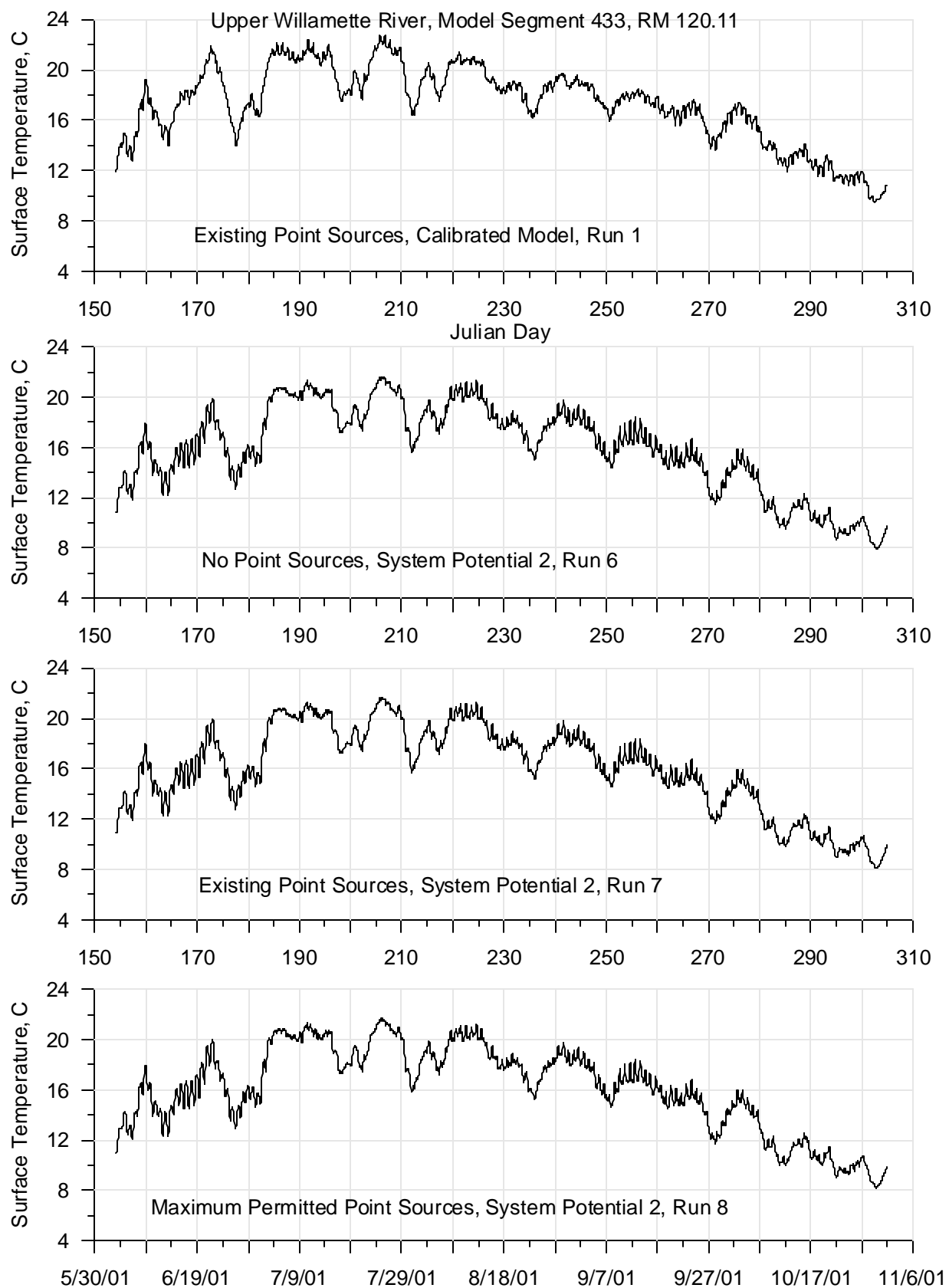


**Figure 121: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 149.4**

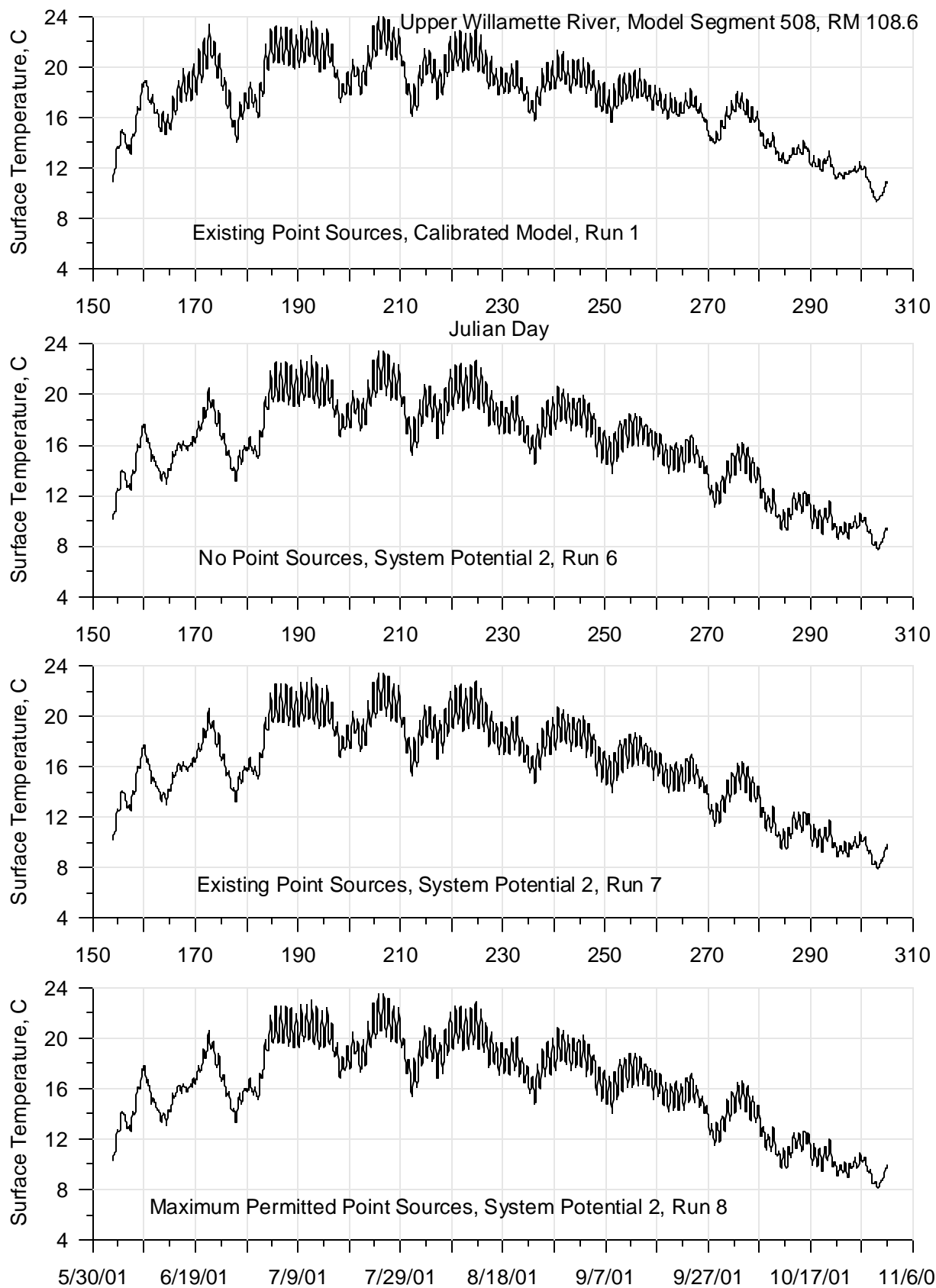




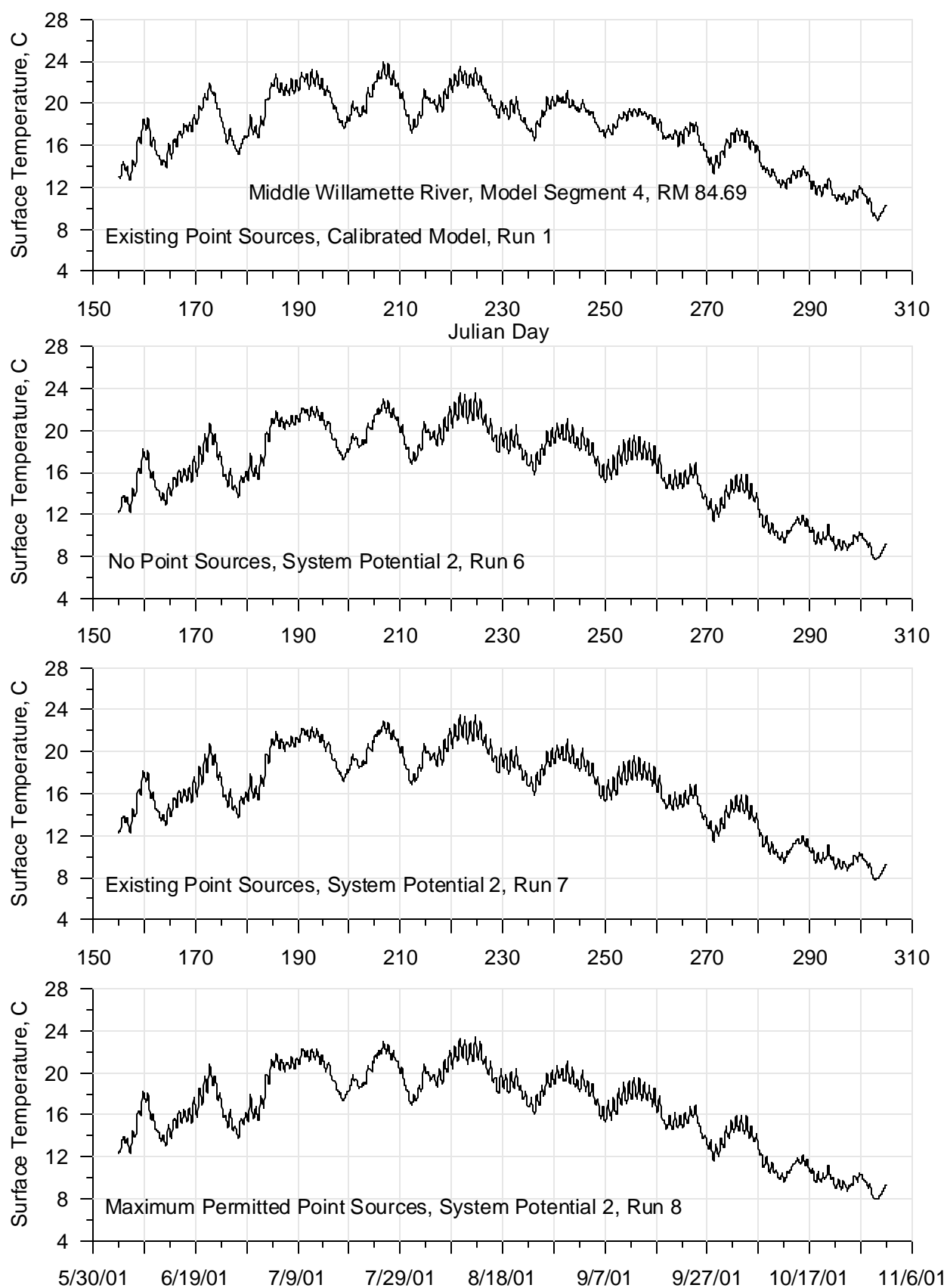
**Figure 122: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 133**



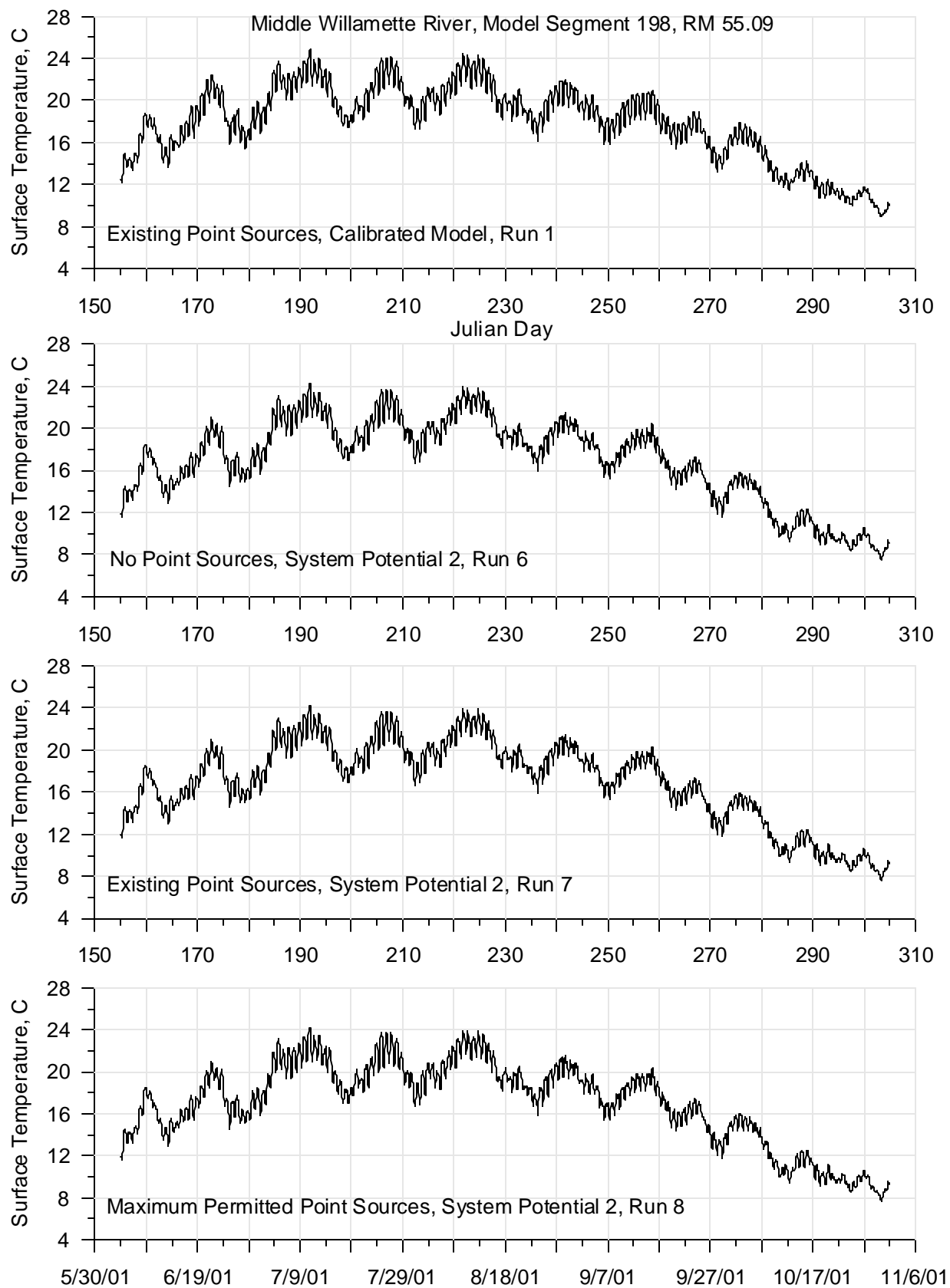
**Figure 123: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 120.11**



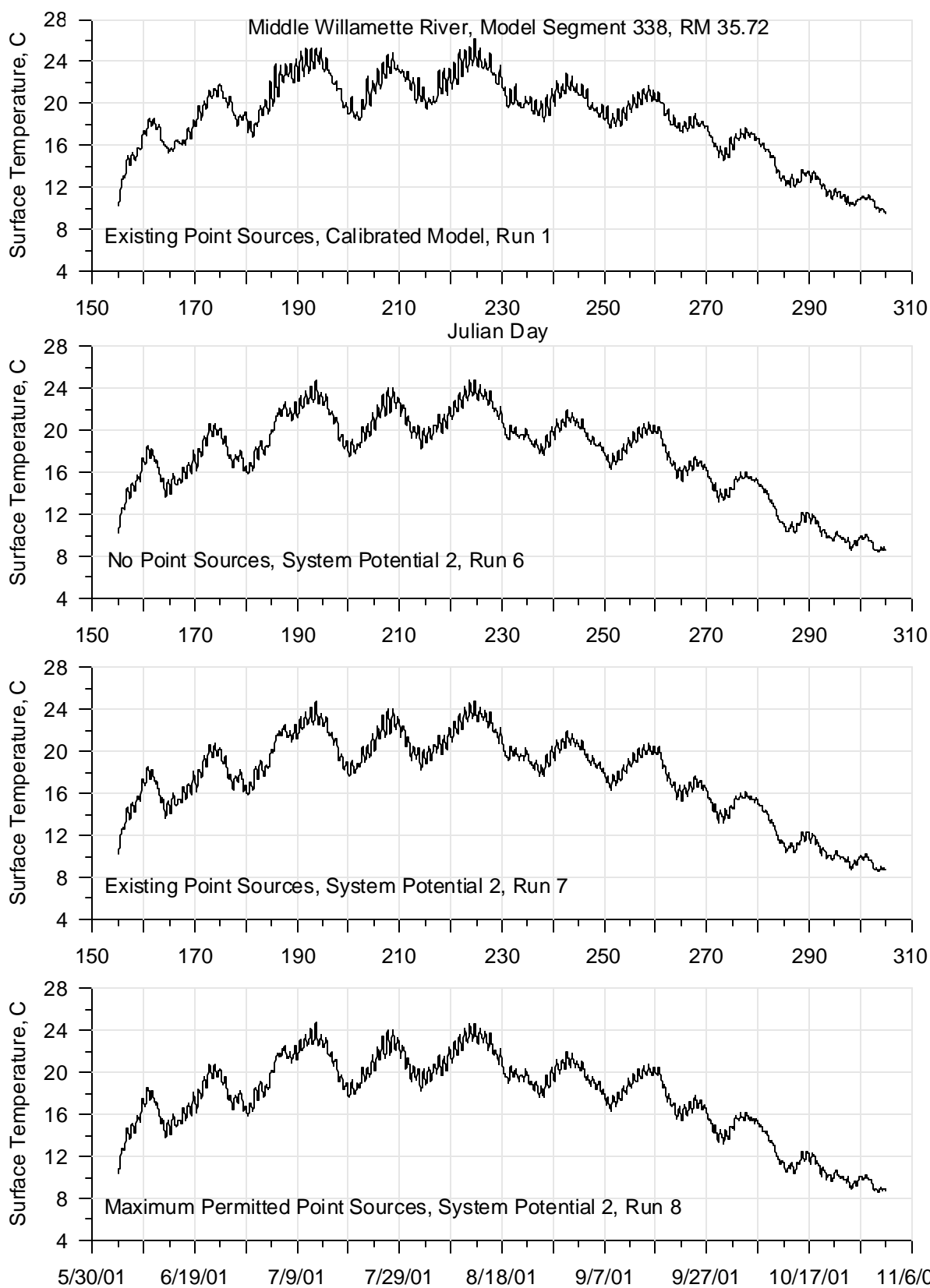
**Figure 124: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 108.6**



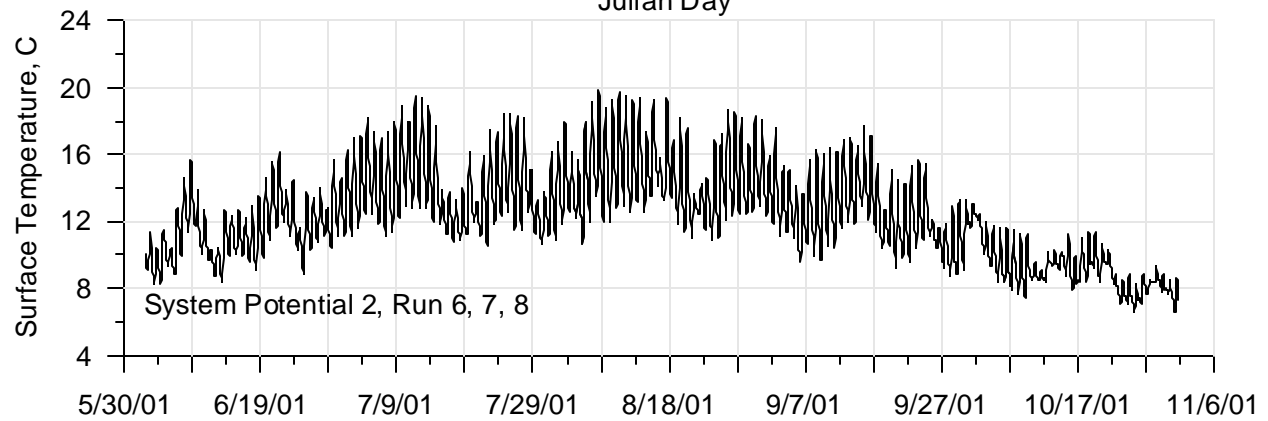
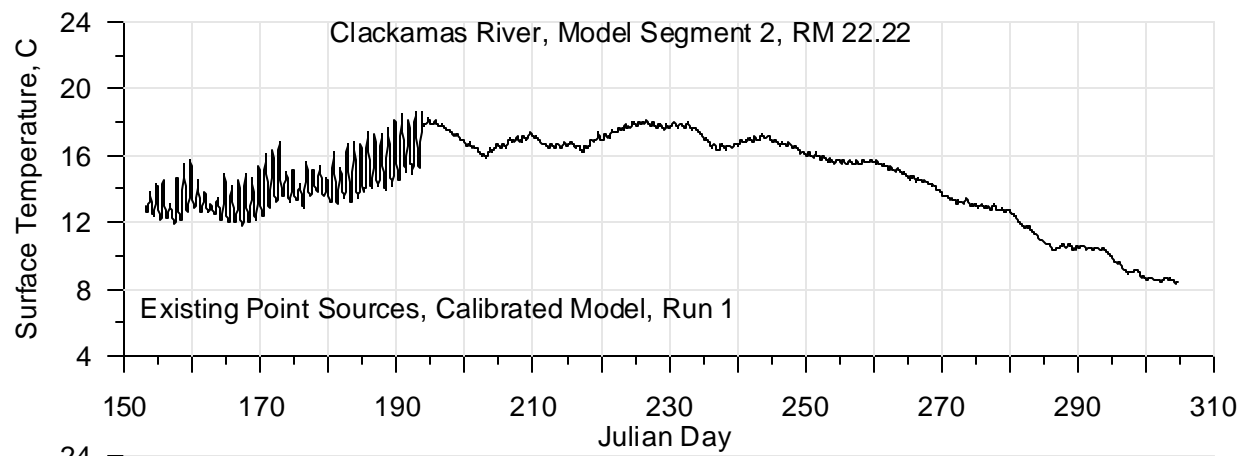
**Figure 125: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 84.69**



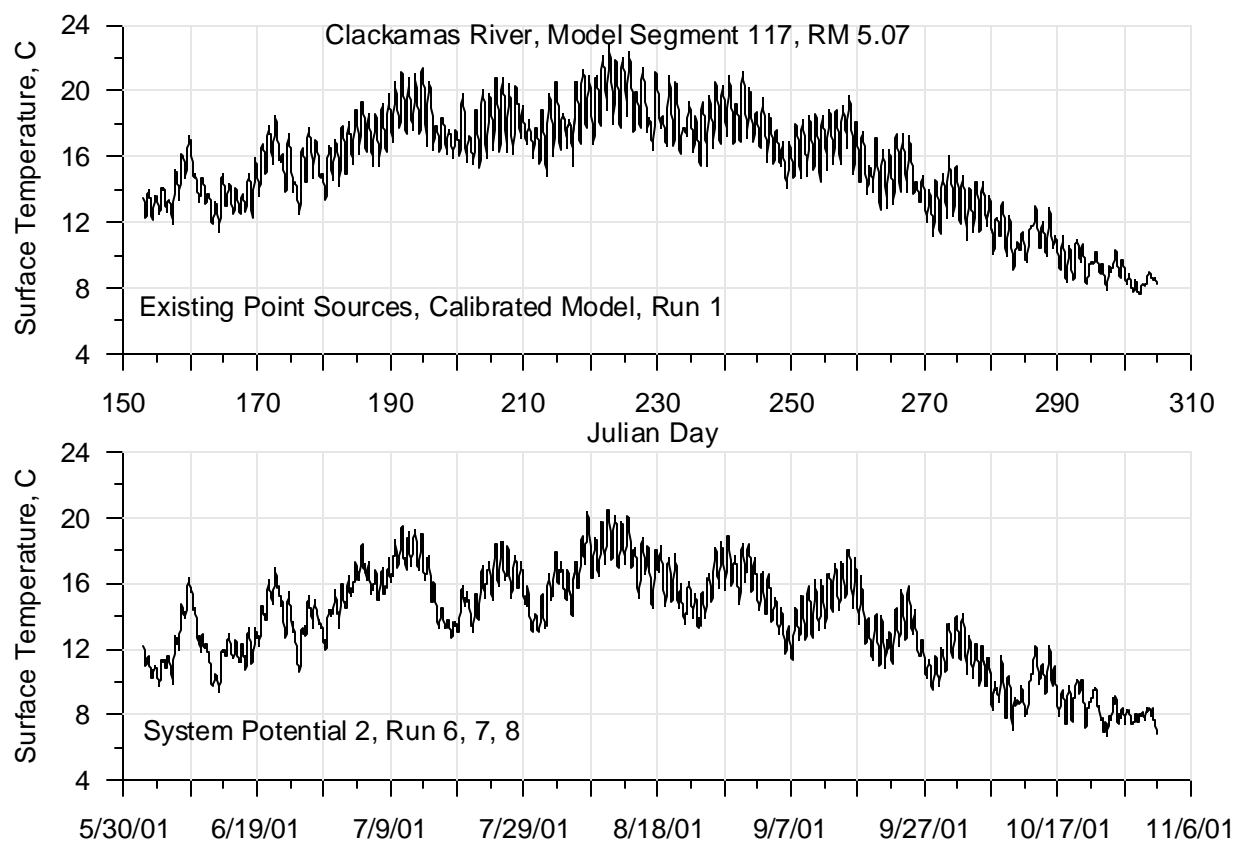
**Figure 126: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 55.09**



**Figure 127: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 35.72**

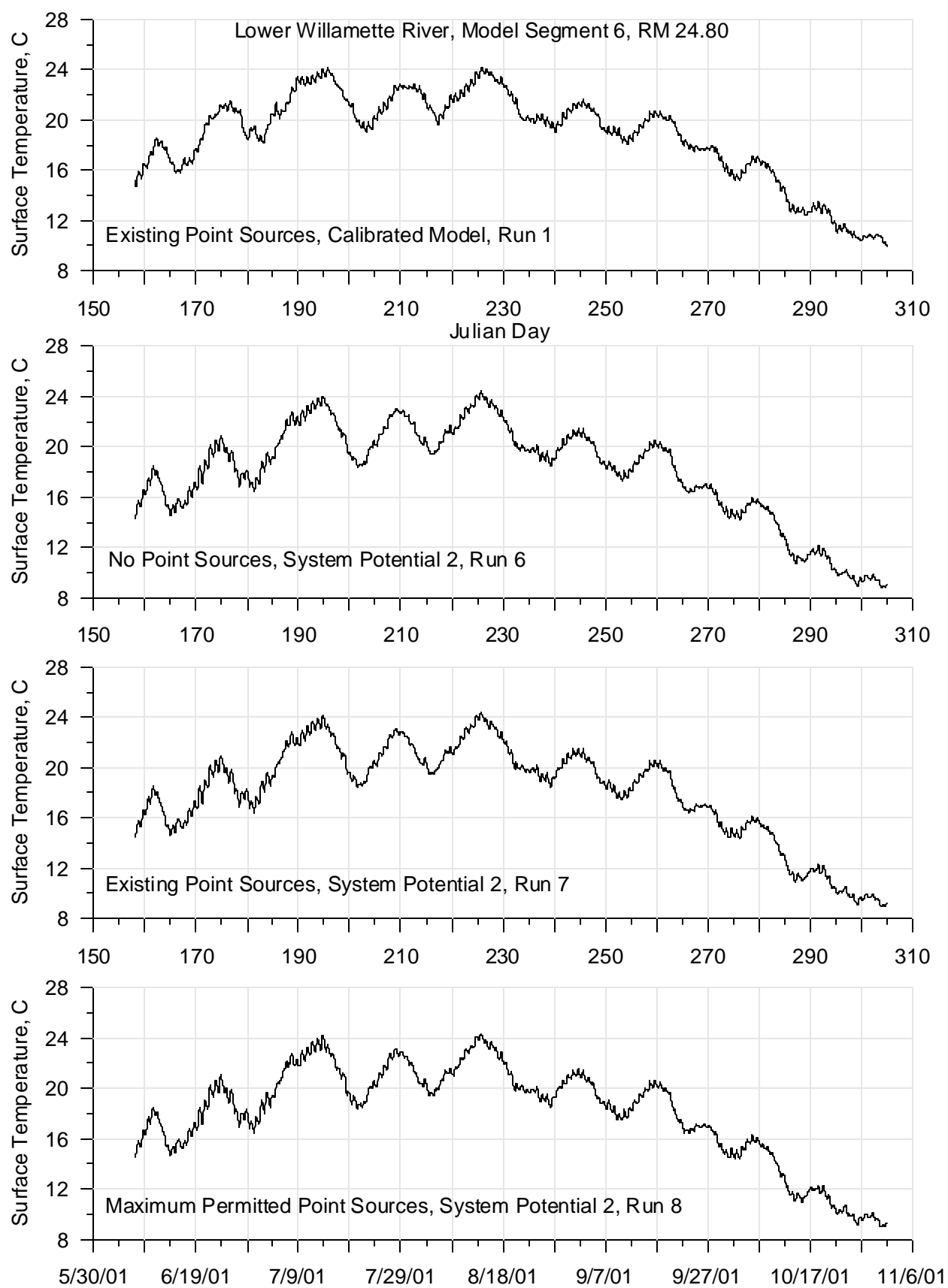


**Figure 128: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Clackamas River at RM 22.22**

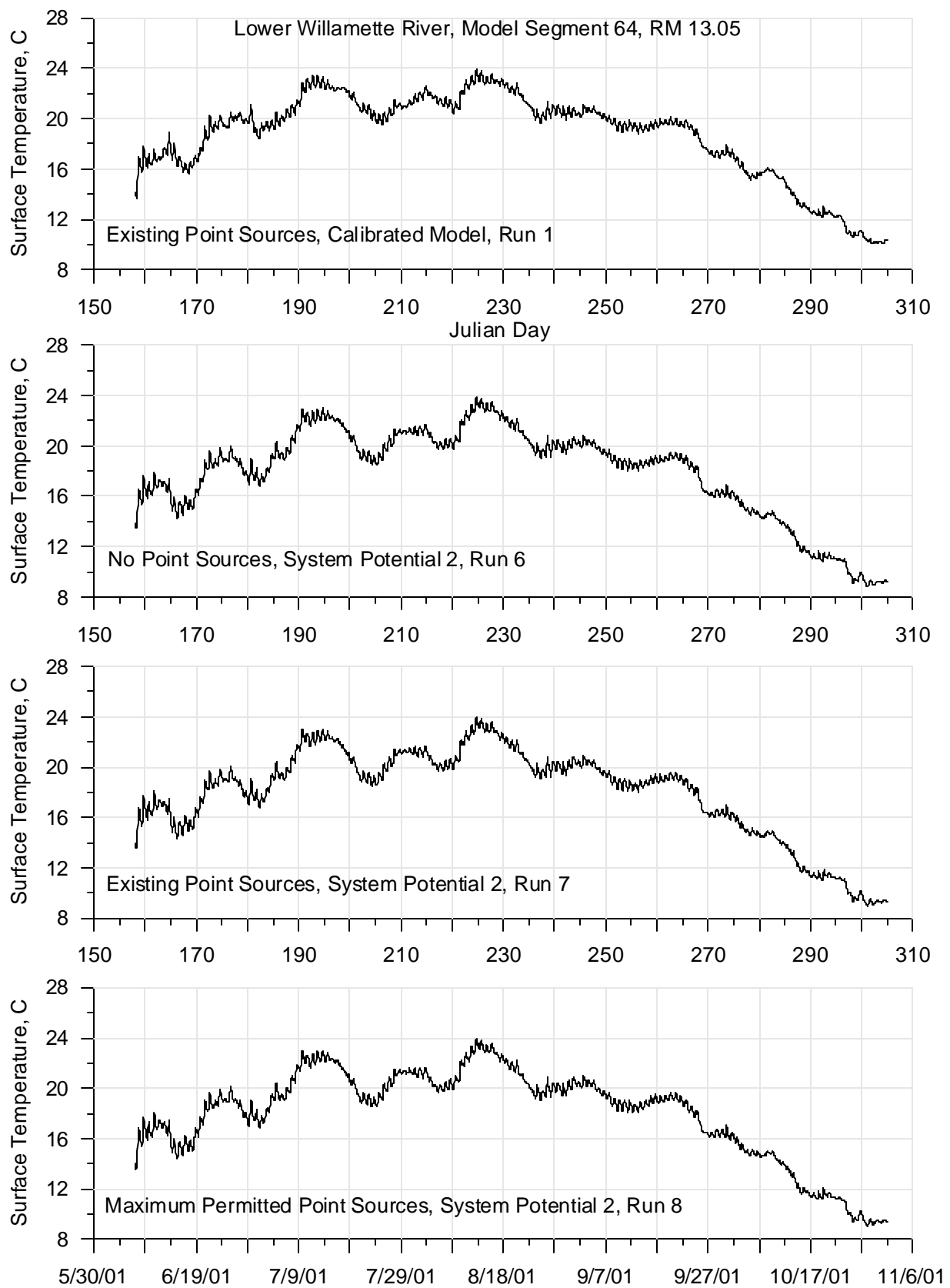


**Figure 129: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Clackamas River at RM 5.07**

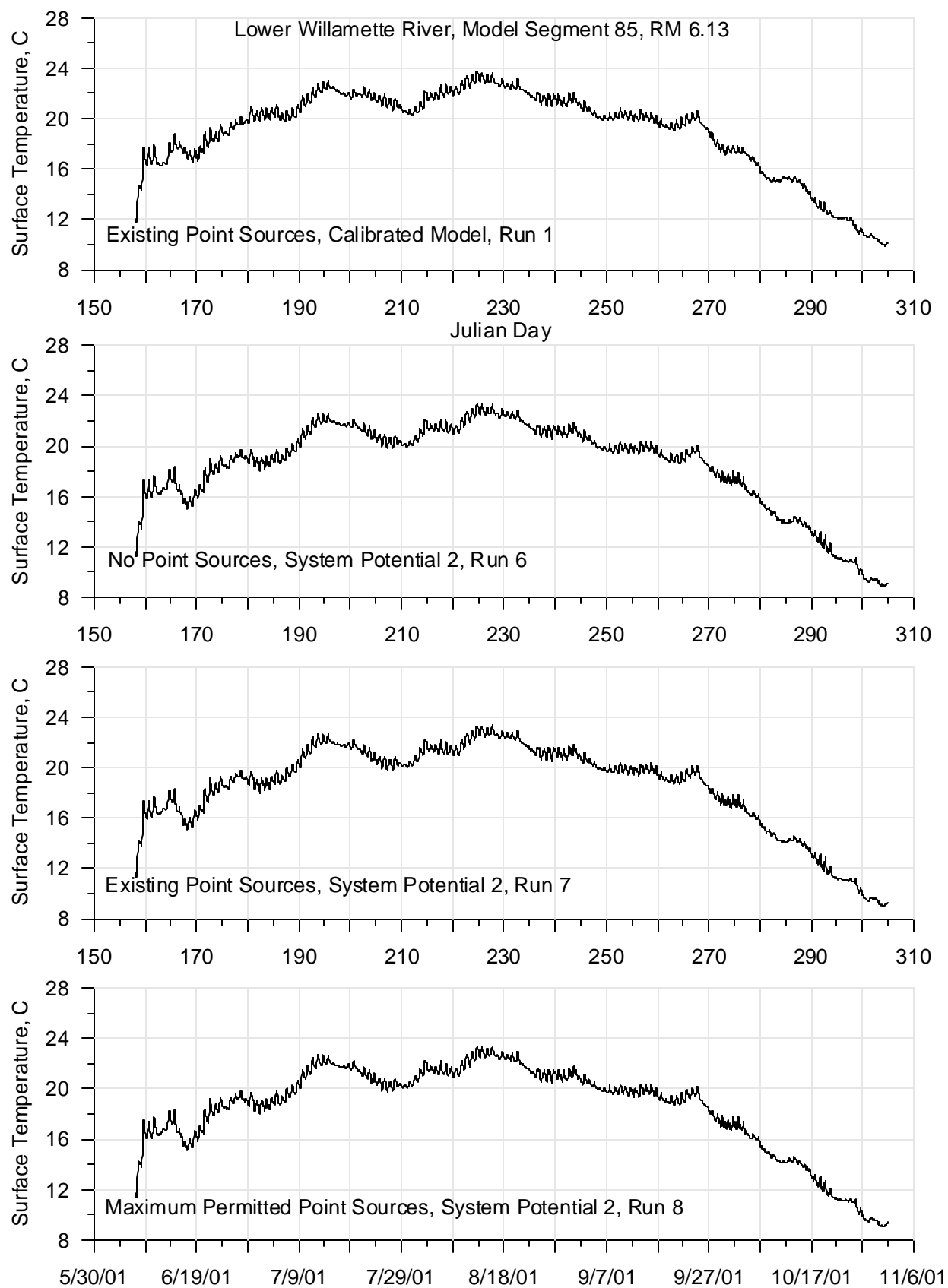




**Figure 130: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 24.8**

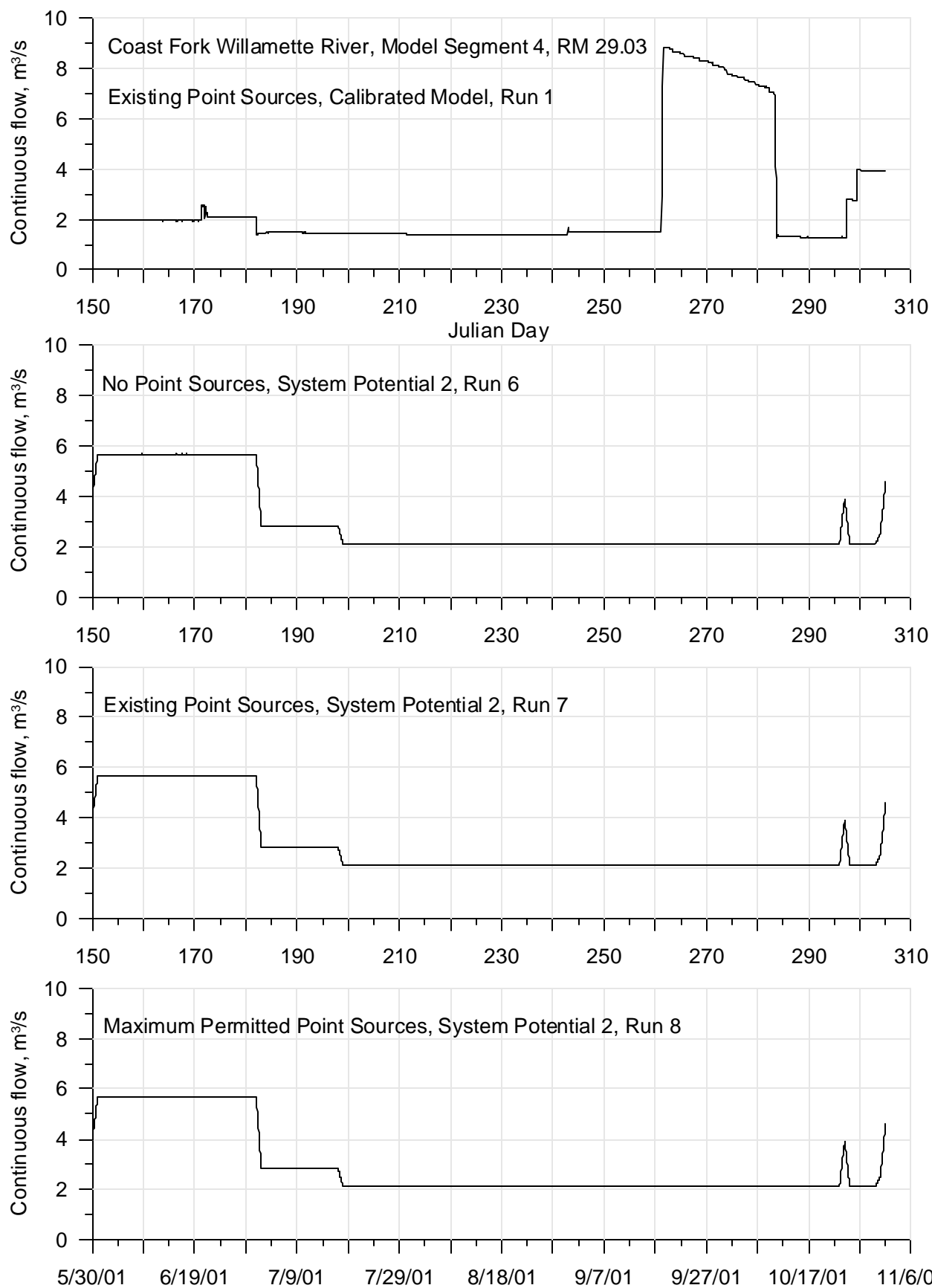


**Figure 131: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 13.05**

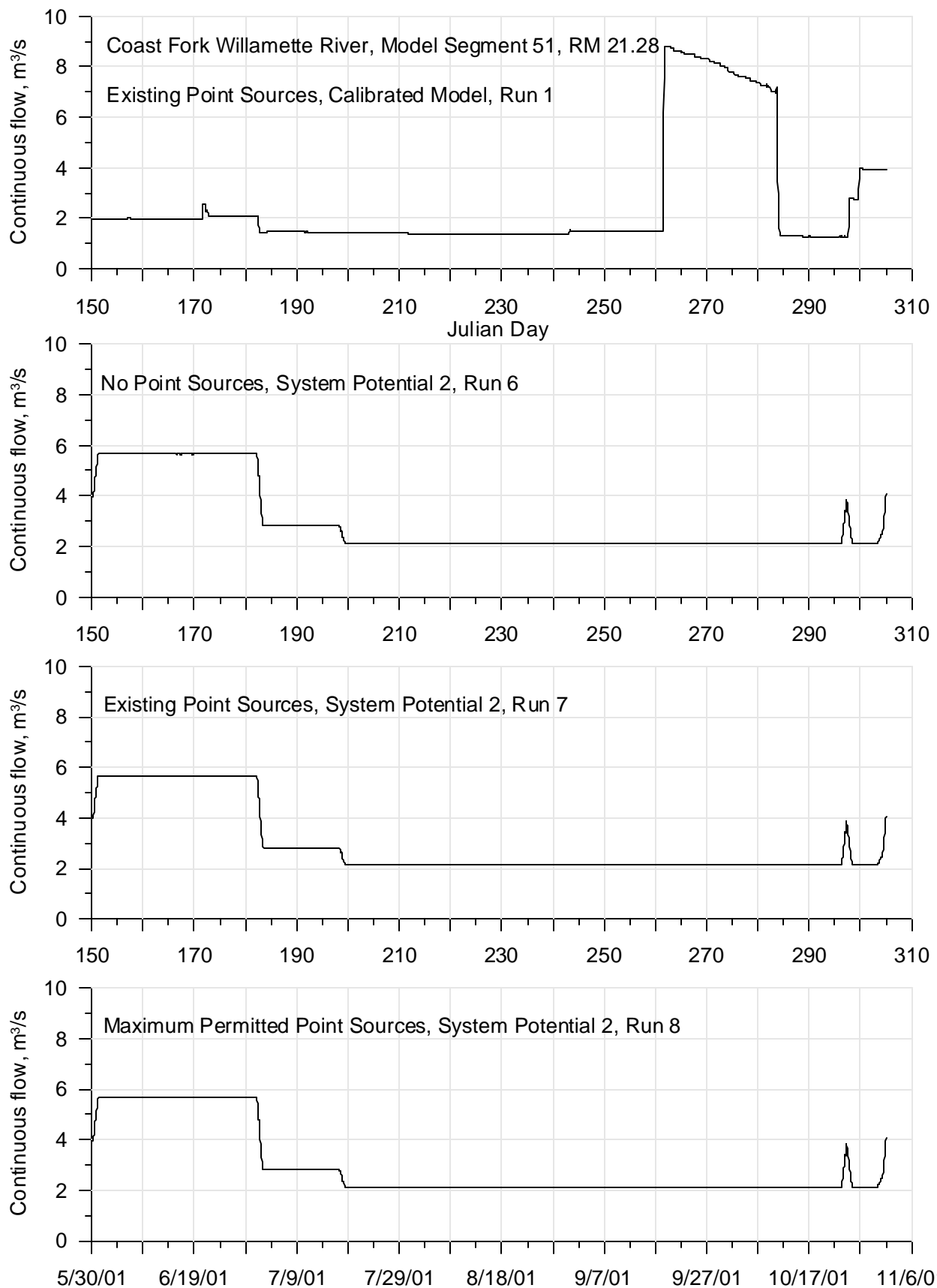


**Figure 132: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2001 for the Willamette River at RM 6.13**

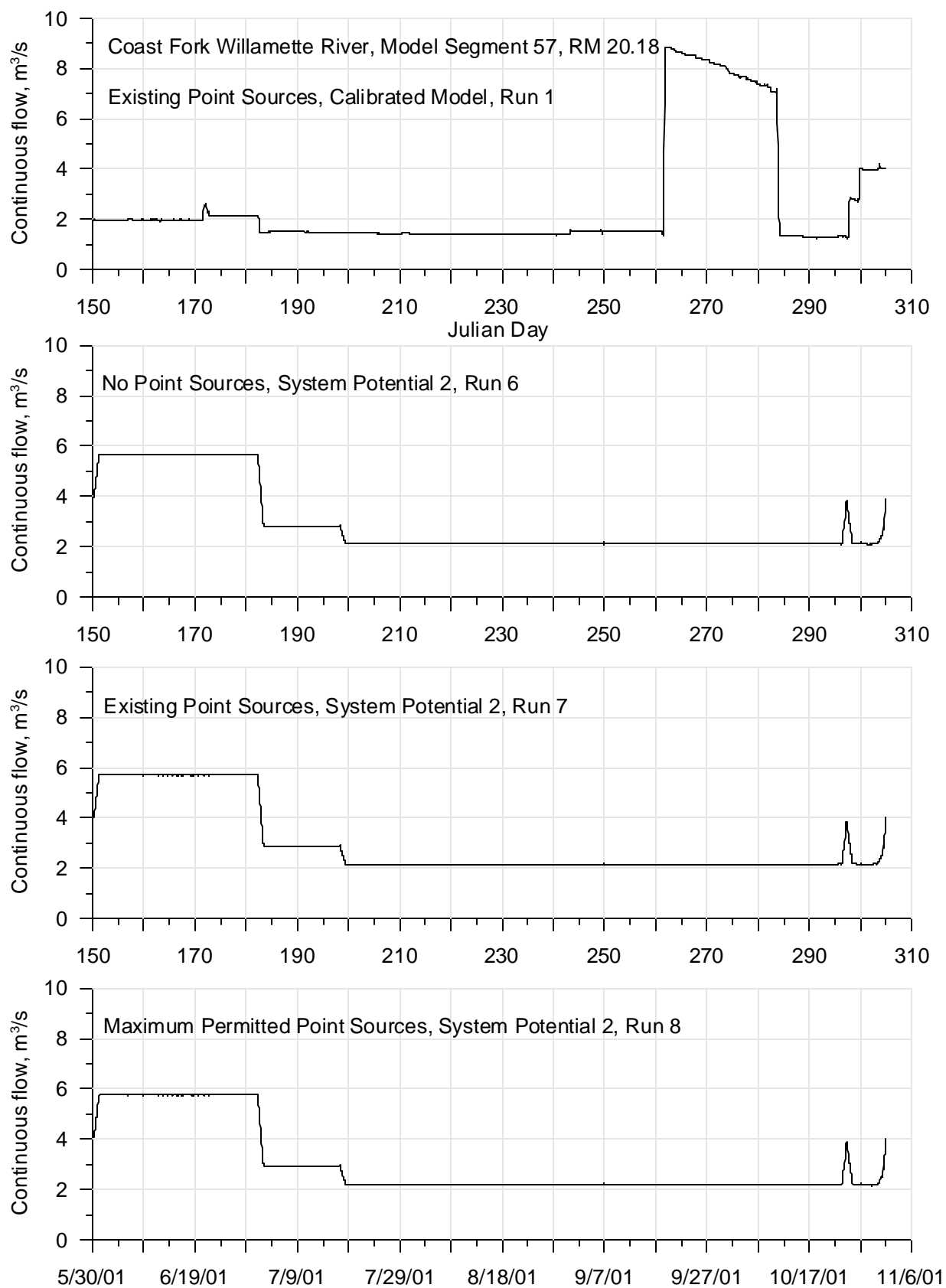
## Continuous Flow



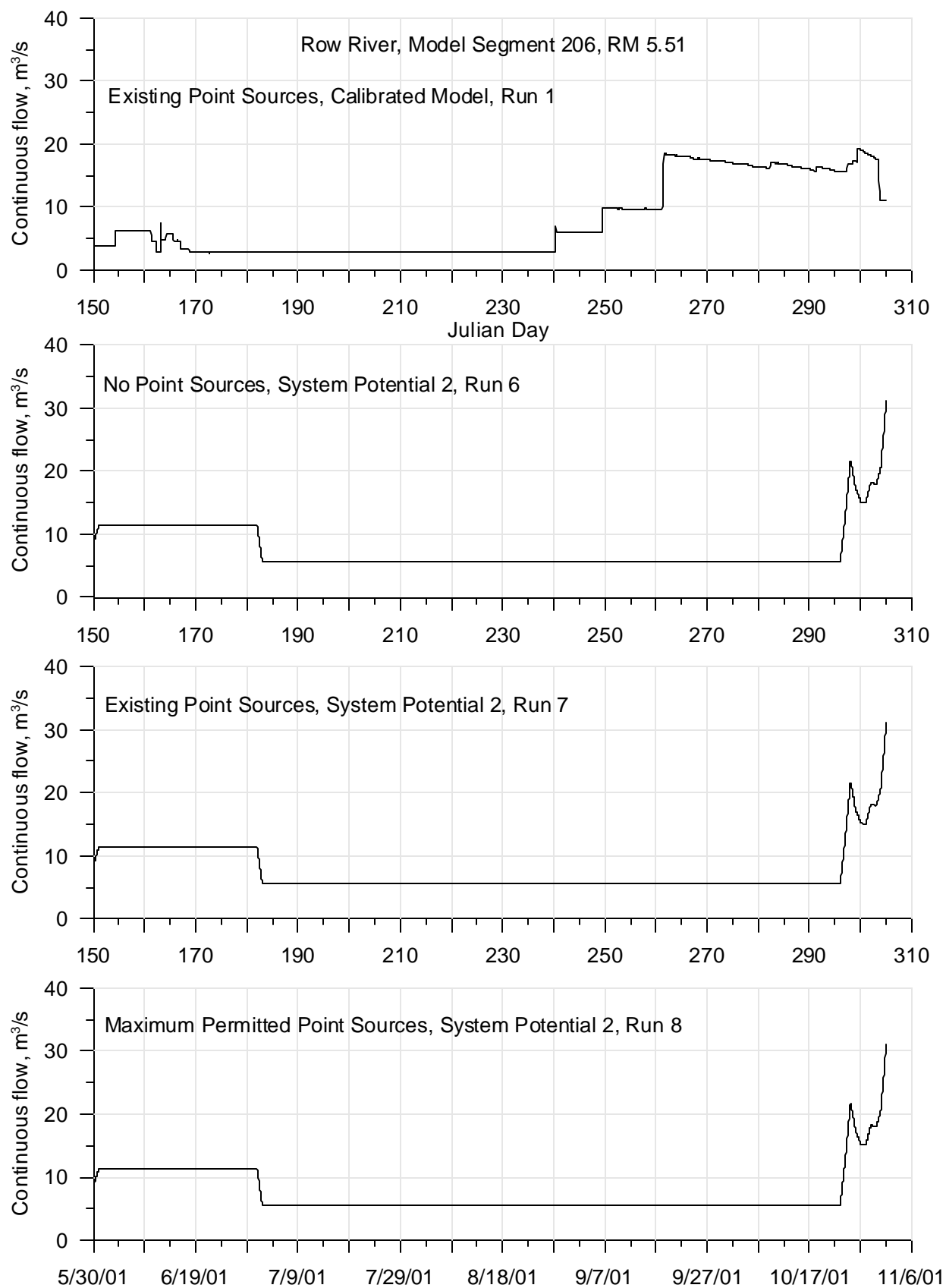
**Figure 133: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Coast Fork Willamette River at RM 29.03**



**Figure 134: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Coast Fork Willamette River at RM 21.28**

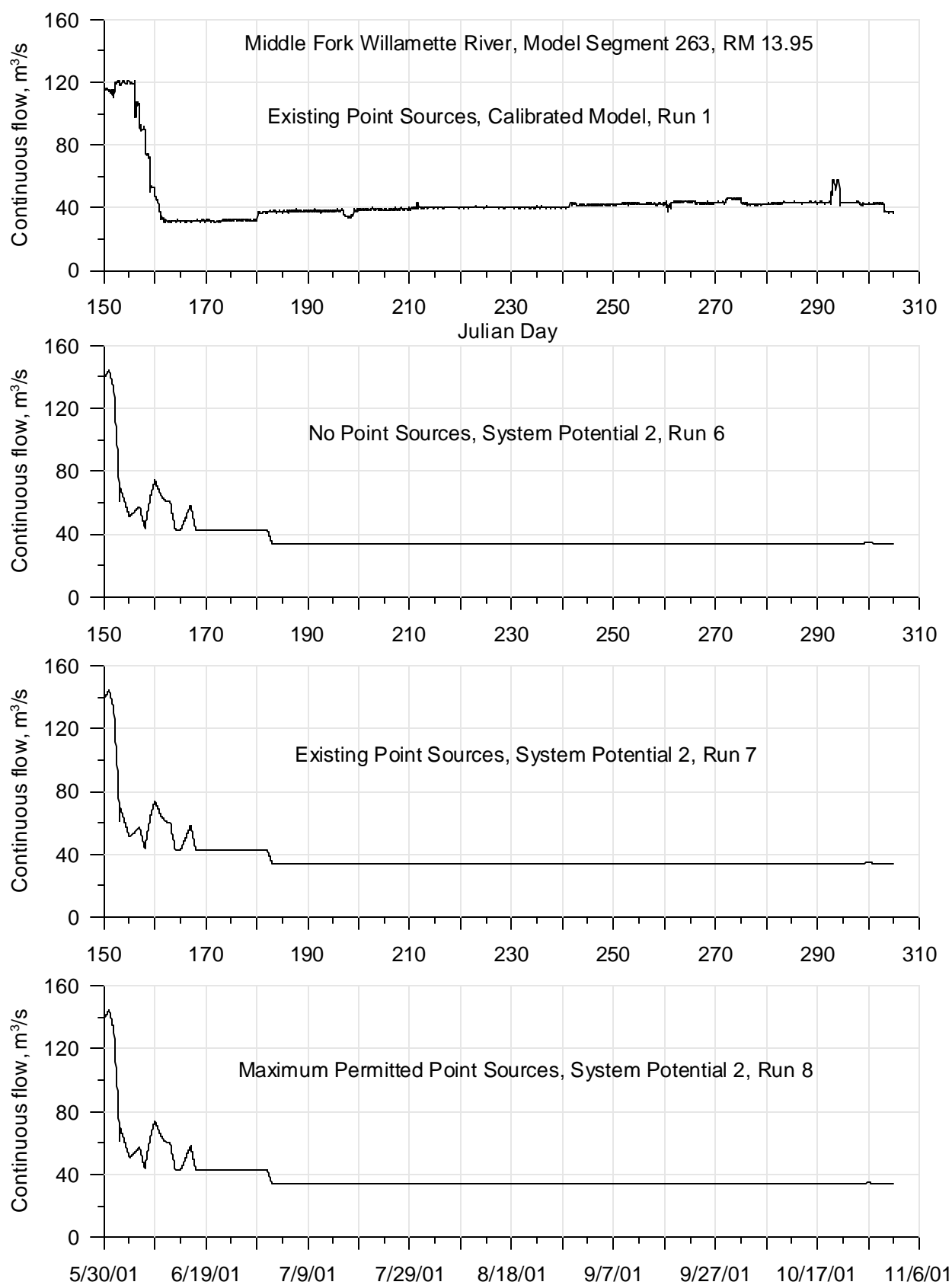


**Figure 135: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Coast Fork Willamette River at RM 20.18**

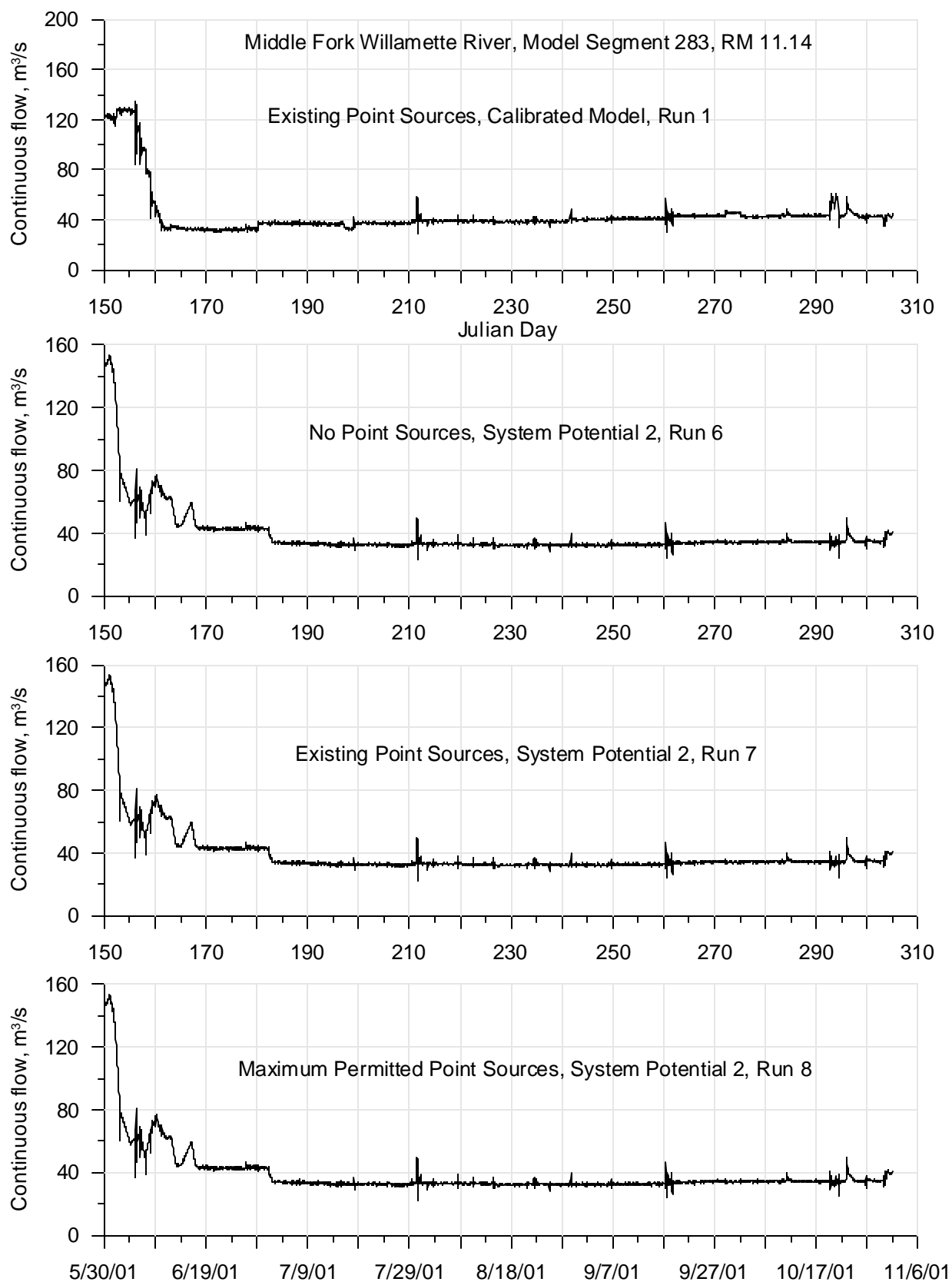


**Figure 136: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Row River at RM 5.51**

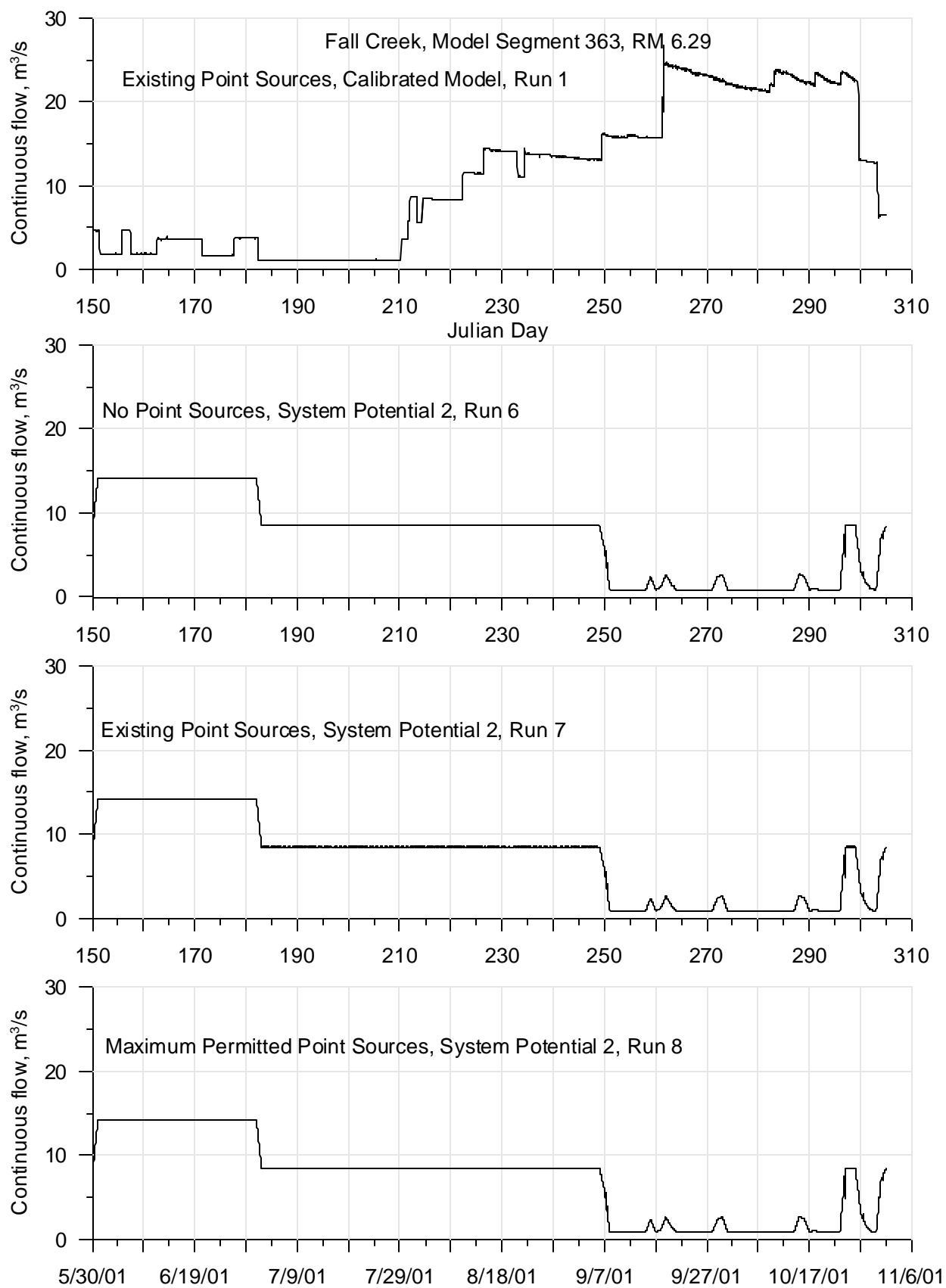




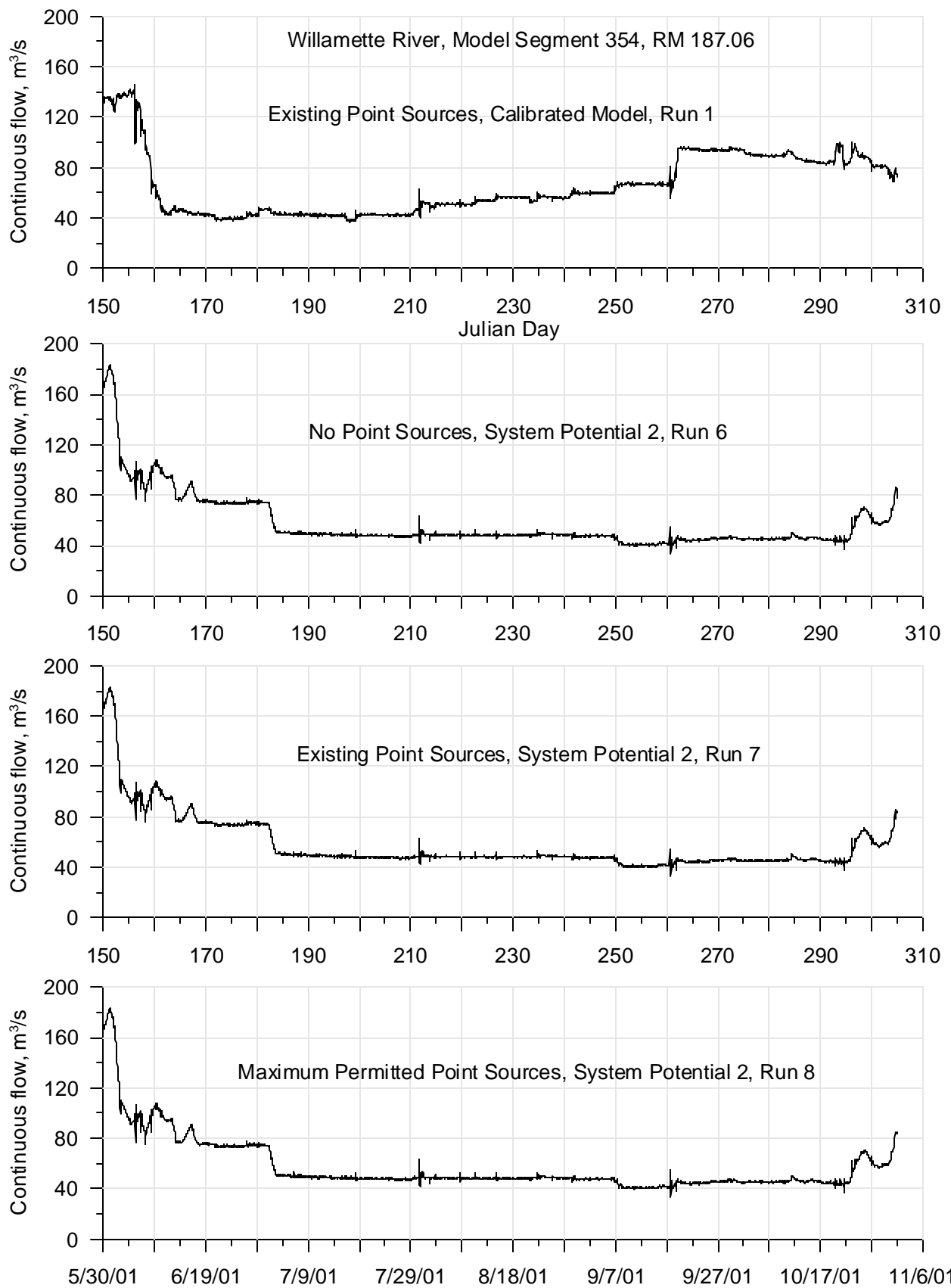
**Figure 137: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Middle Fork Willamette River at RM 13.95**



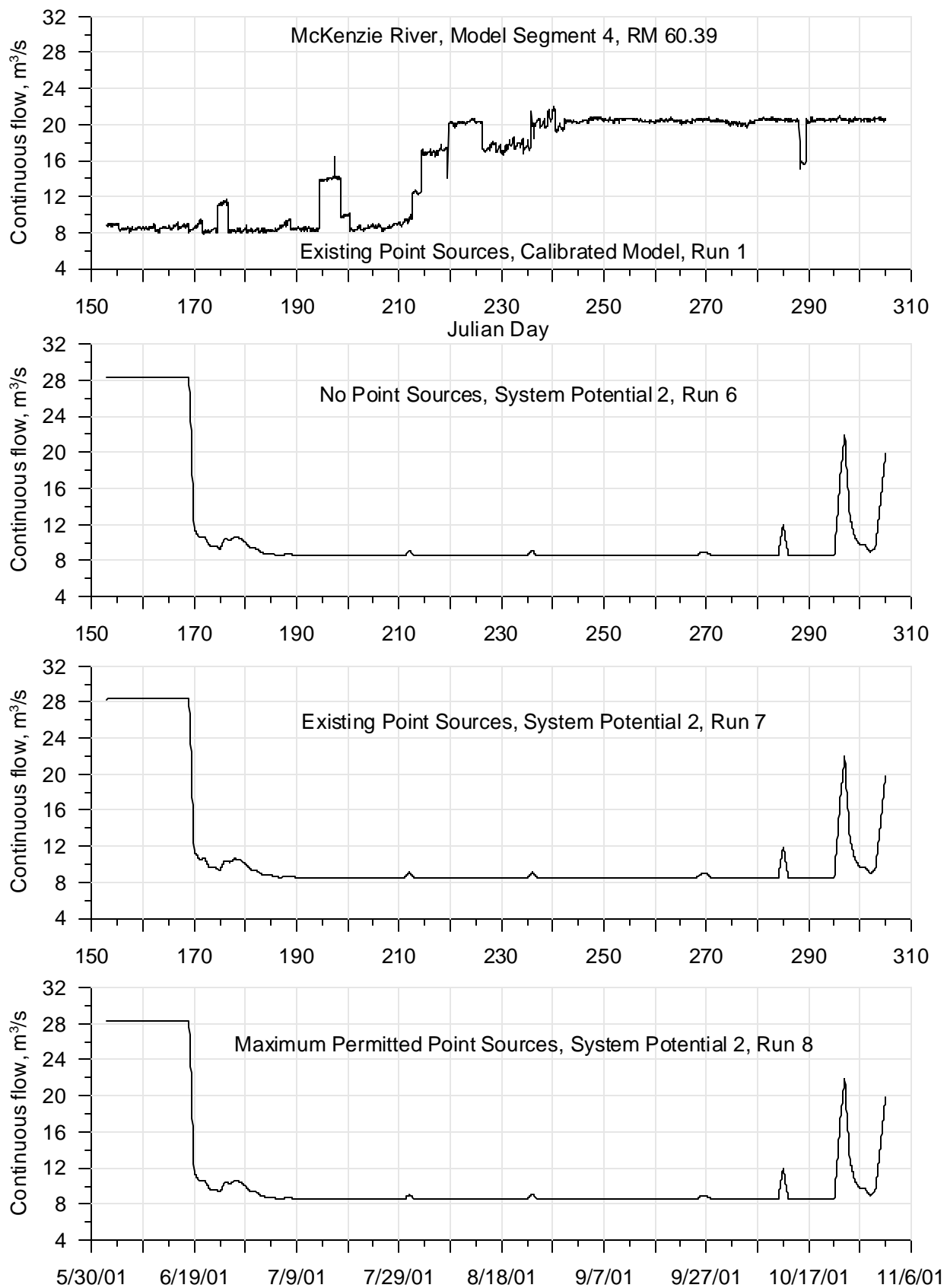
**Figure 138: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Middle Fork Willamette River at RM 11.14**



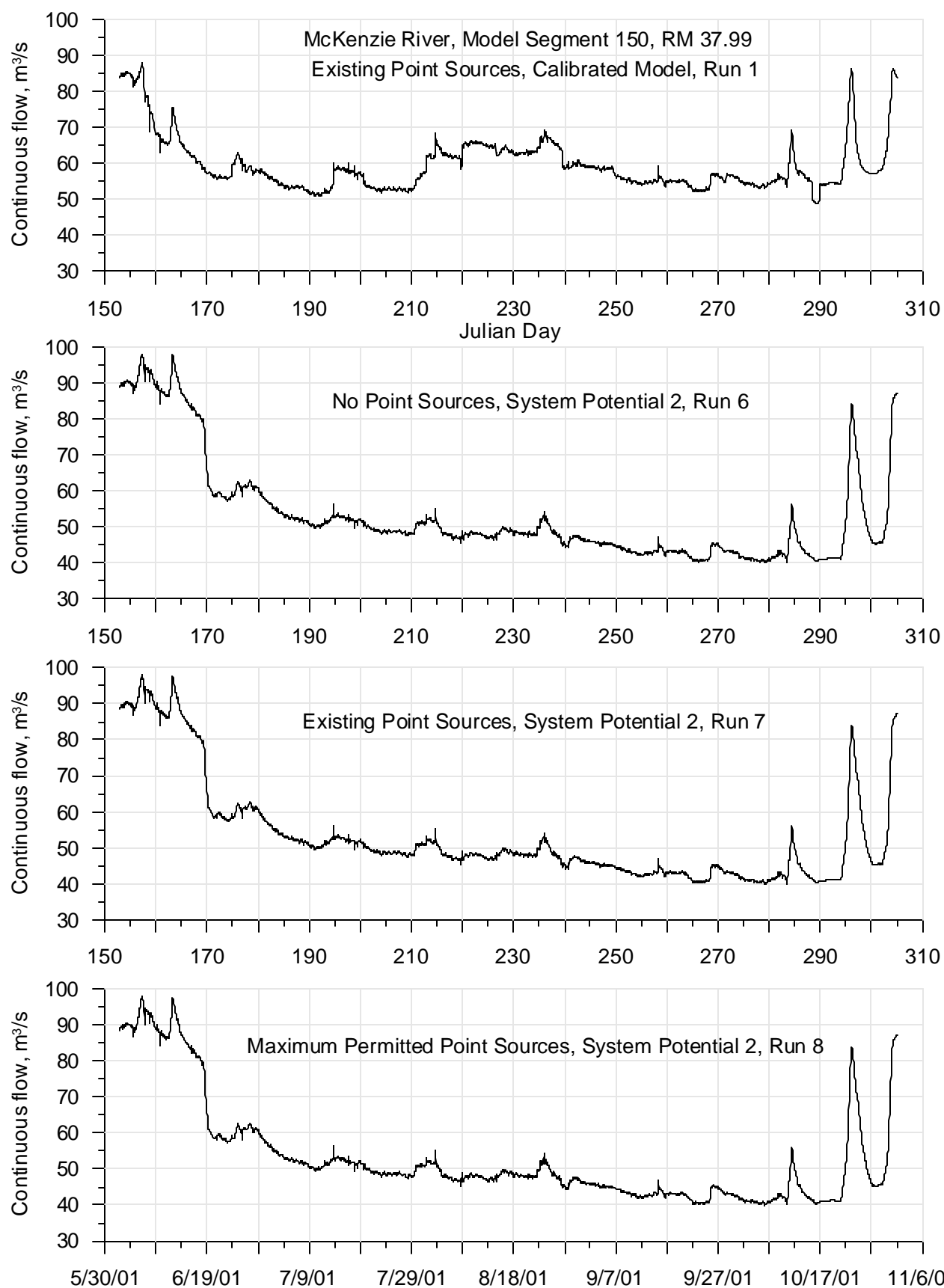
**Figure 139: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Fall Creek at RM 6.29**



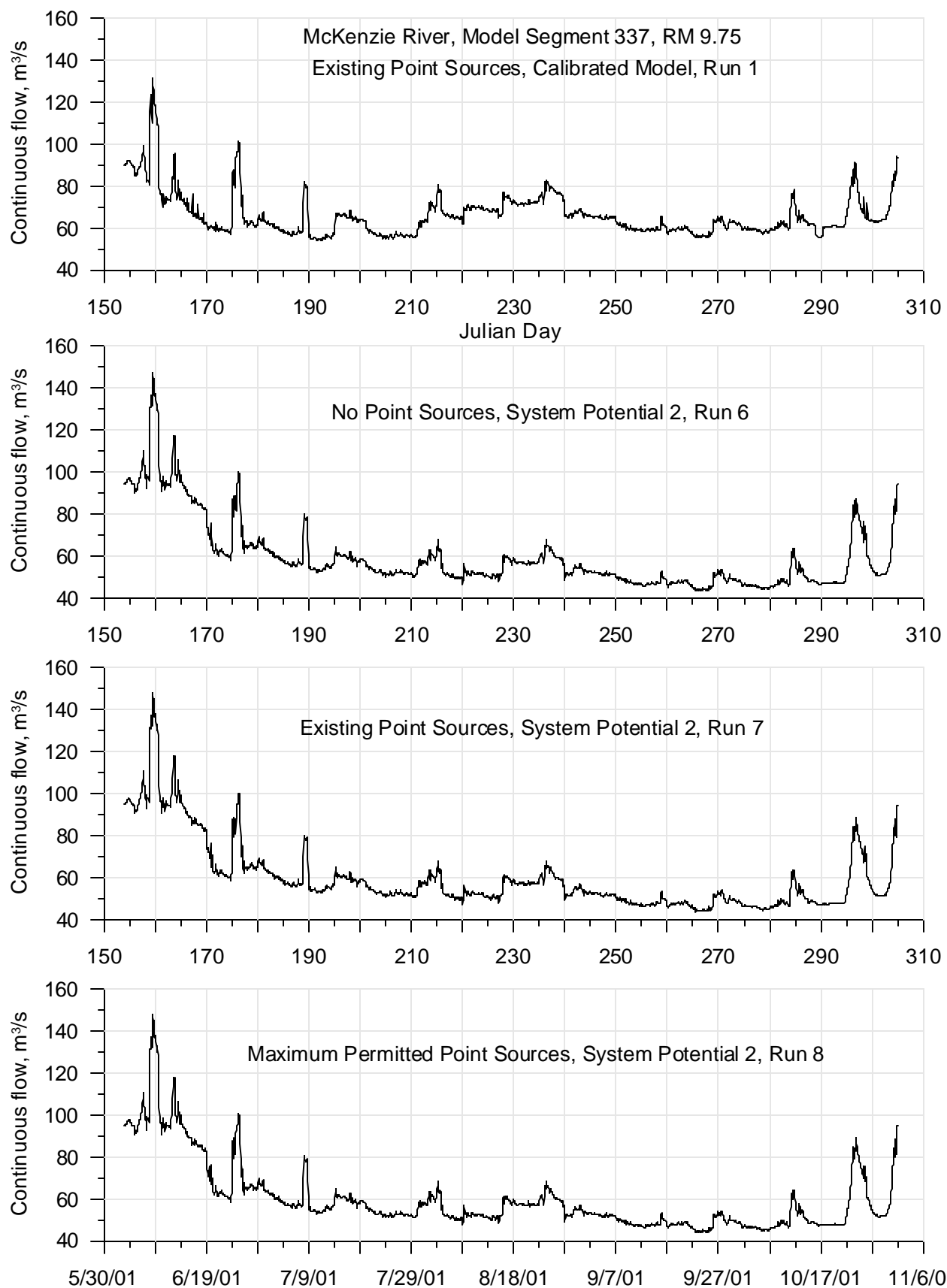
**Figure 140: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 187.06**



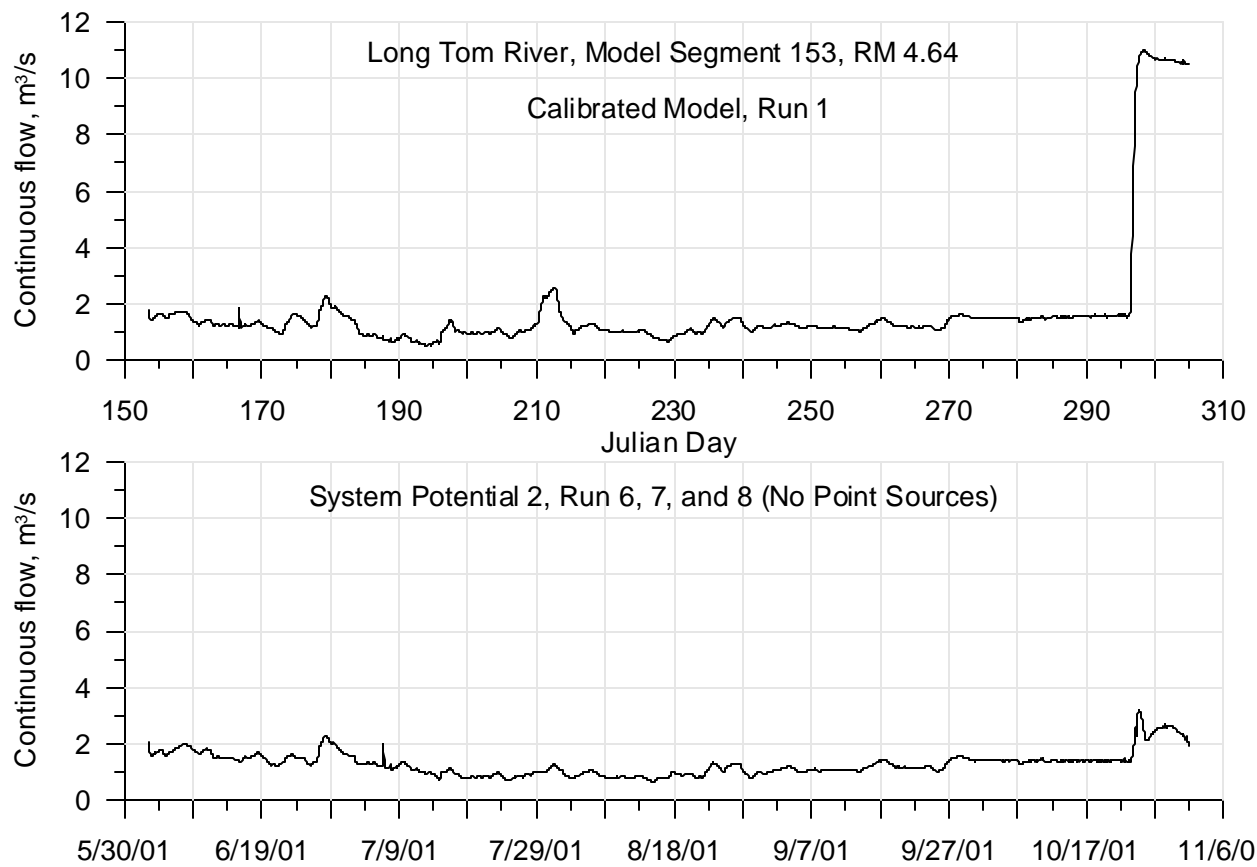
**Figure 141: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the McKenzie River at RM 60.39**



**Figure 142: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the McKenzie River at RM 37.99**

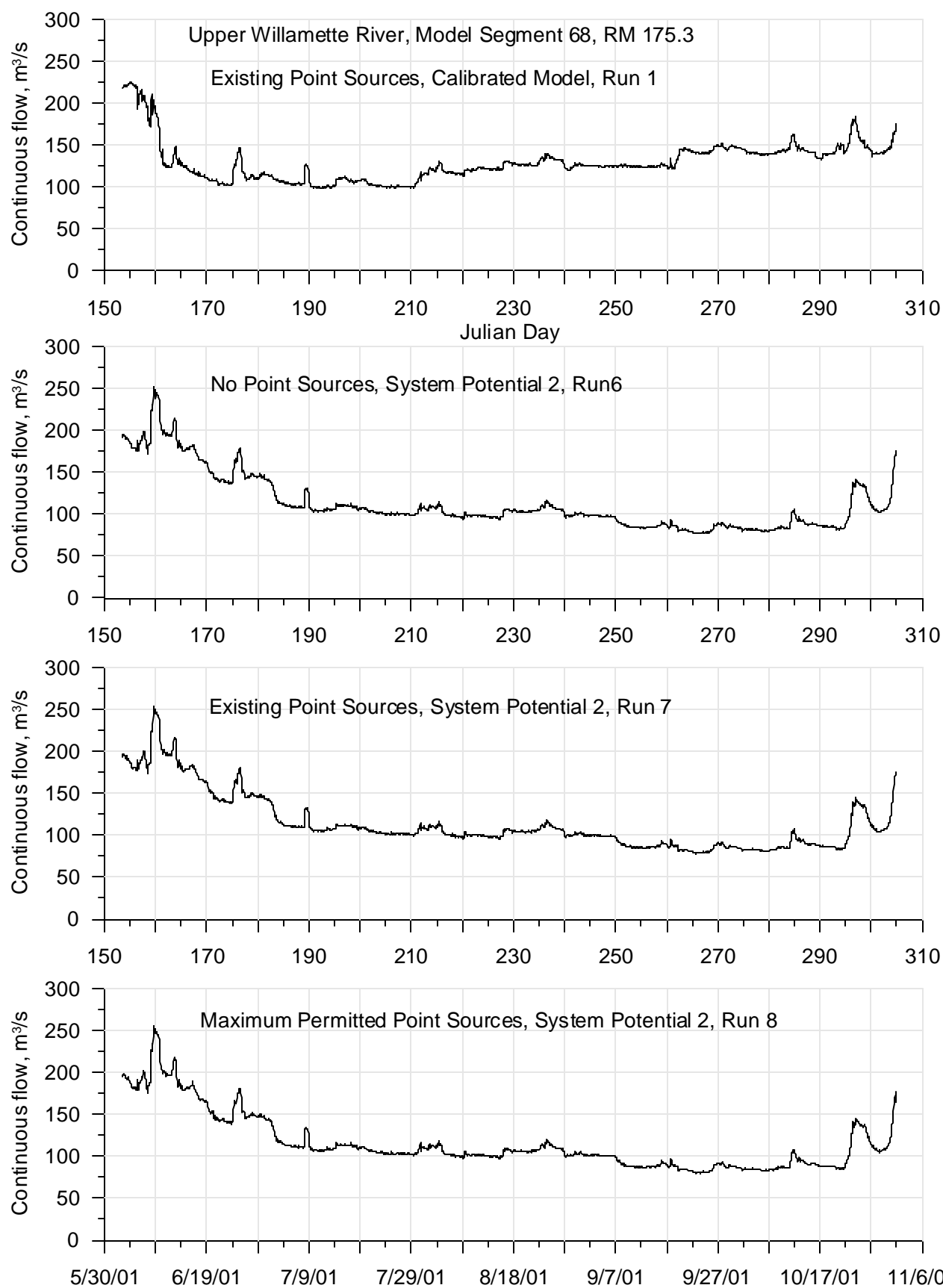


**Figure 143: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the McKenzie River at RM 9.75**

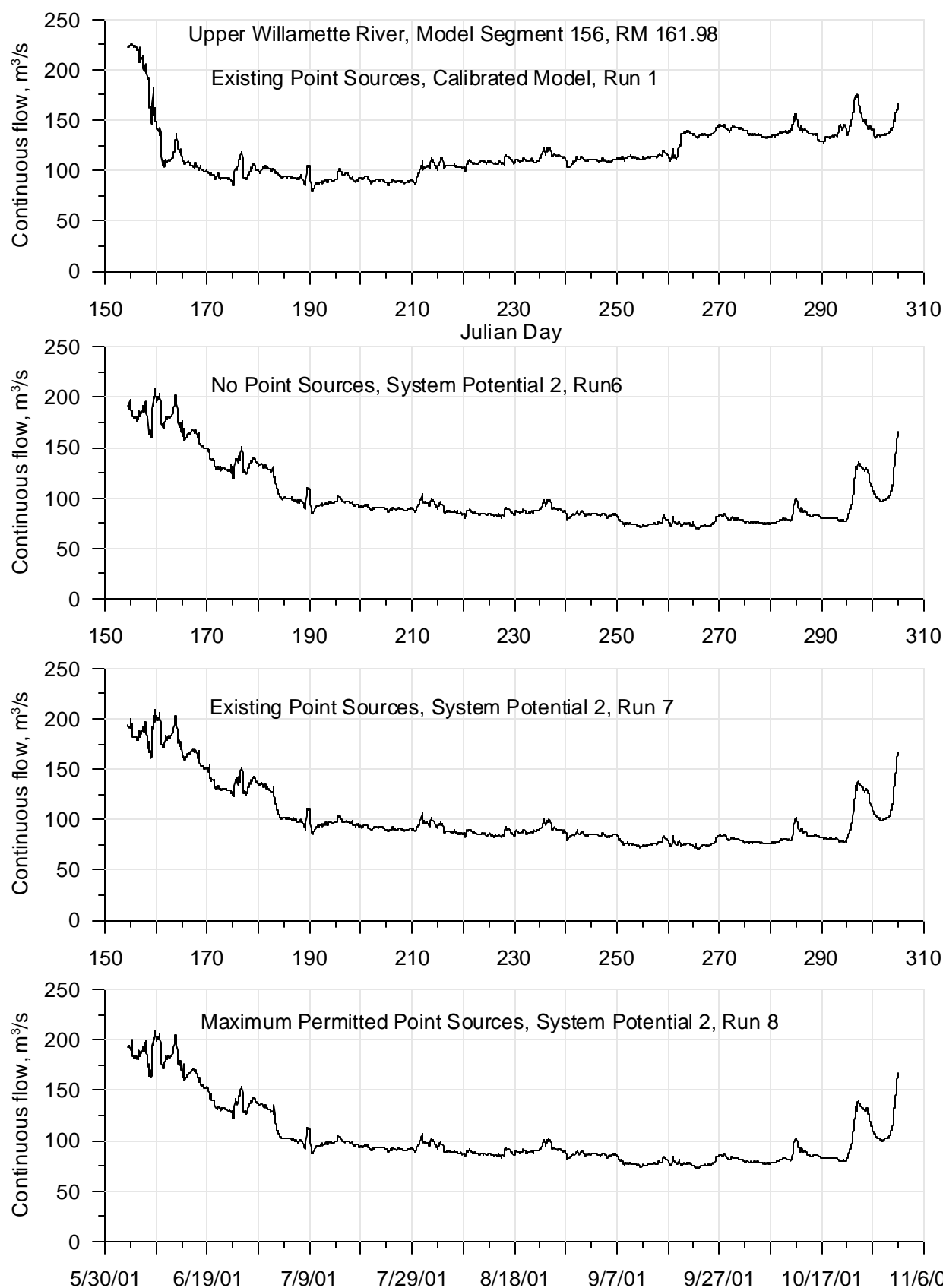


**Figure 144: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Long Tom River at RM 4.64**

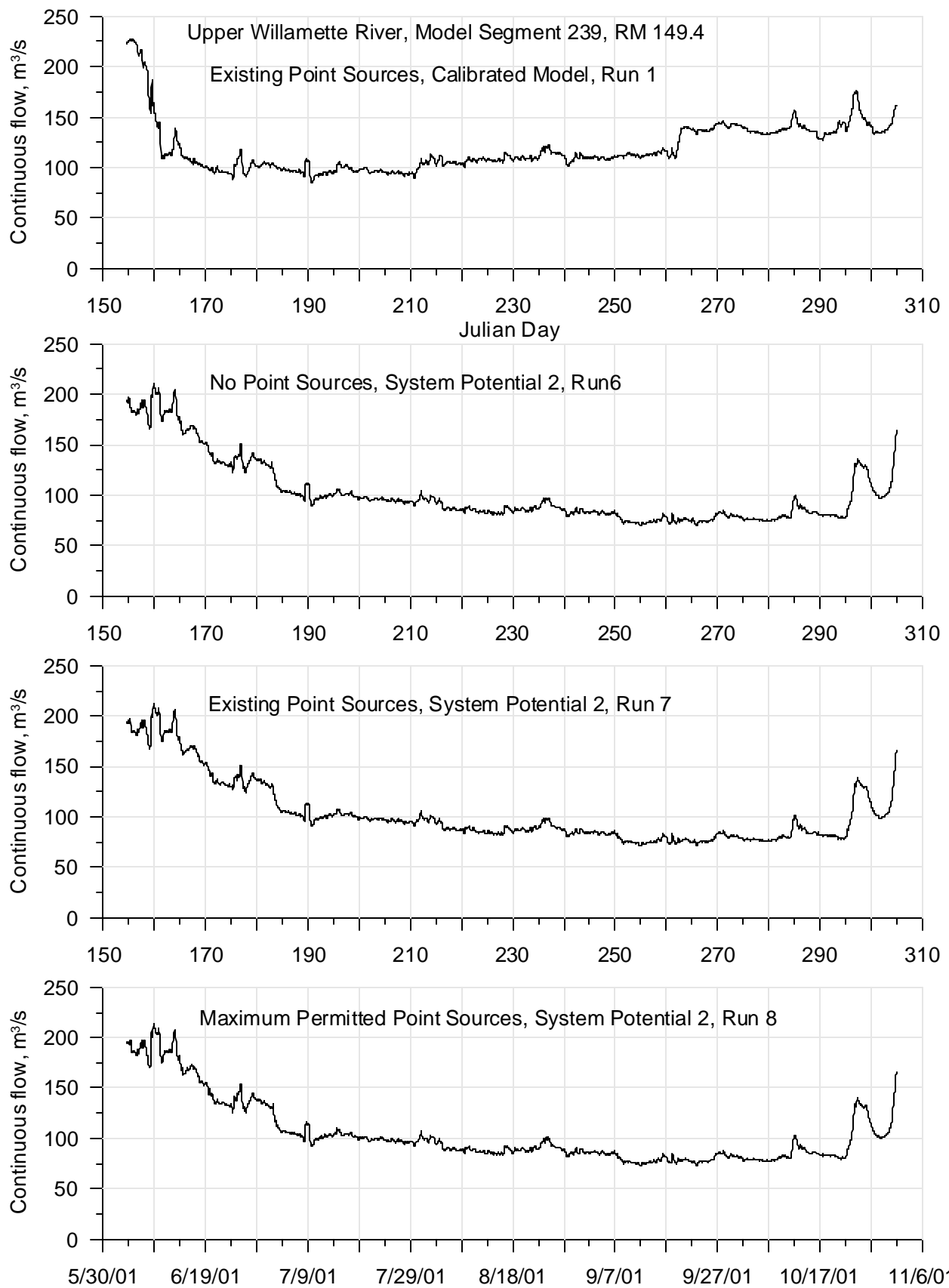




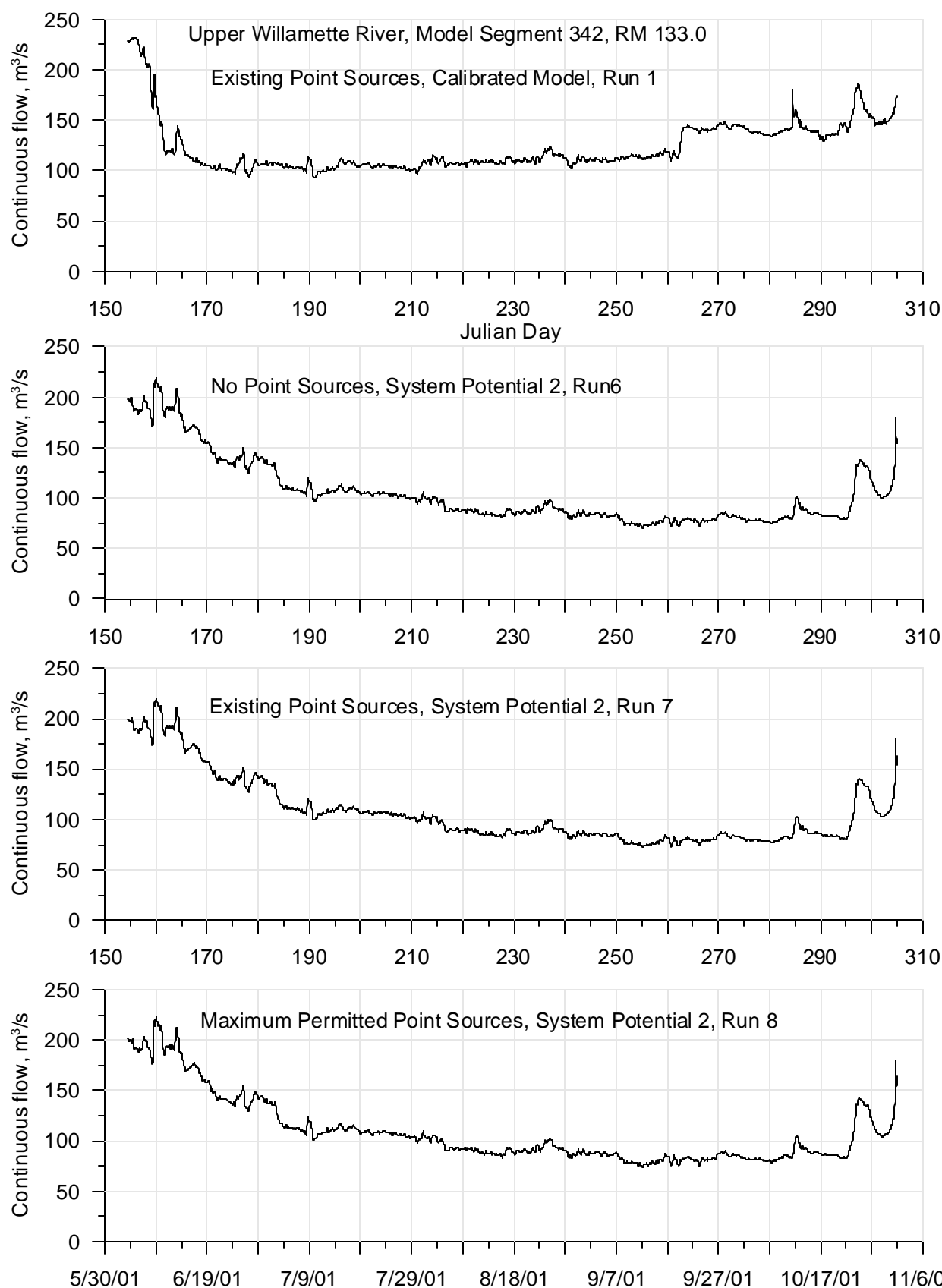
**Figure 145: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 175.3**



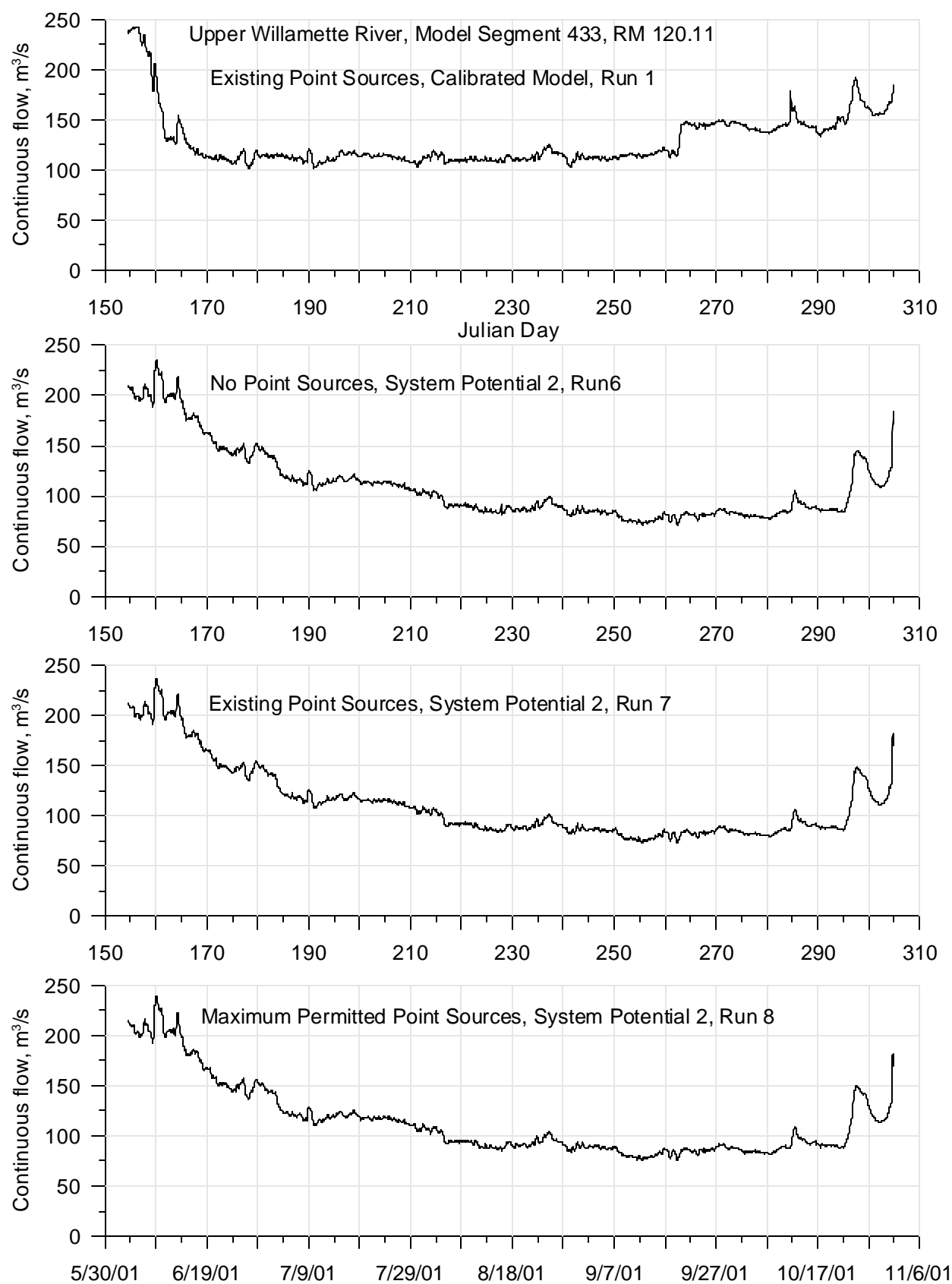
**Figure 146: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 161.98**



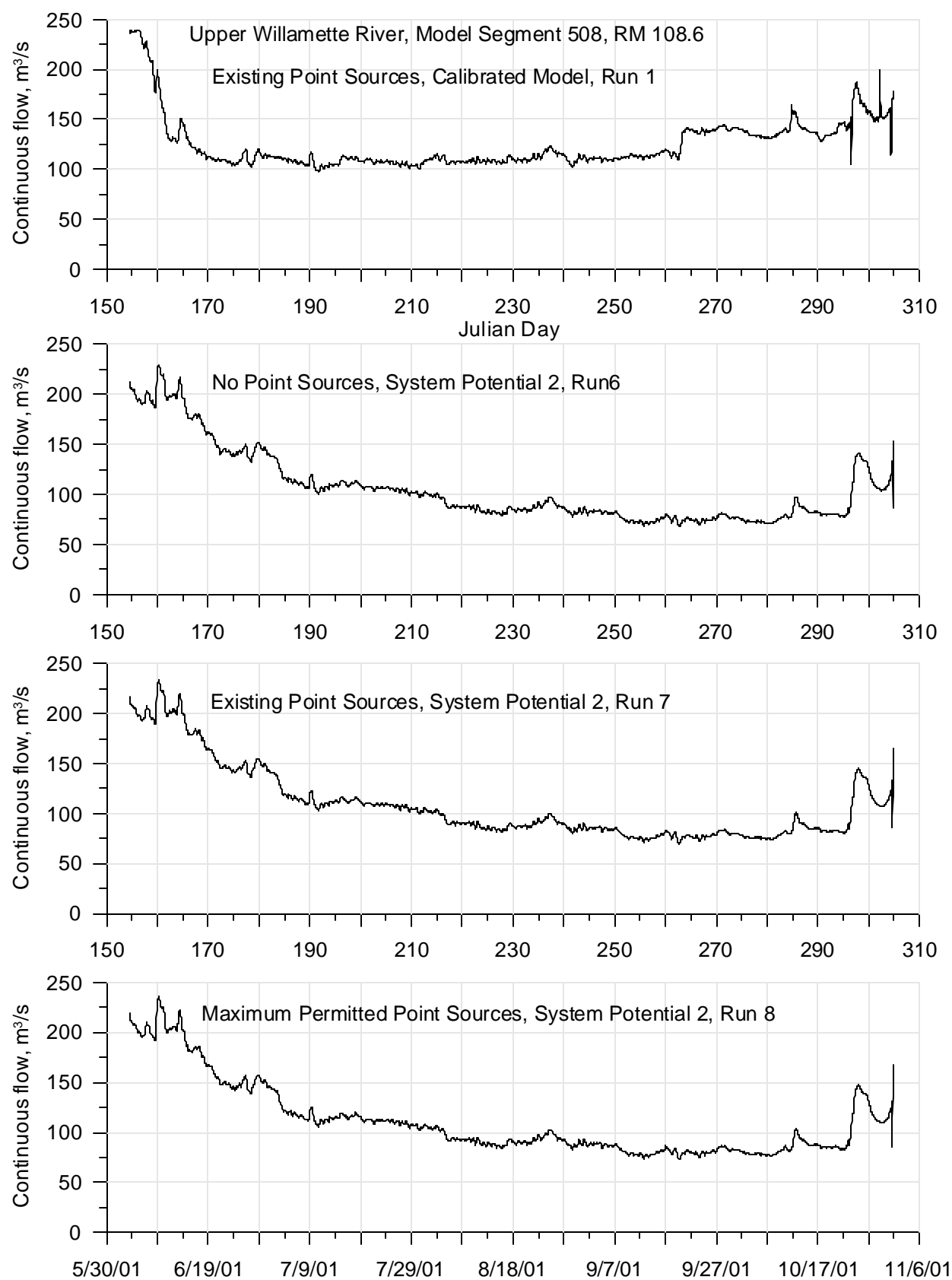
**Figure 147: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 149.4**



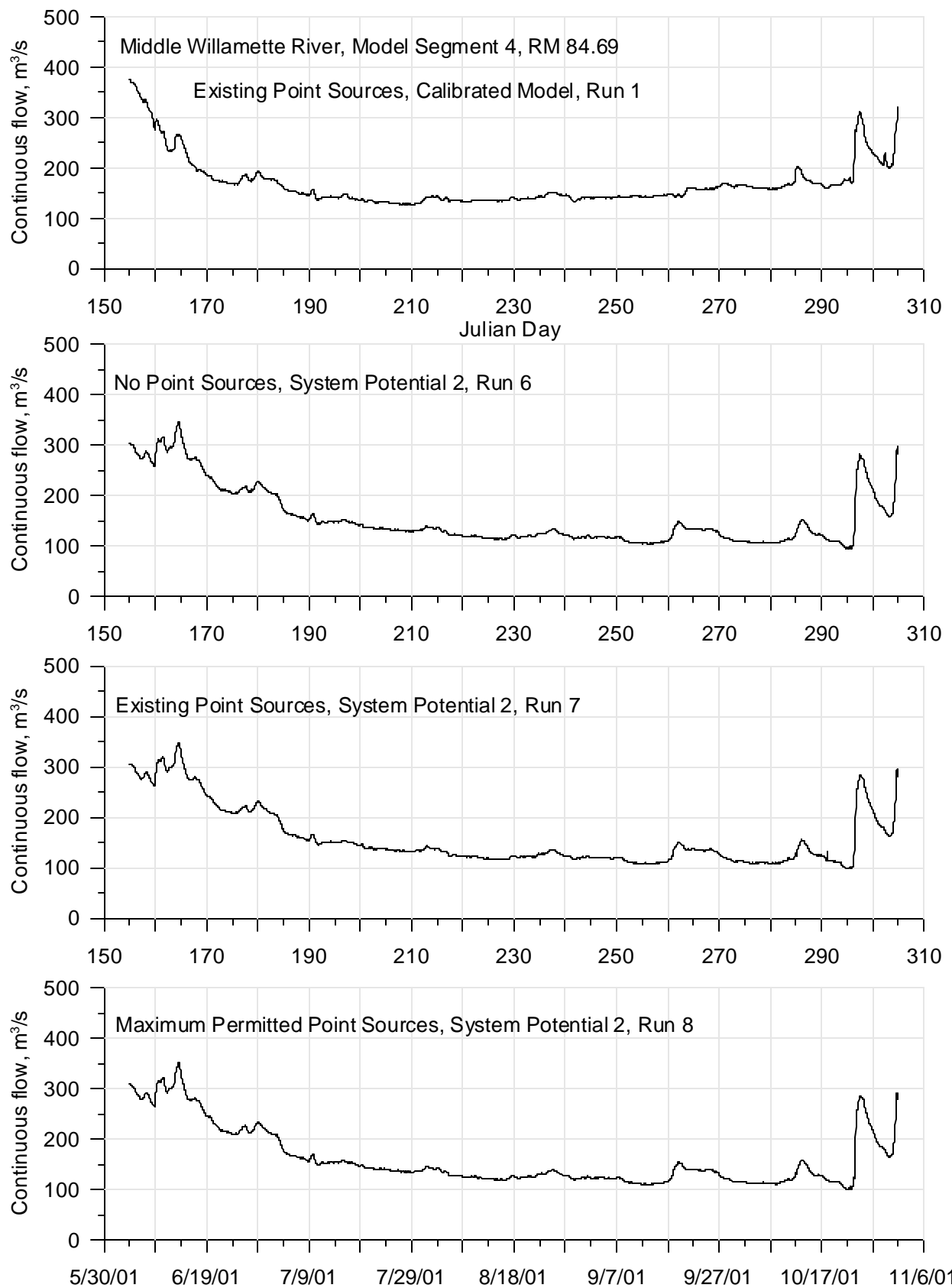
**Figure 148: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 133**



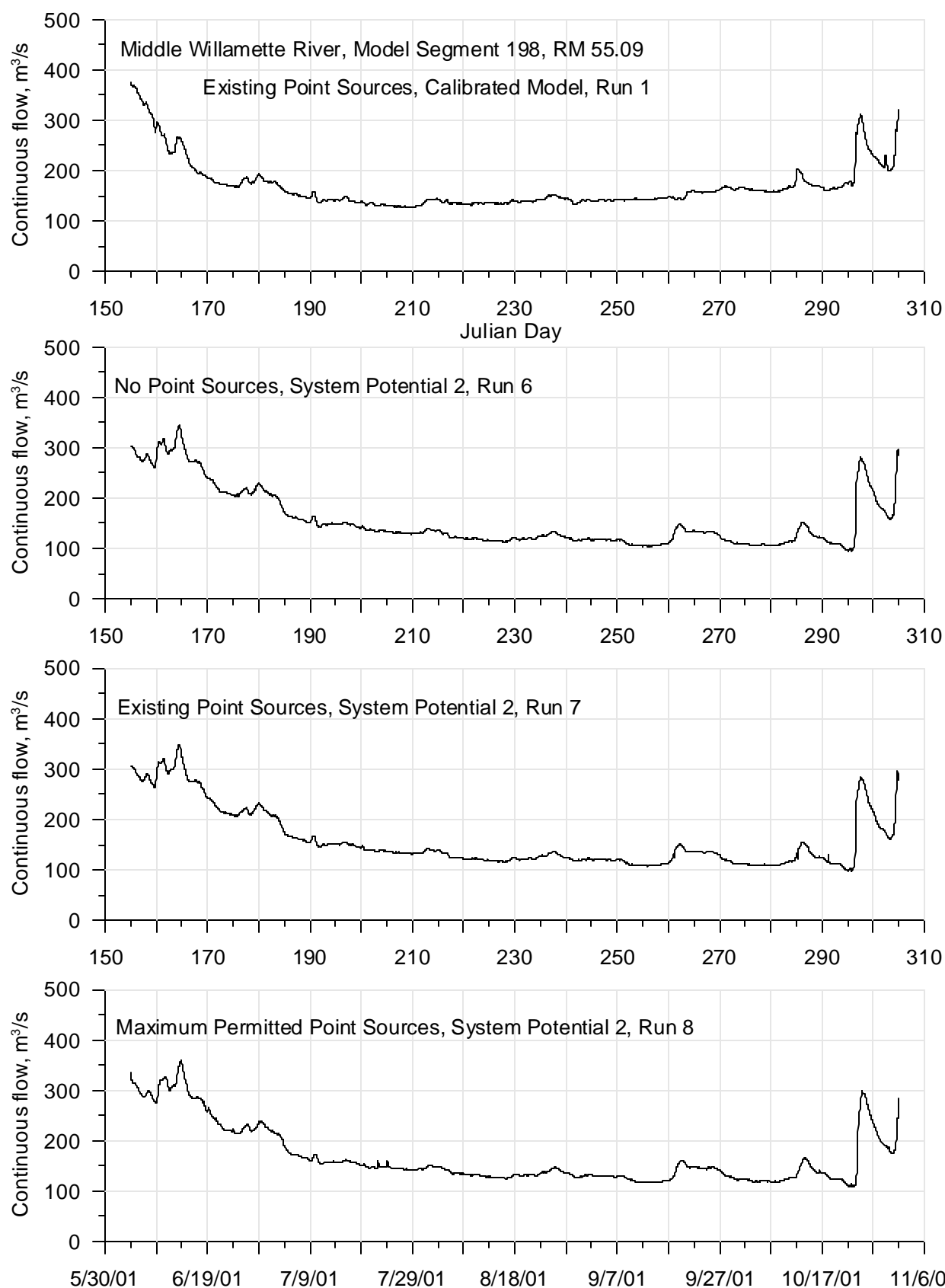
**Figure 149: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 120.11**



**Figure 150: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 108.6**

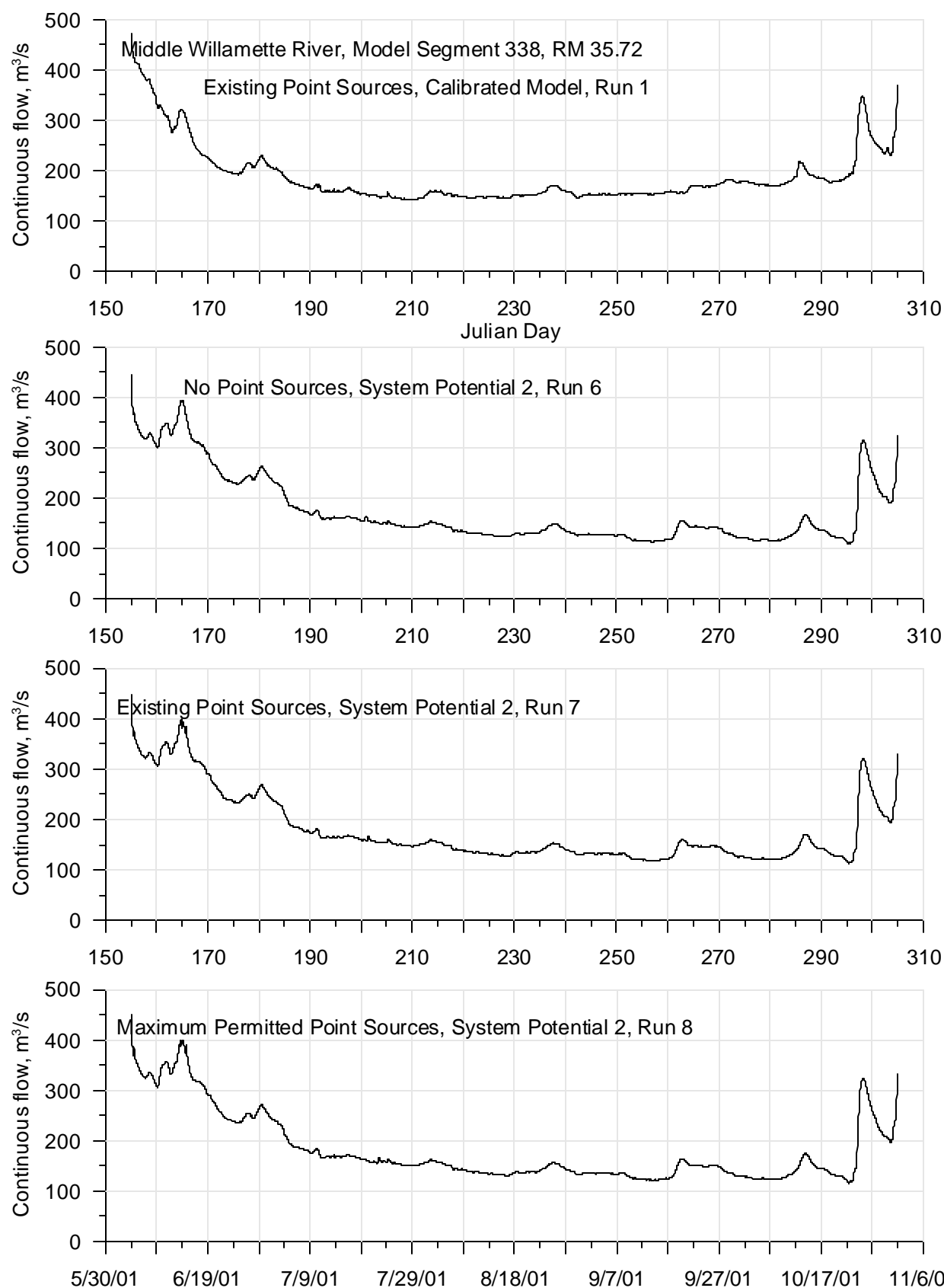


**Figure 151: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 84.69**

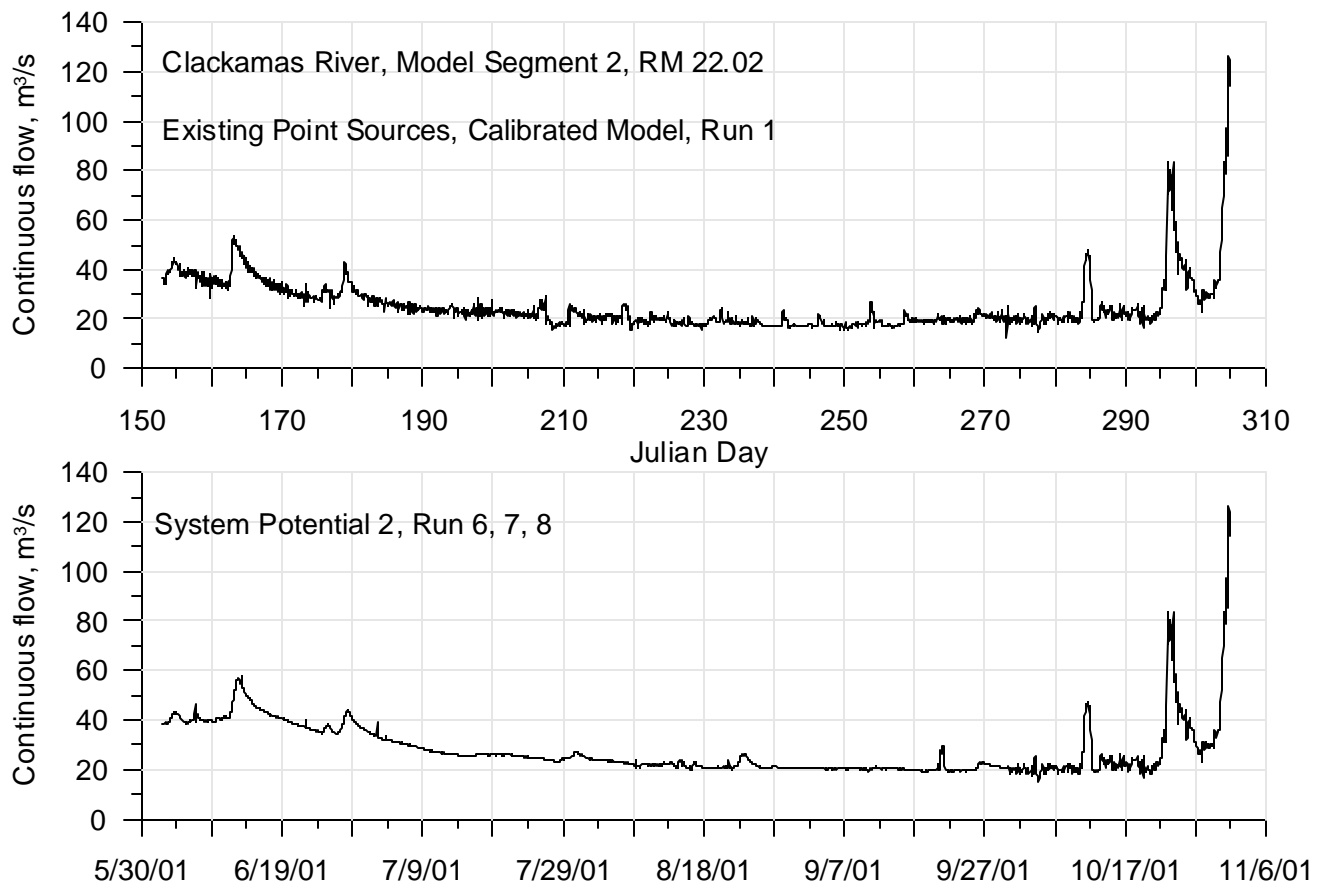


**Figure 152: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 55.09**

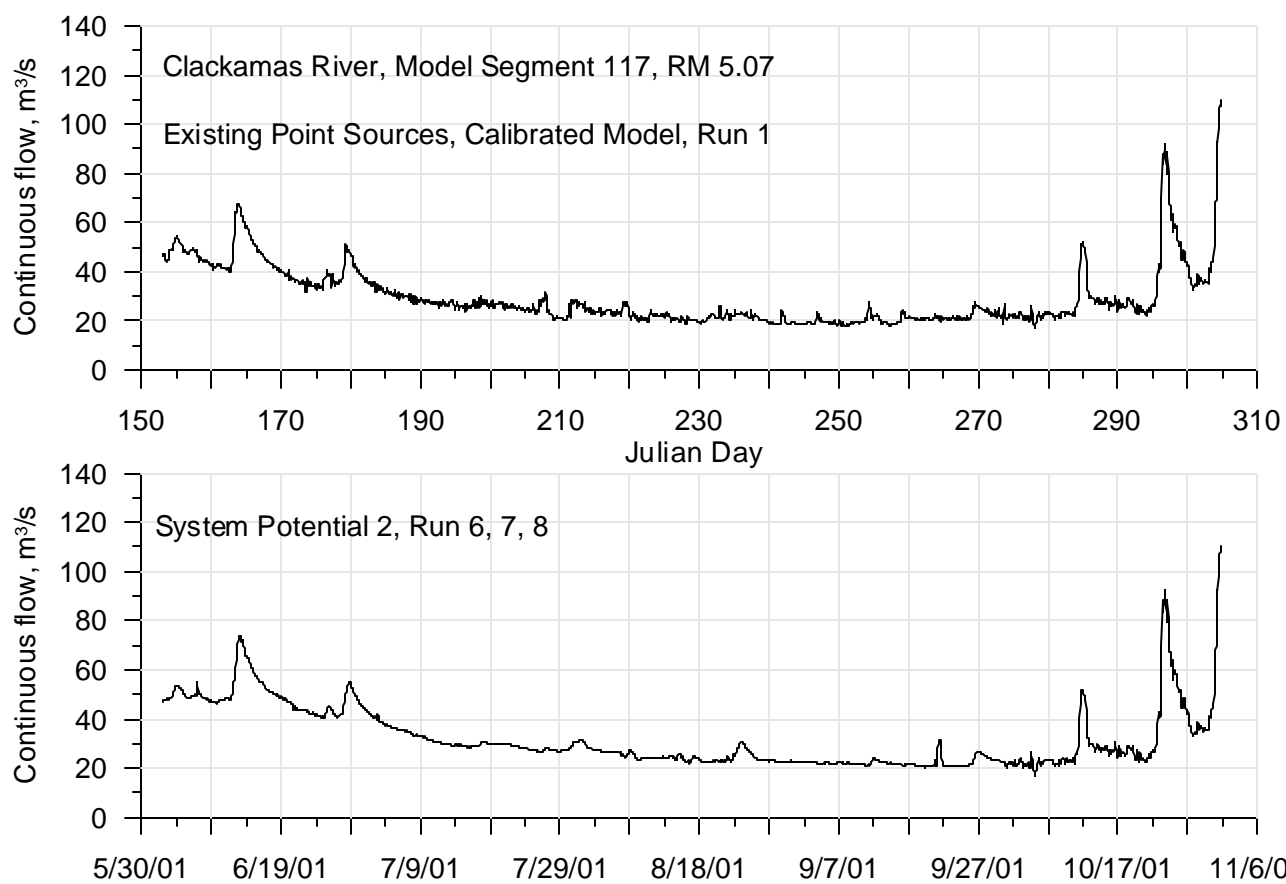




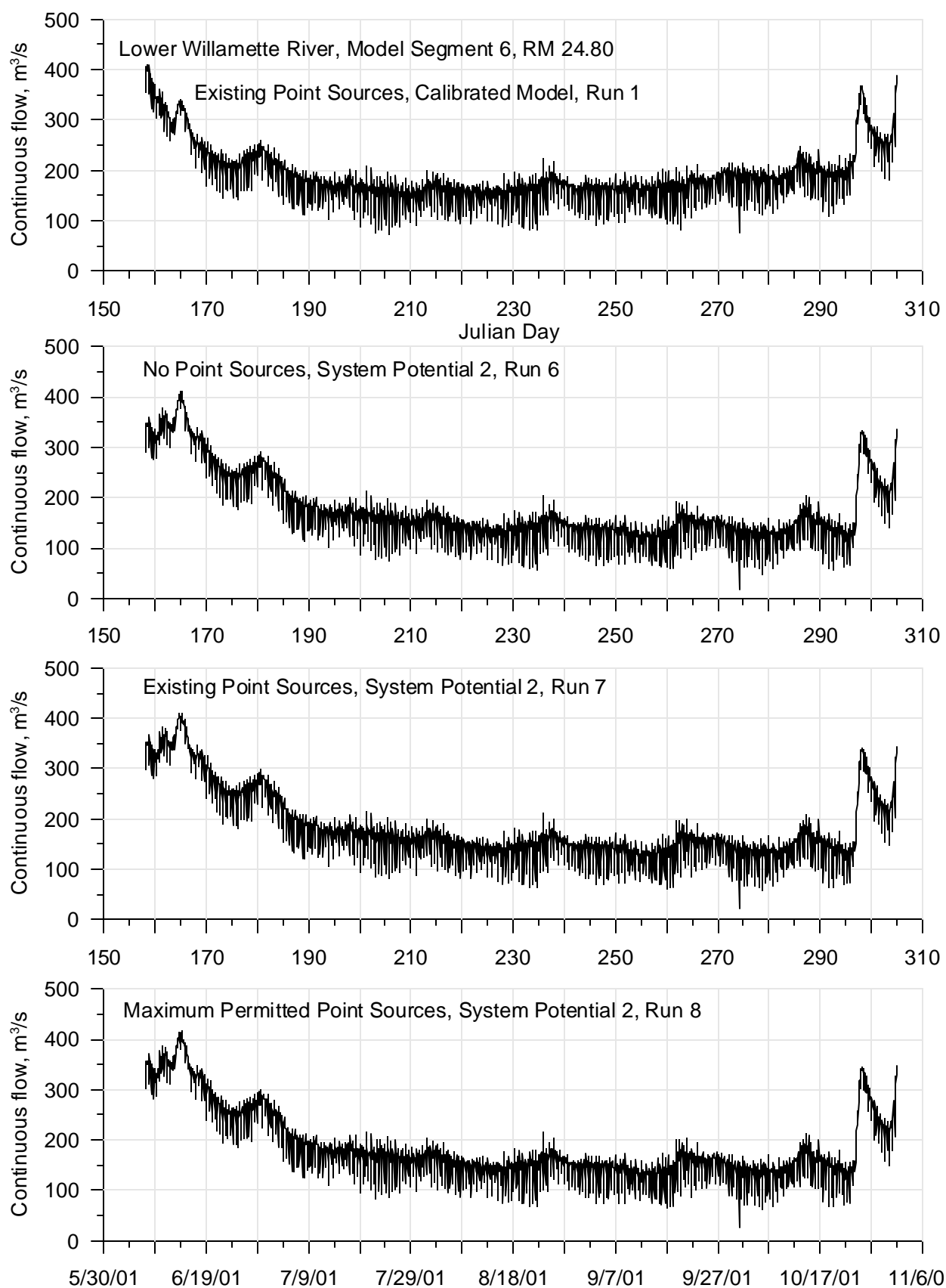
**Figure 153: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 35.72**



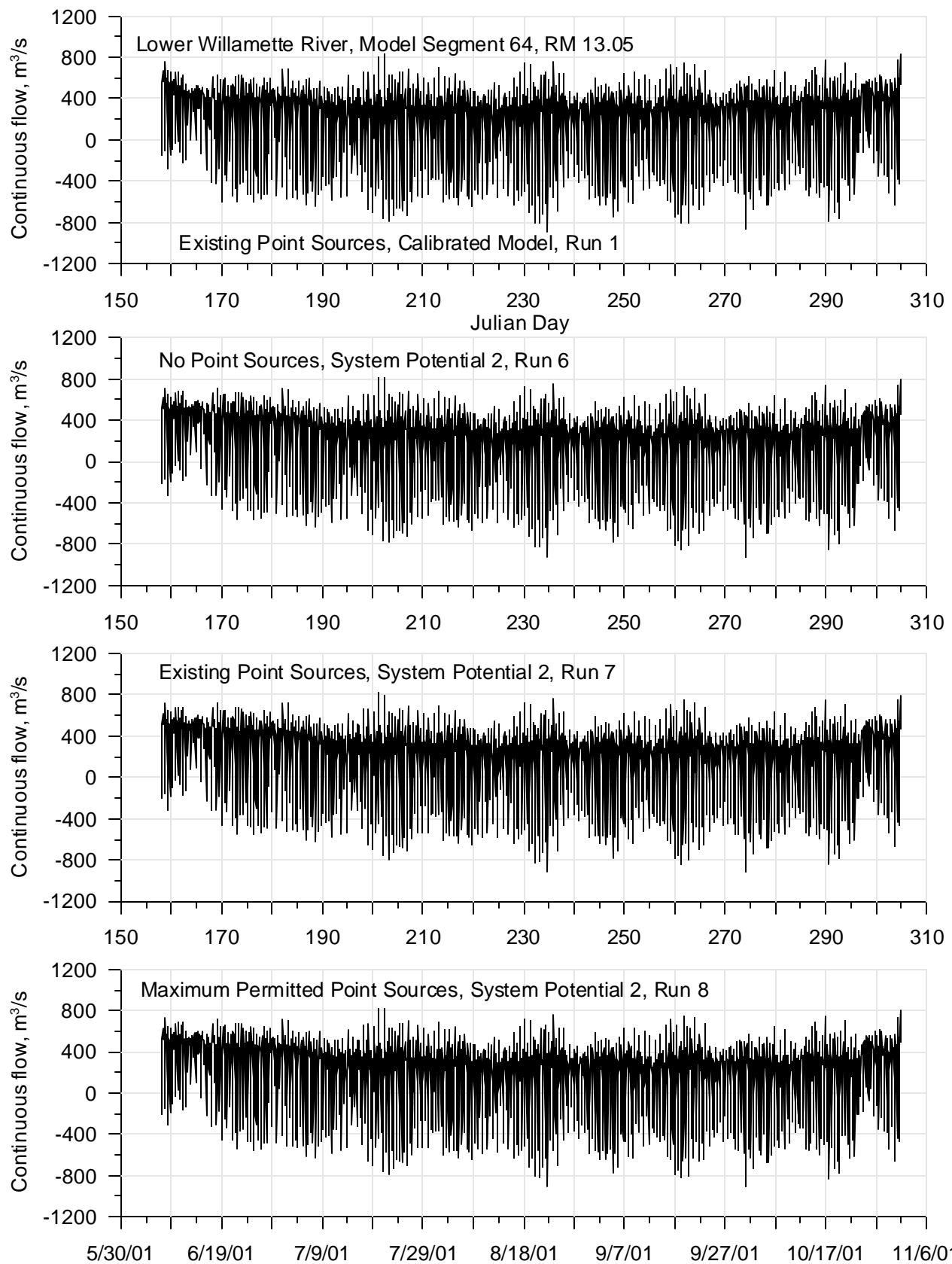
**Figure 154: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Clackamas River at RM 22.22**



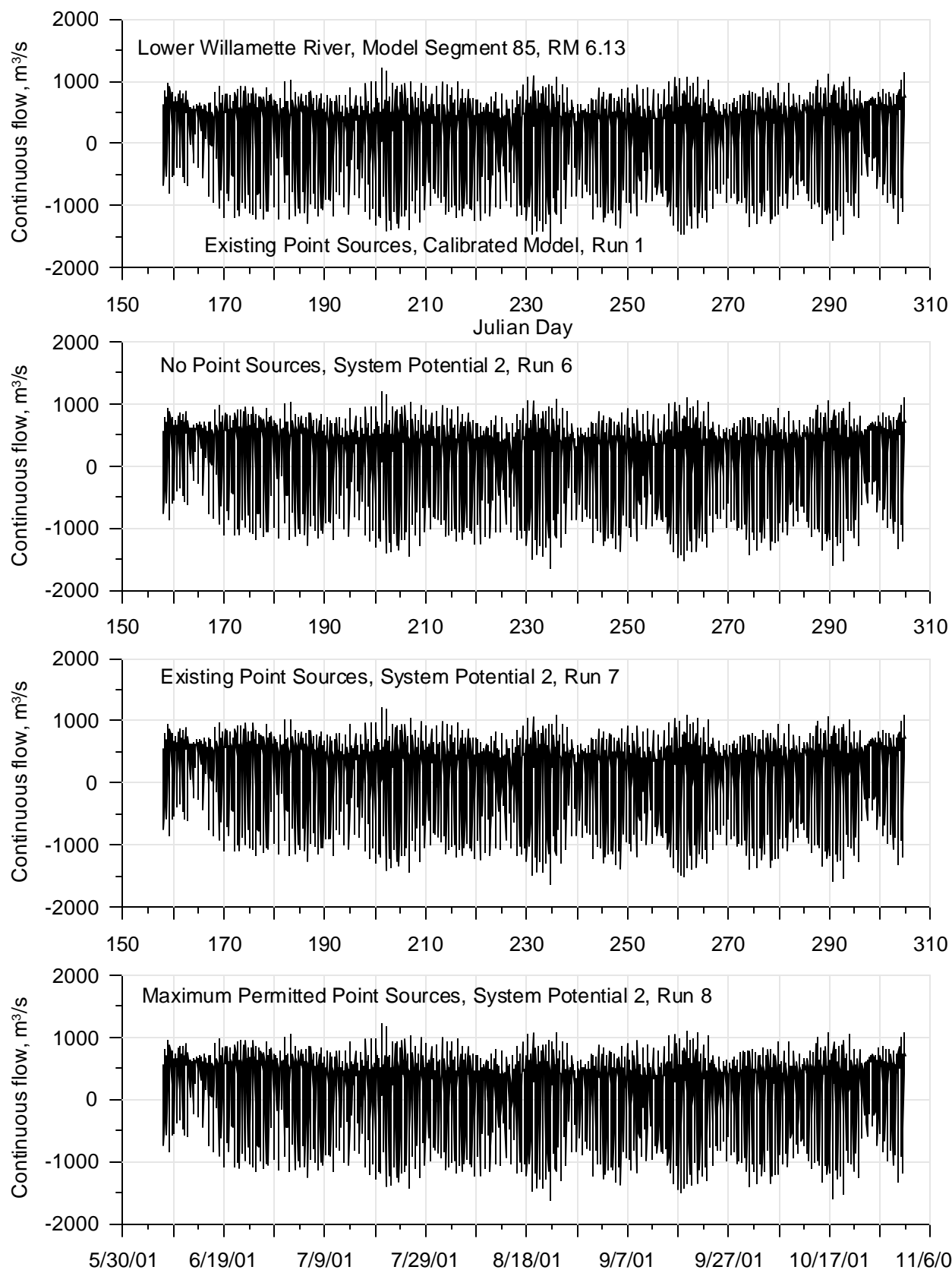
**Figure 155: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Clackamas River at RM 5.07**



**Figure 156: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 24.8**

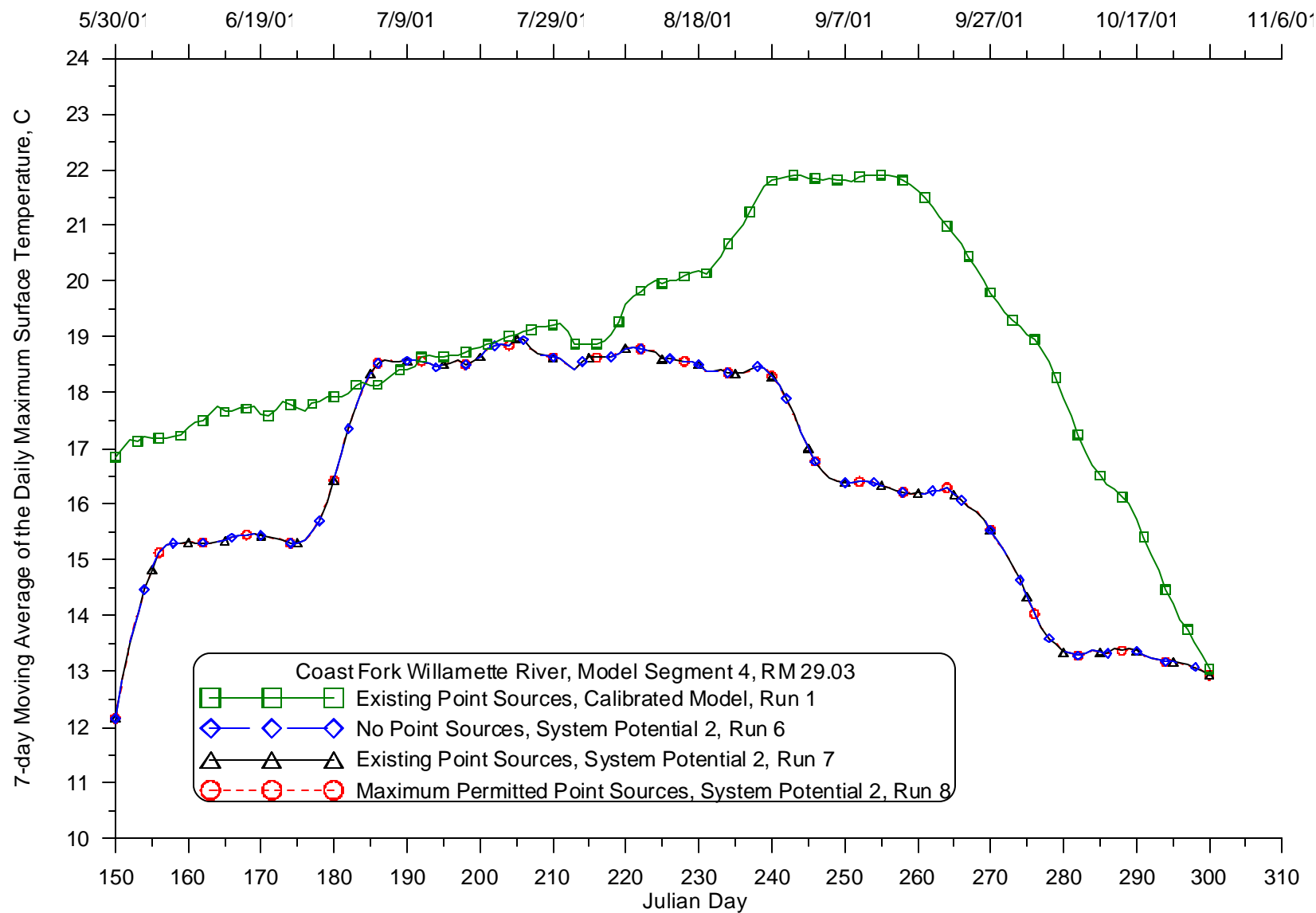


**Figure 157: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 13.05**



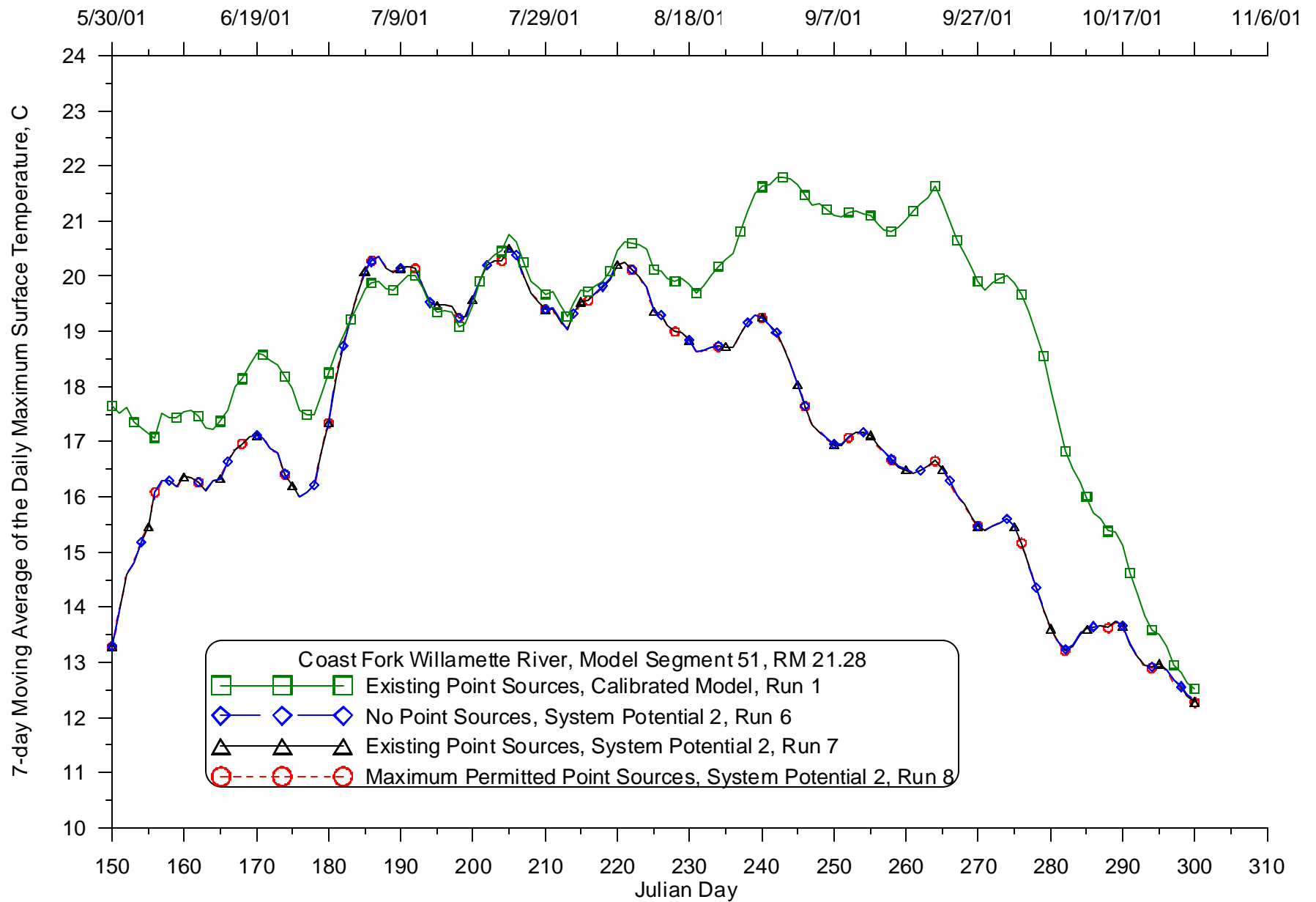
**Figure 158: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2001 for the Willamette River at RM 6.13**

**Daily seven day moving average of daily maximum temperature**



**Figure 159: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Coast Fork Willamette River at RM 29.03**





**Figure 160: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Coast Fork Willamette River at RM 21.28**

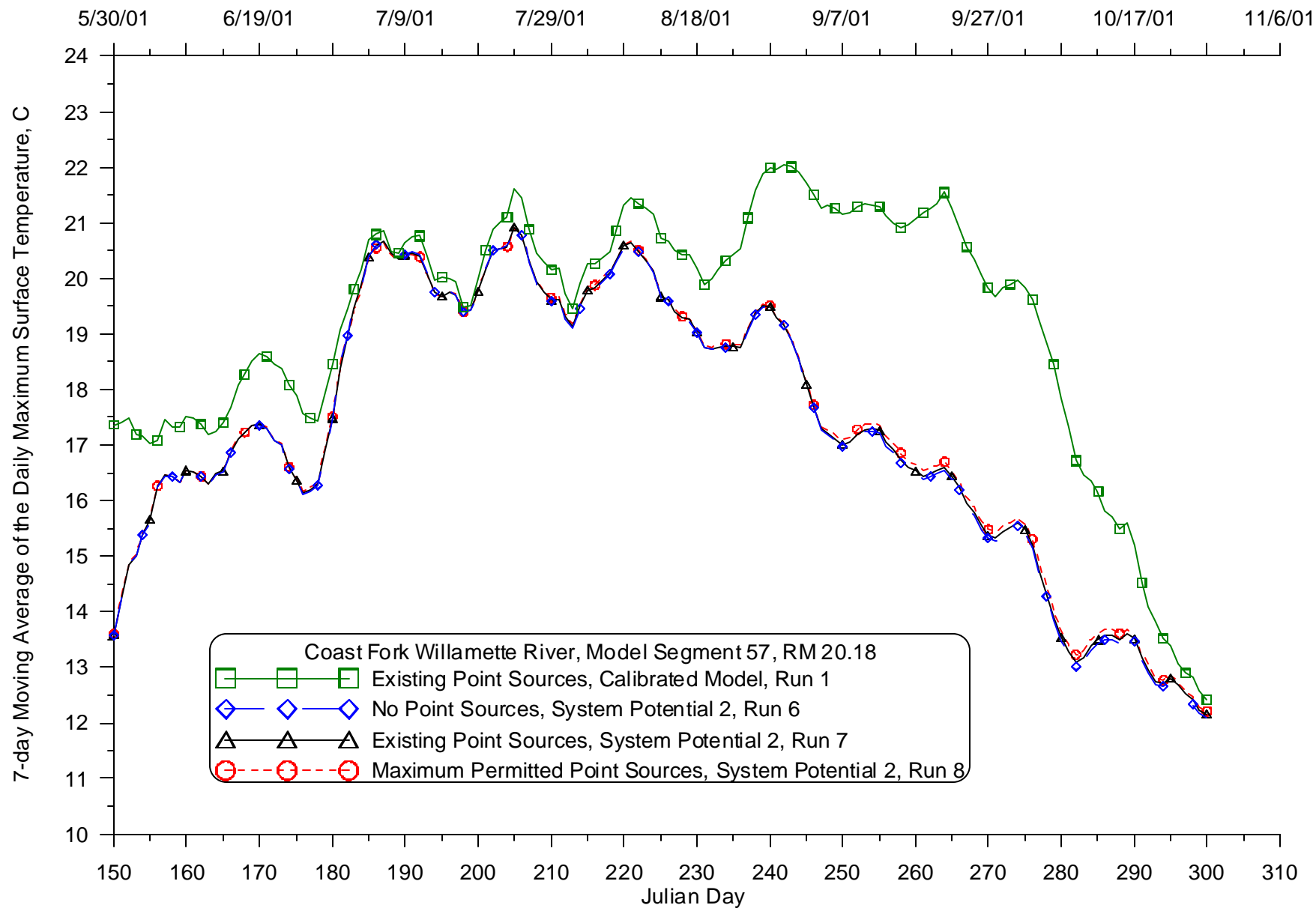
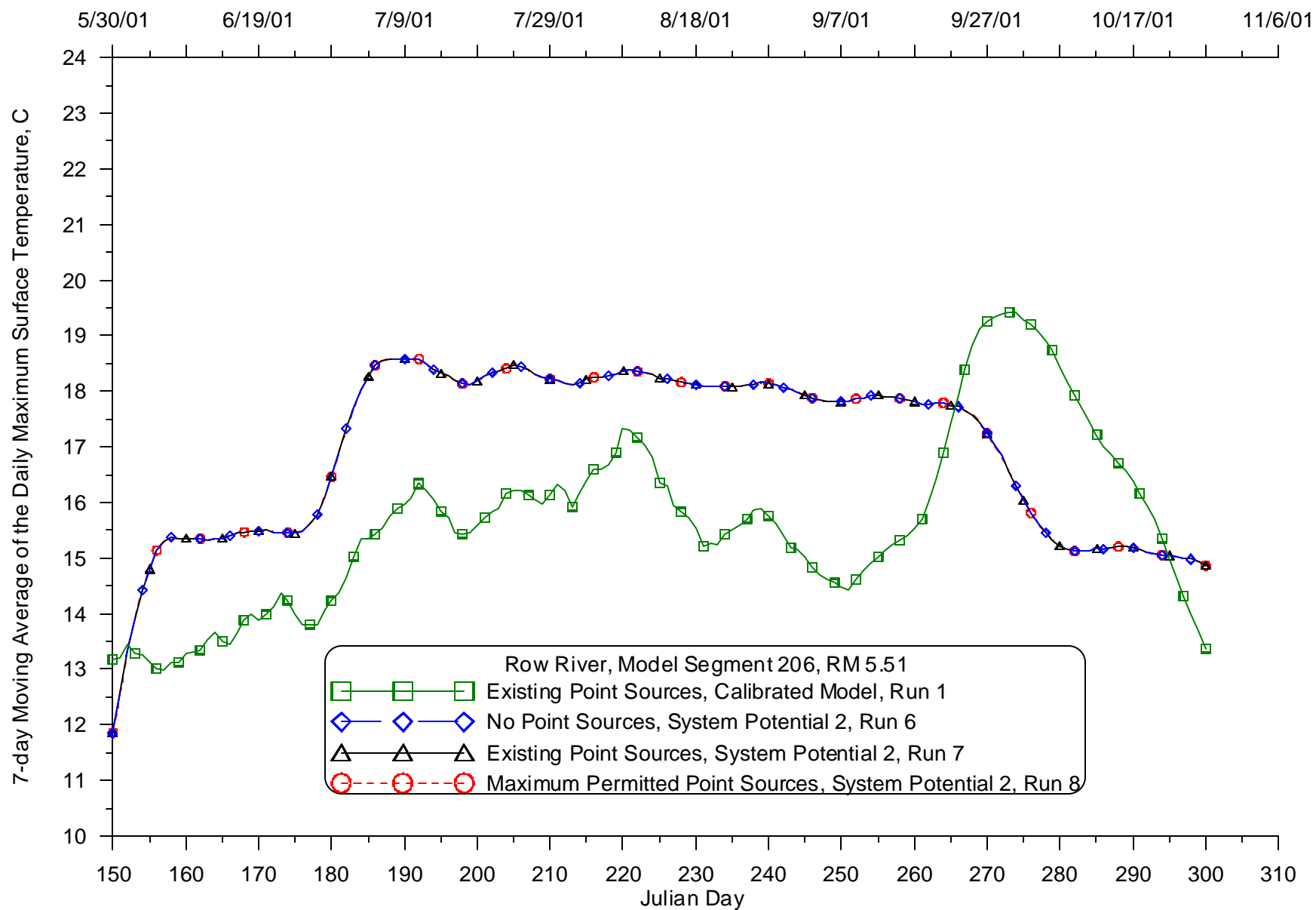
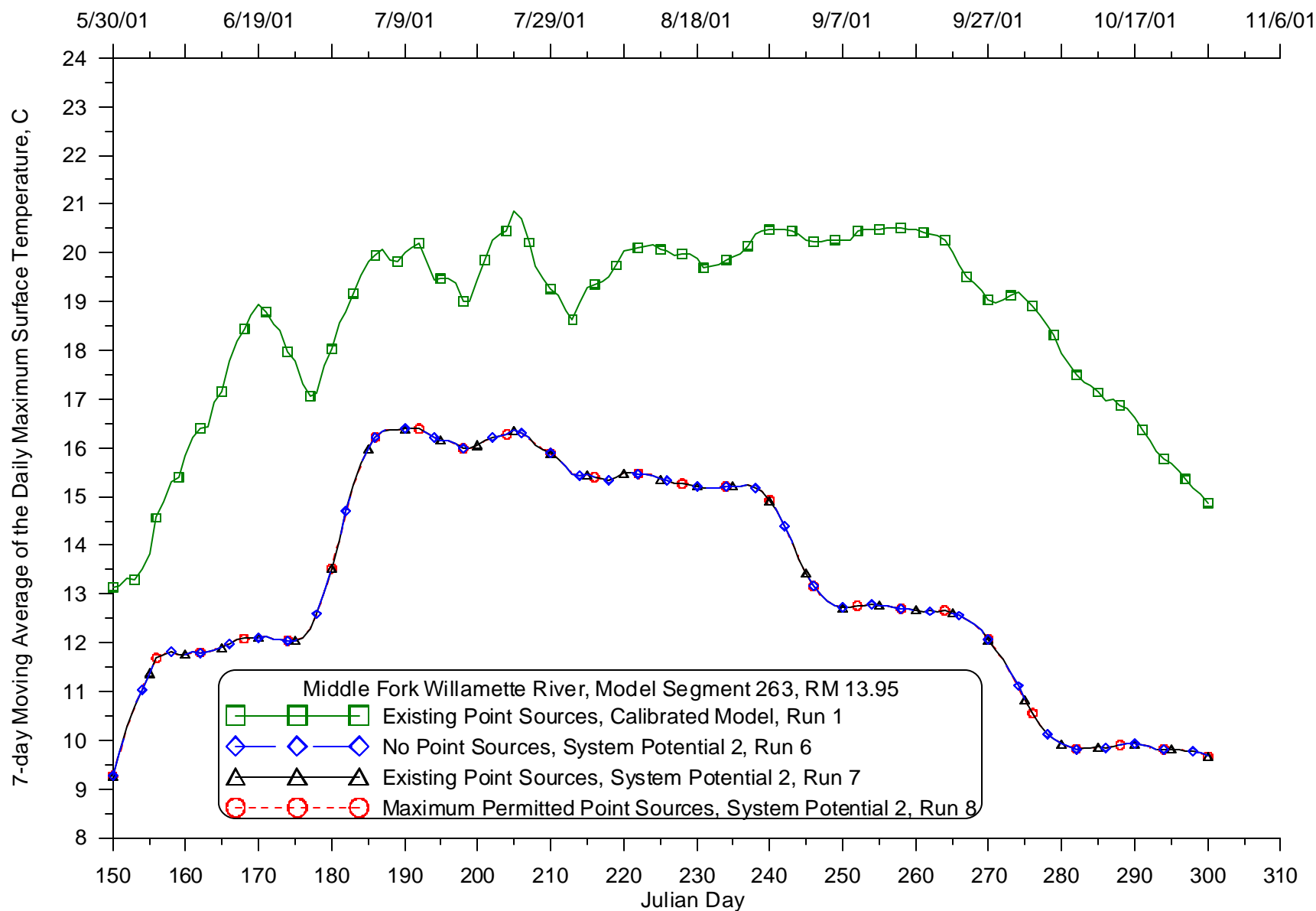


Figure 161: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Coast Fork Willamette River at RM 20.18



**Figure 162: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Row River at RM 5.51**



**Figure 163: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Middle Fork Willamette River at RM 13.95**

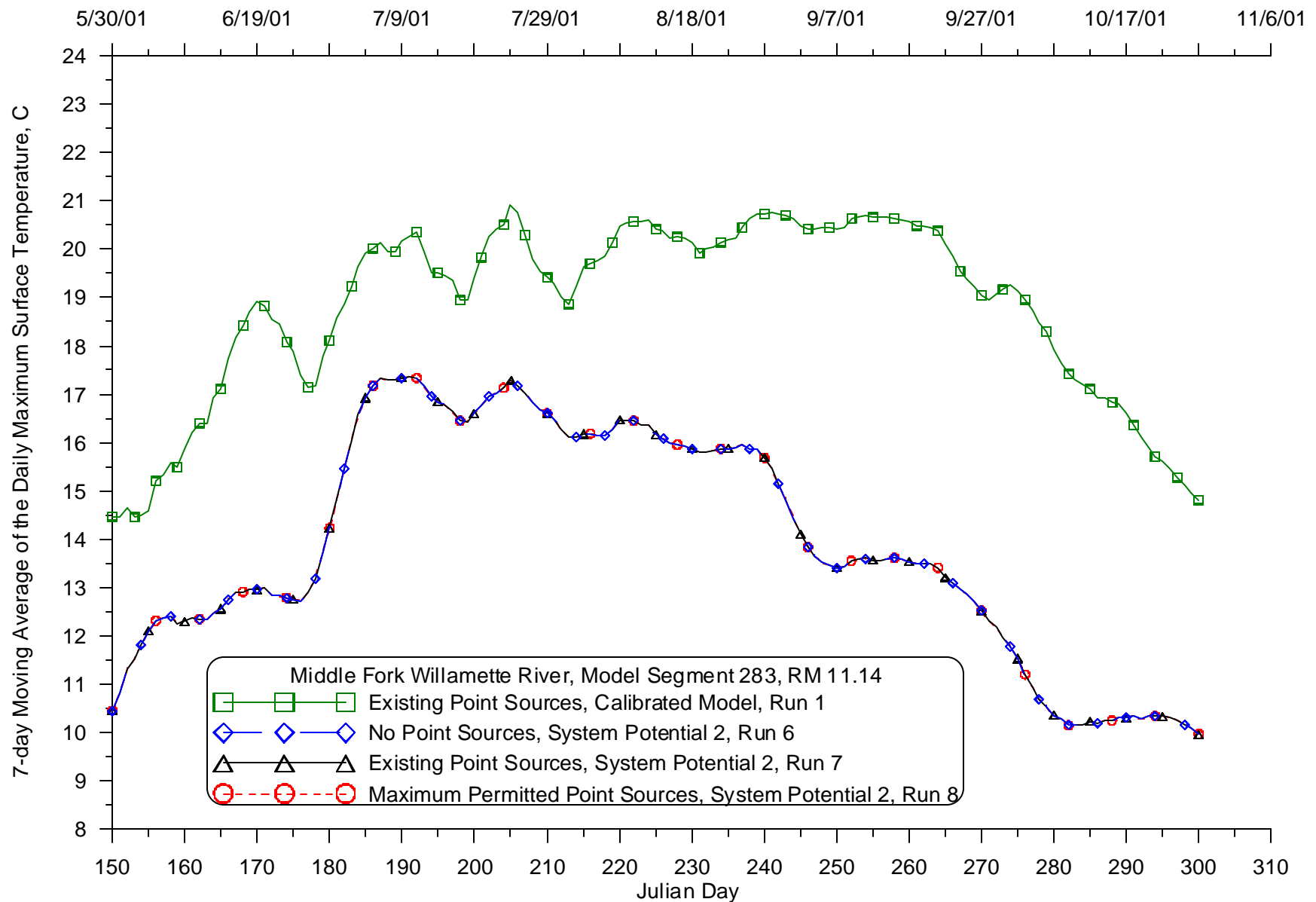
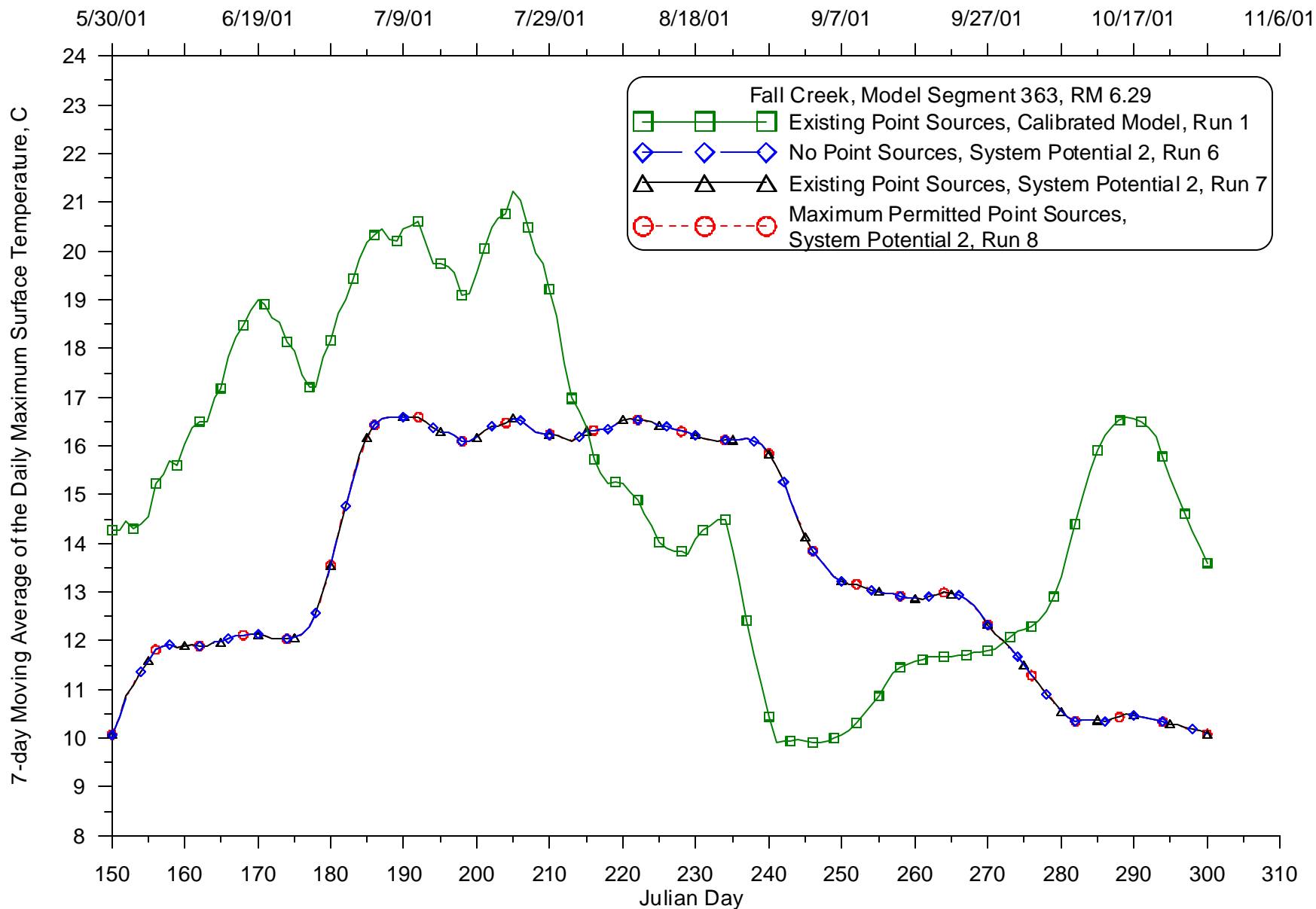


Figure 164: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Middle Fork Willamette River at RM 11.14



**Figure 165: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Fall Creek at RM 6.29**

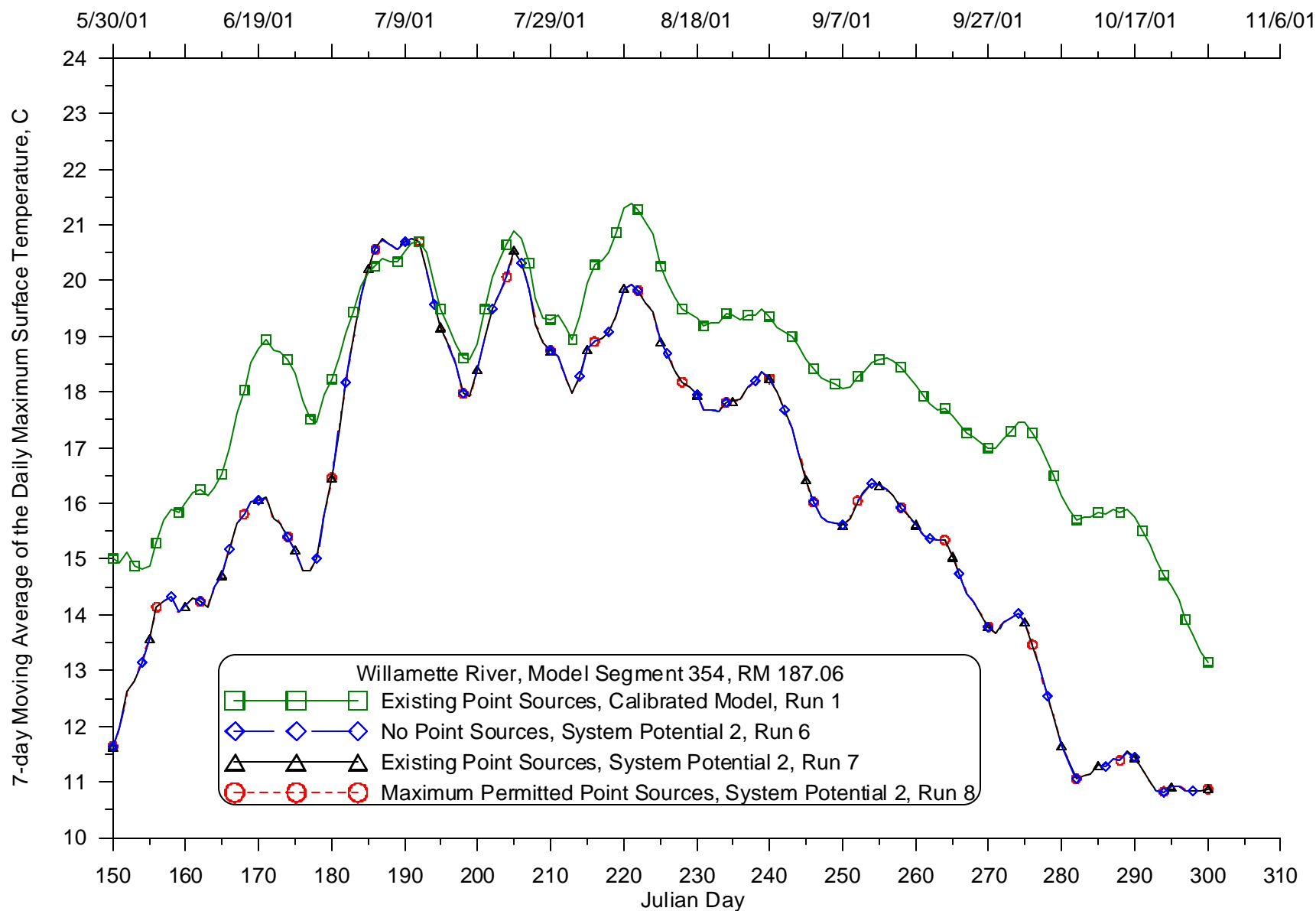
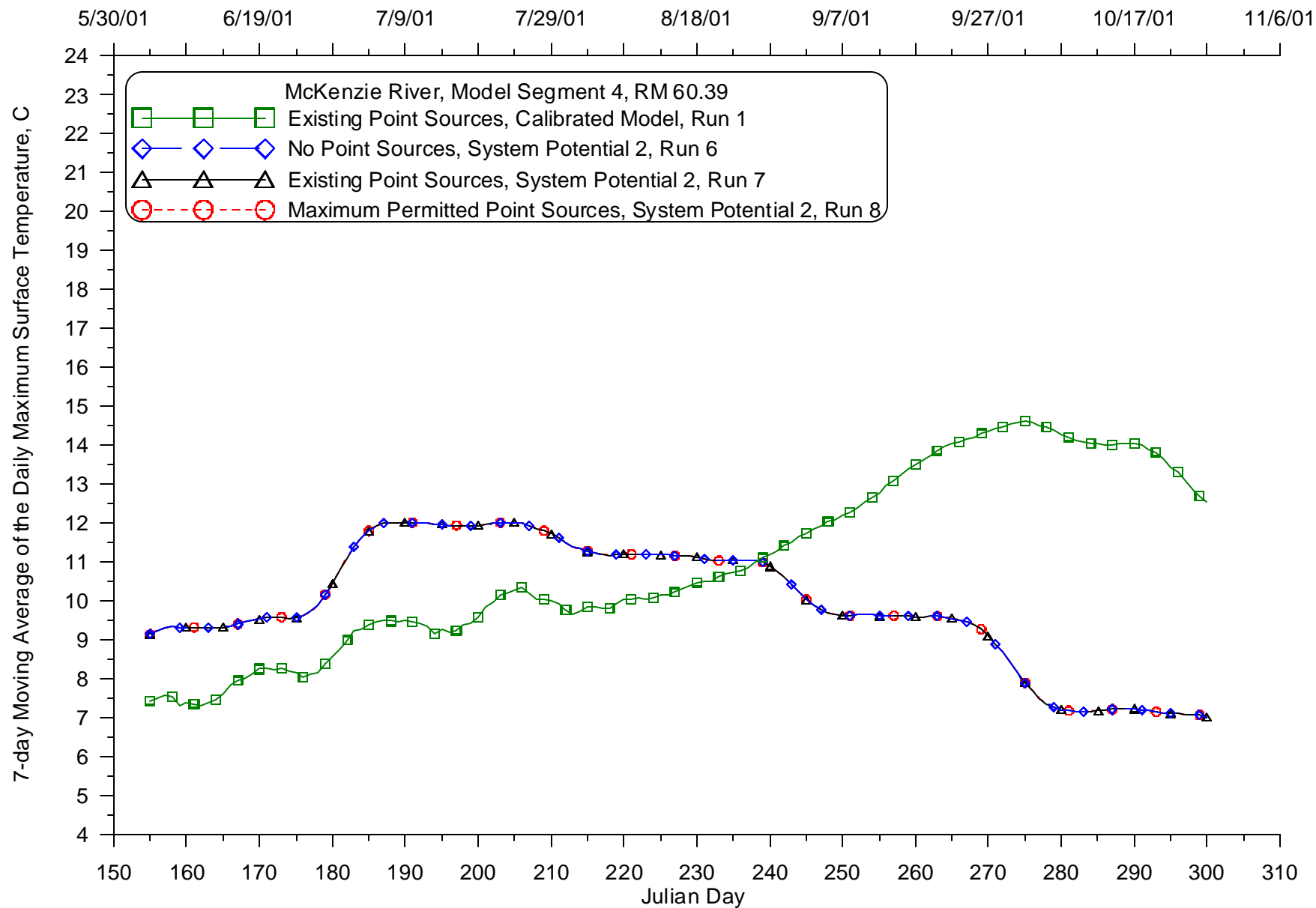
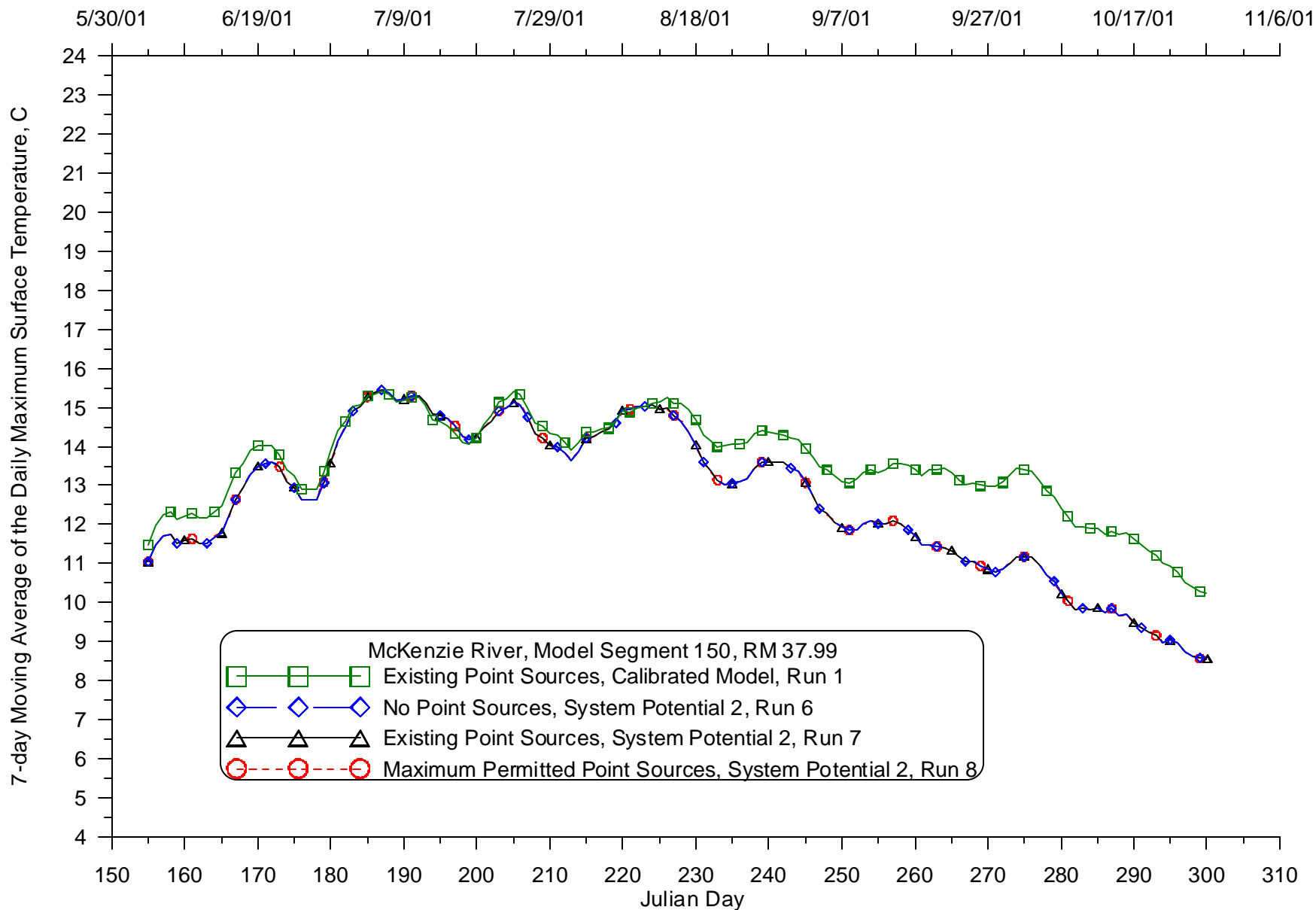


Figure 166: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 187.06

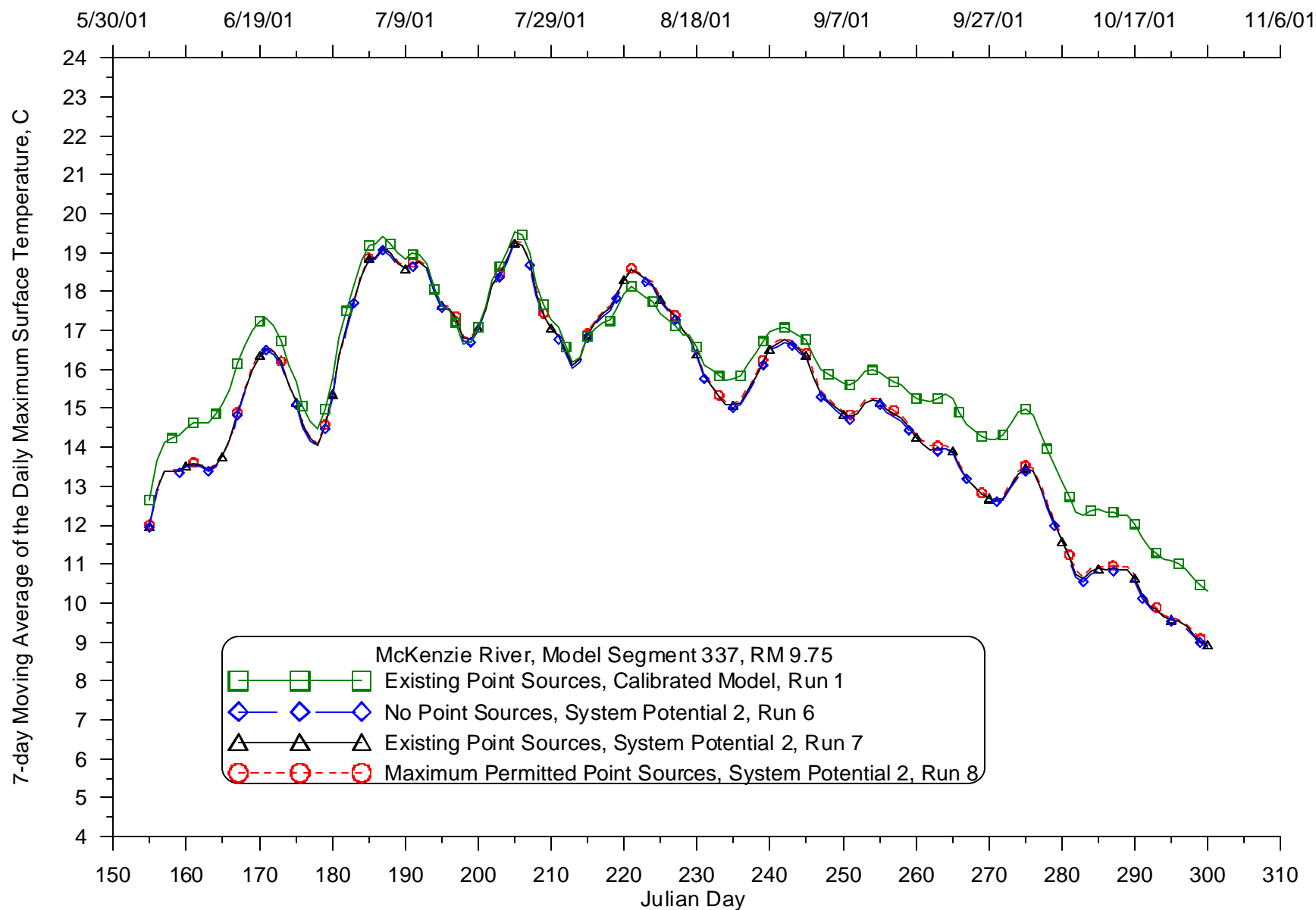


**Figure 167: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the McKenzie River at RM 60.39**

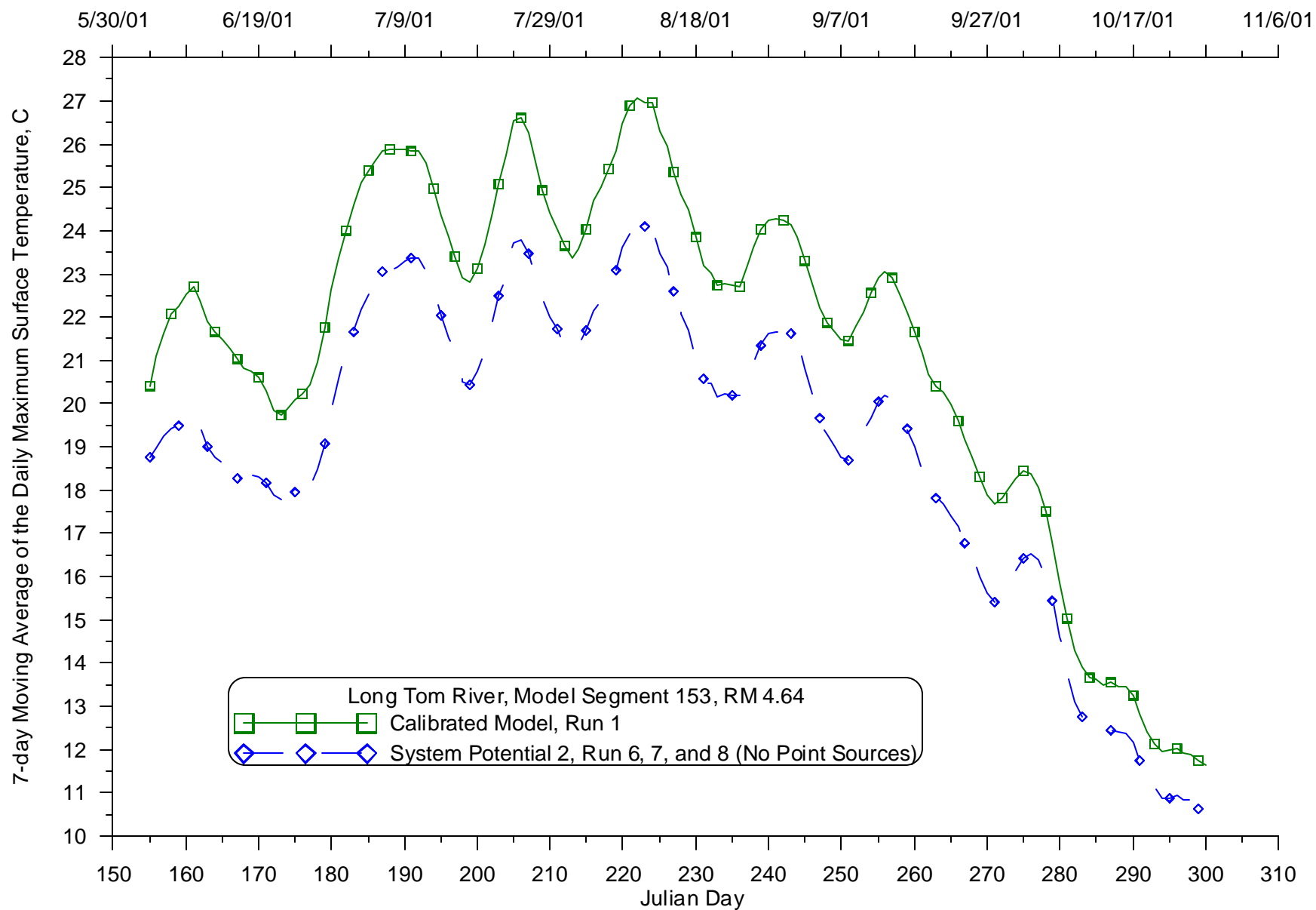




**Figure 168: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the McKenzie River at RM 37.99**



**Figure 169: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the McKenzie River at RM 9.75**



**Figure 170: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Long Tom River at RM 4.64**

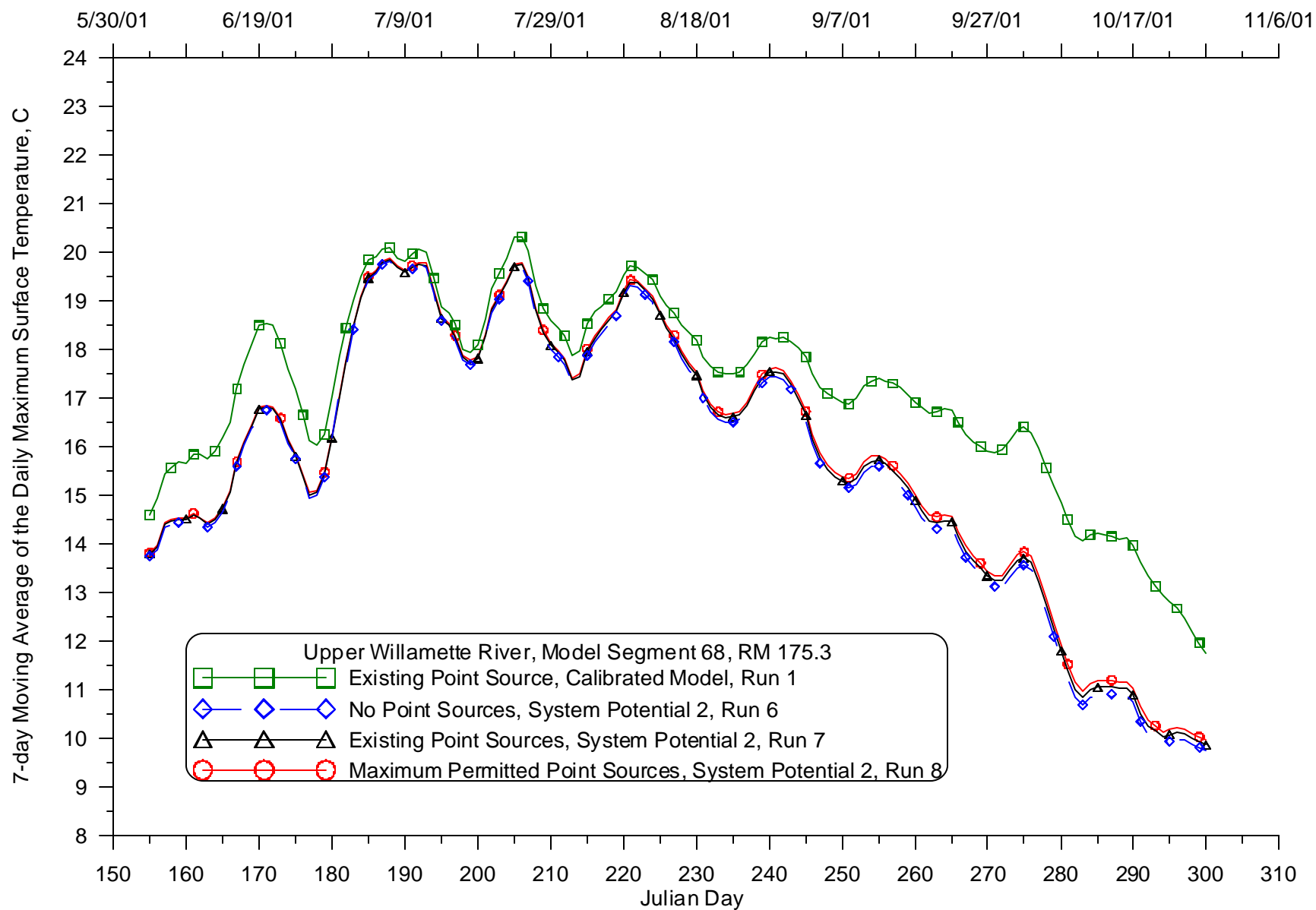


Figure 171: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 175.3

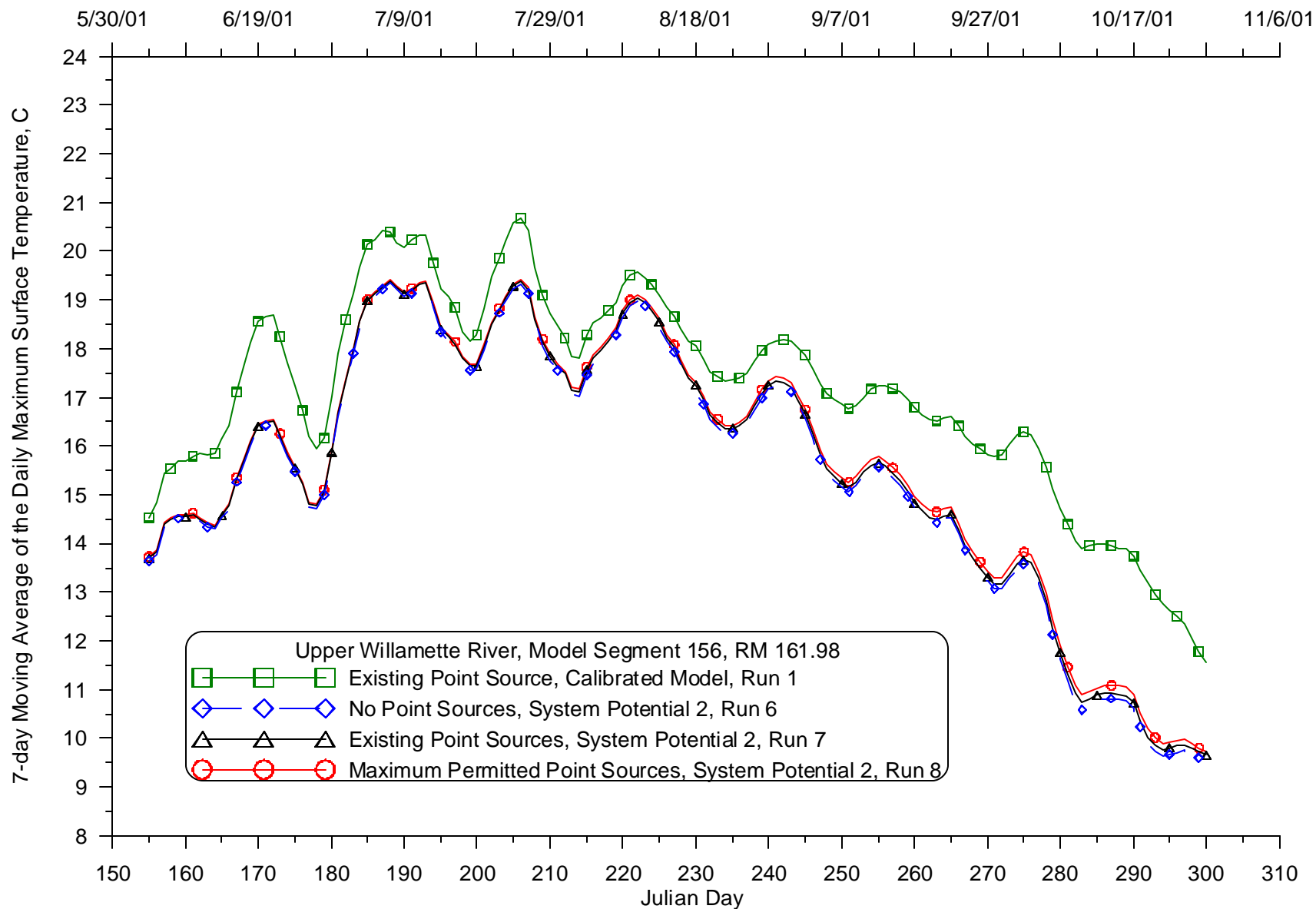


Figure 172: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 161.98

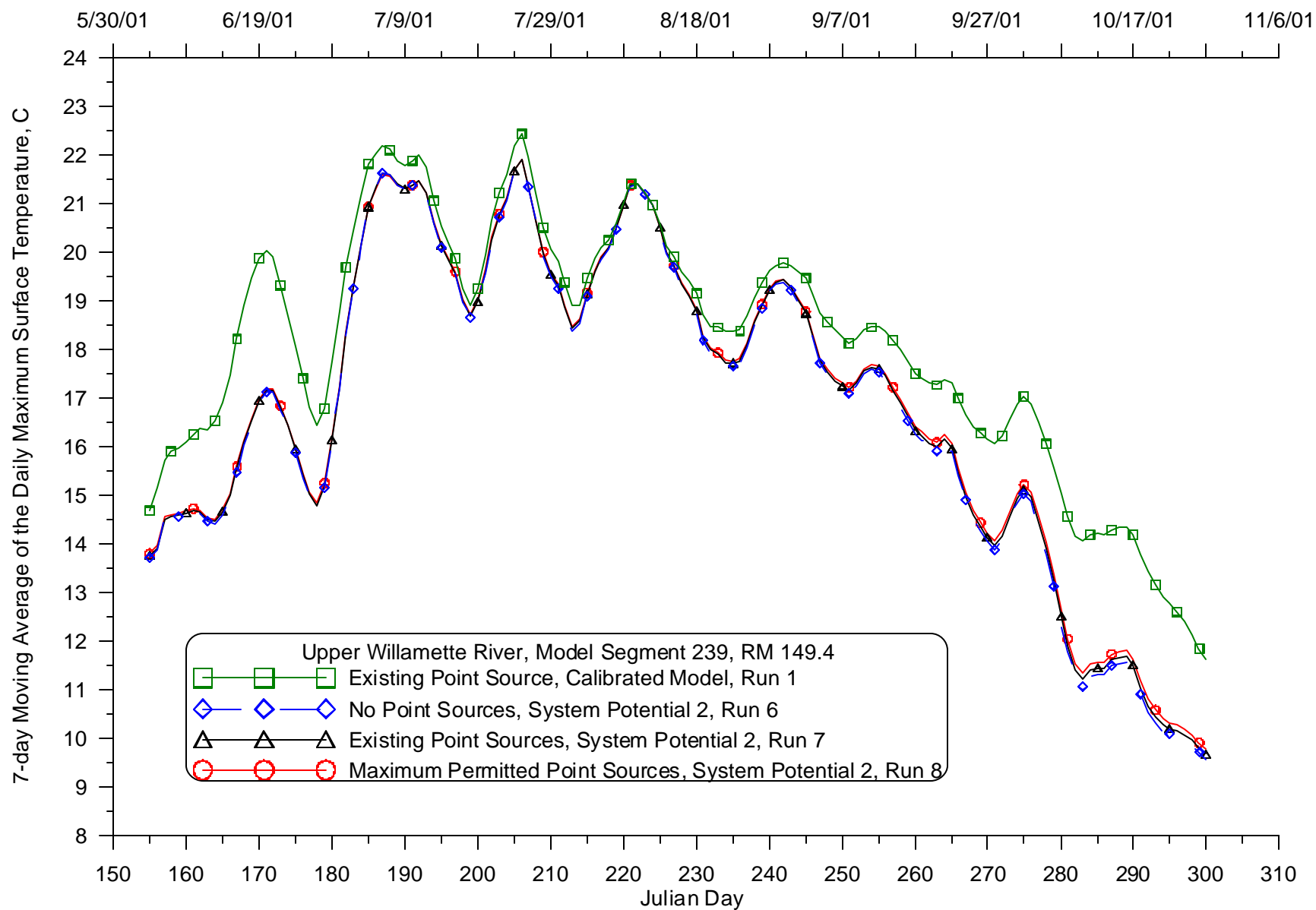


Figure 173: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 149.4

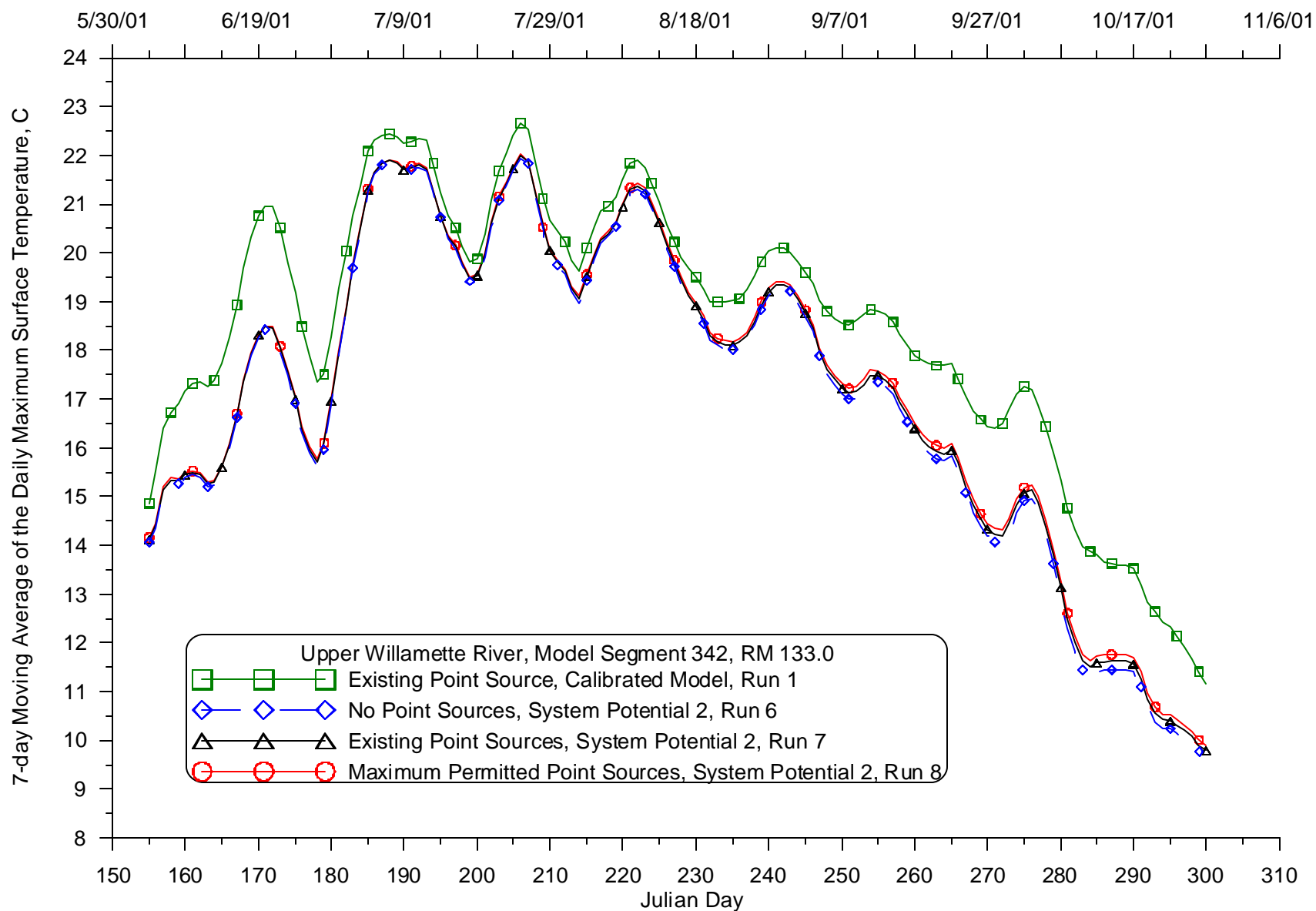


Figure 174: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 133

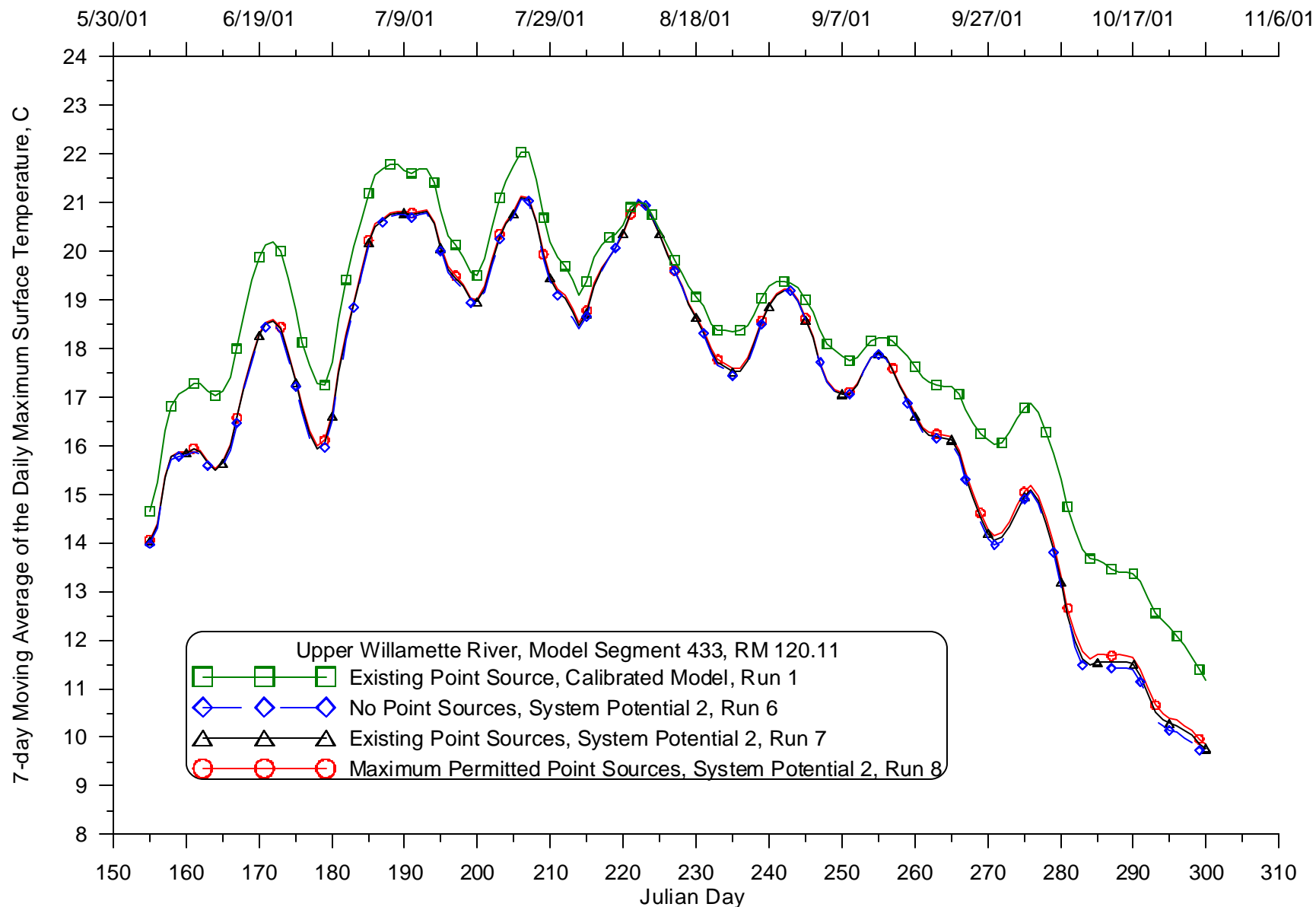
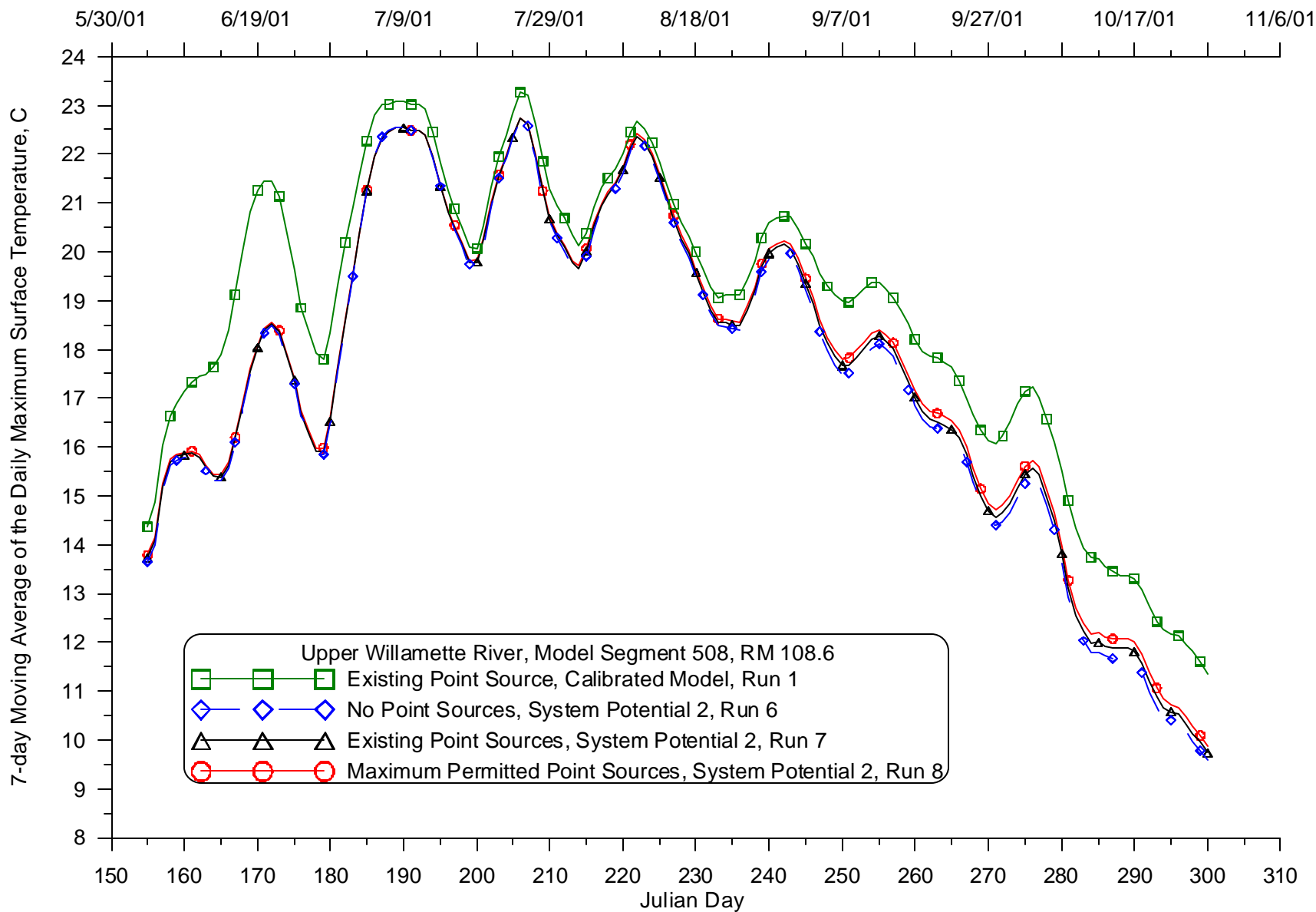
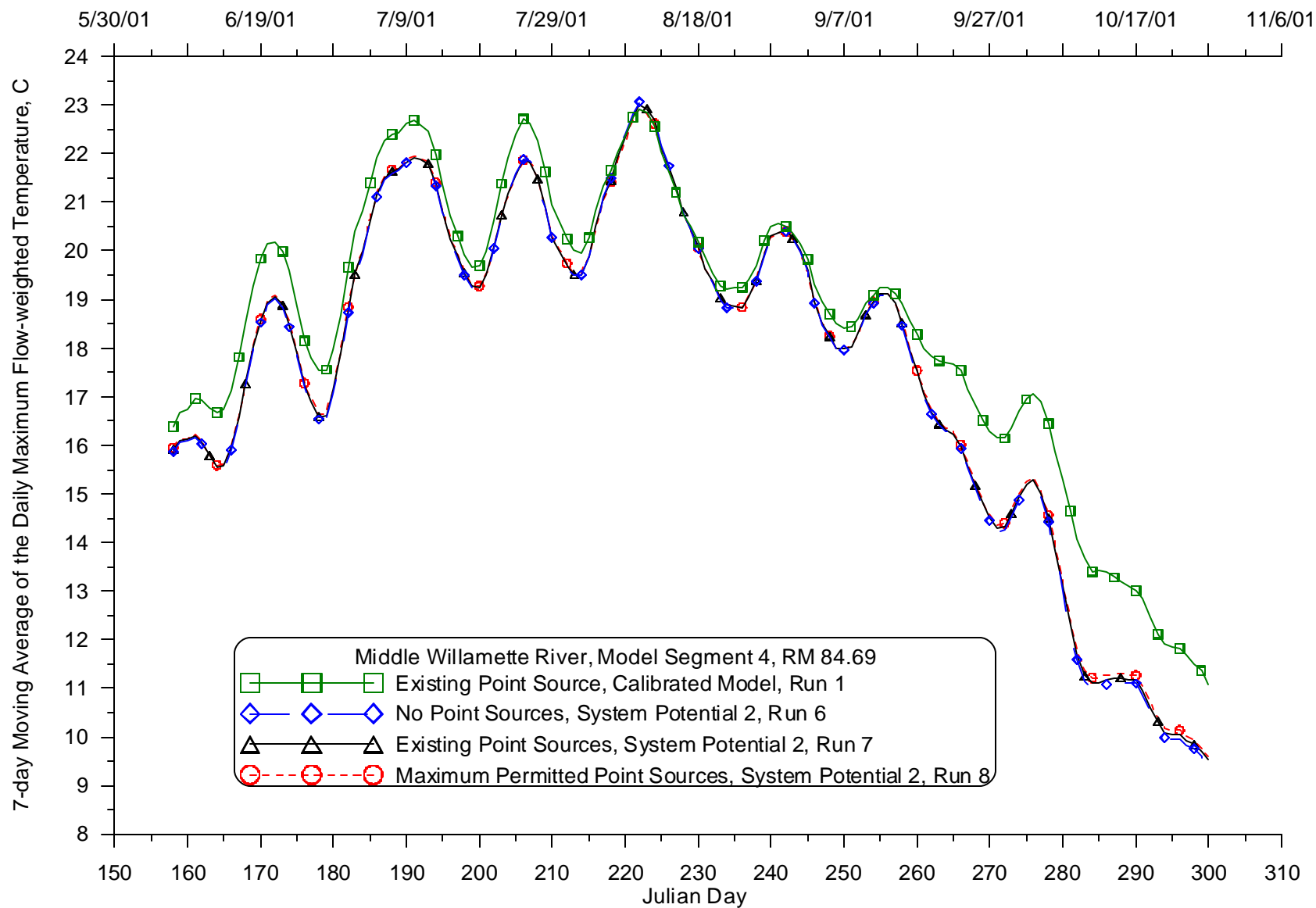


Figure 175: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 120.11

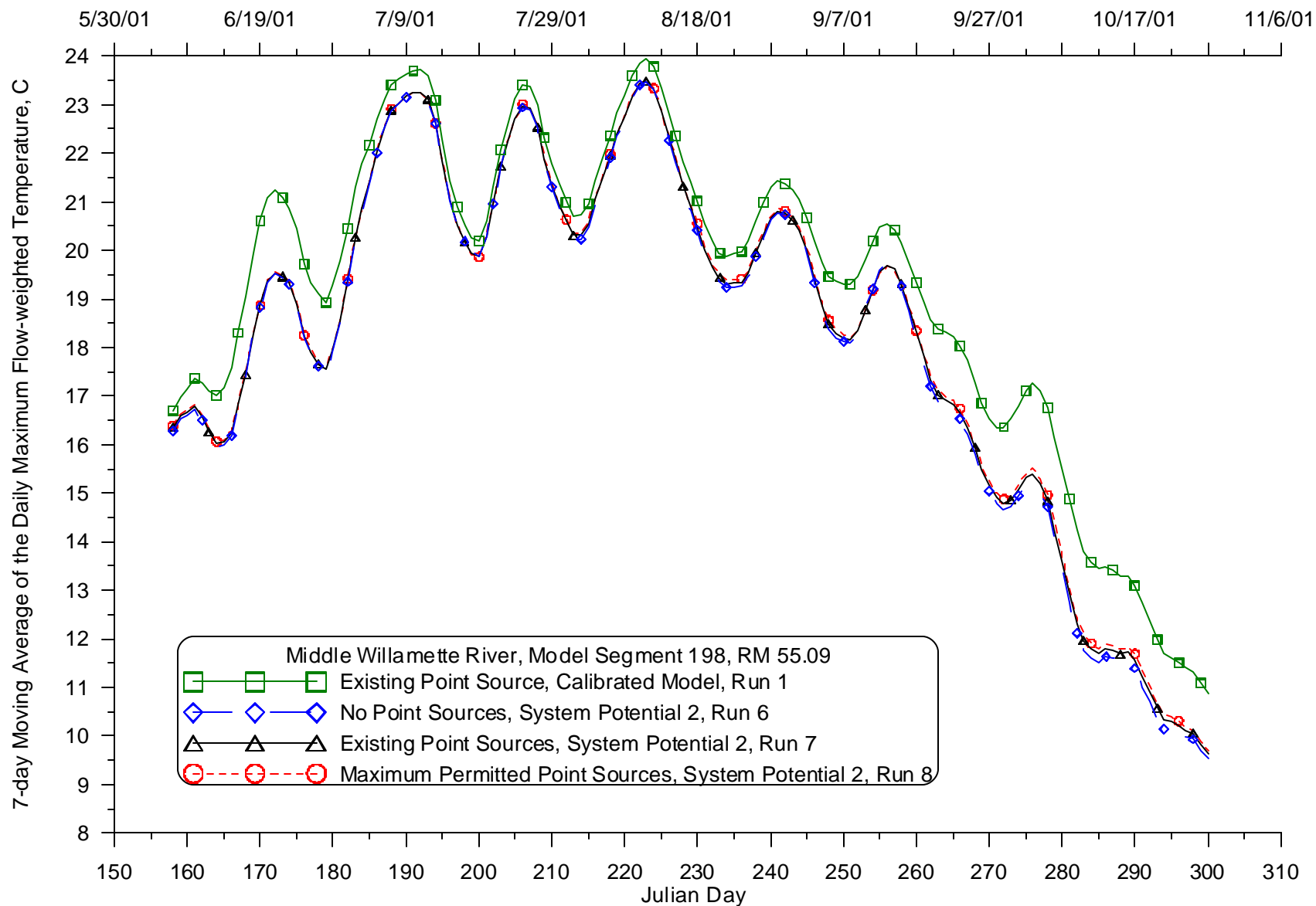




**Figure 176: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 108.6**



**Figure 177: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 84.69**



**Figure 178: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 55.09**

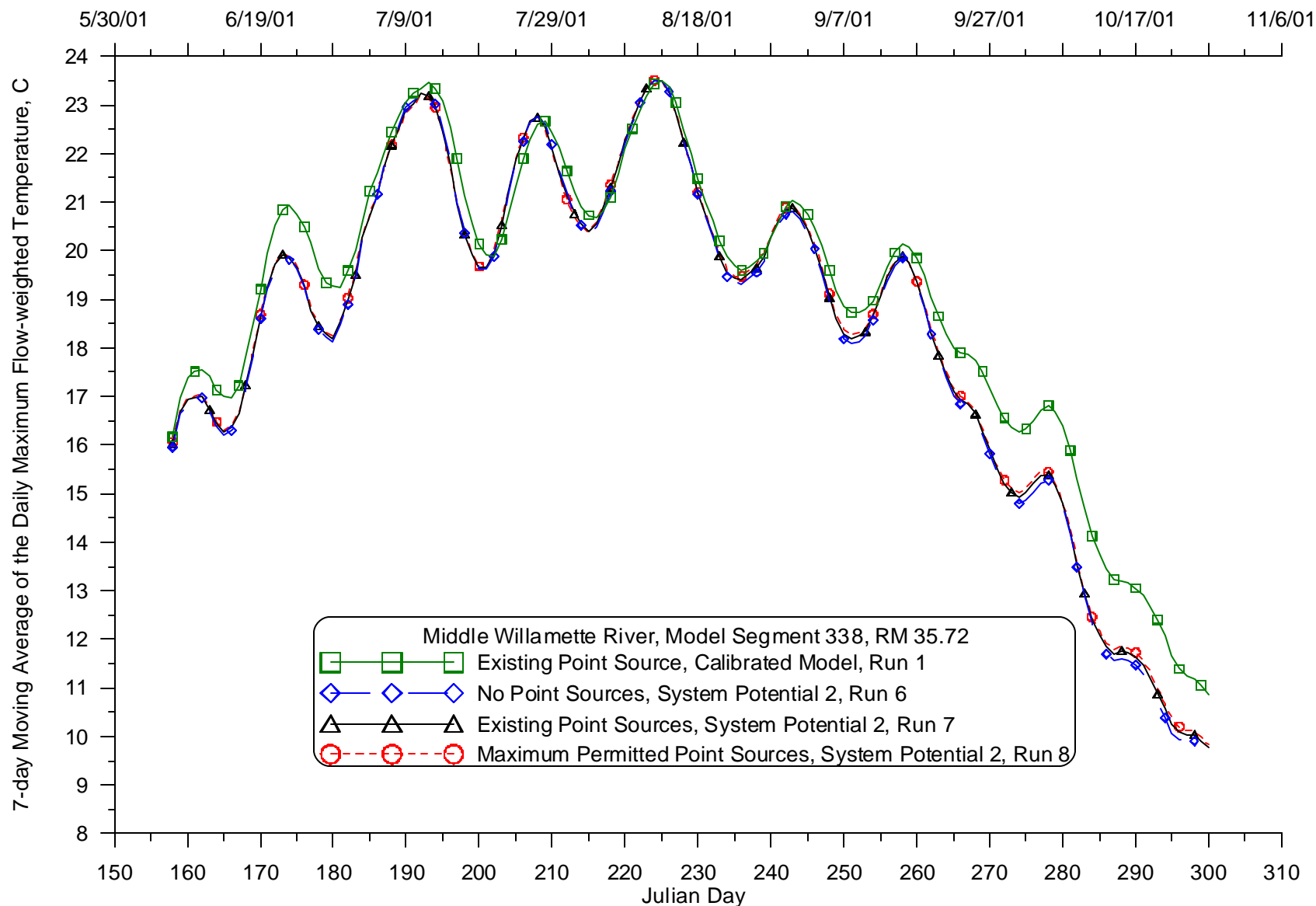
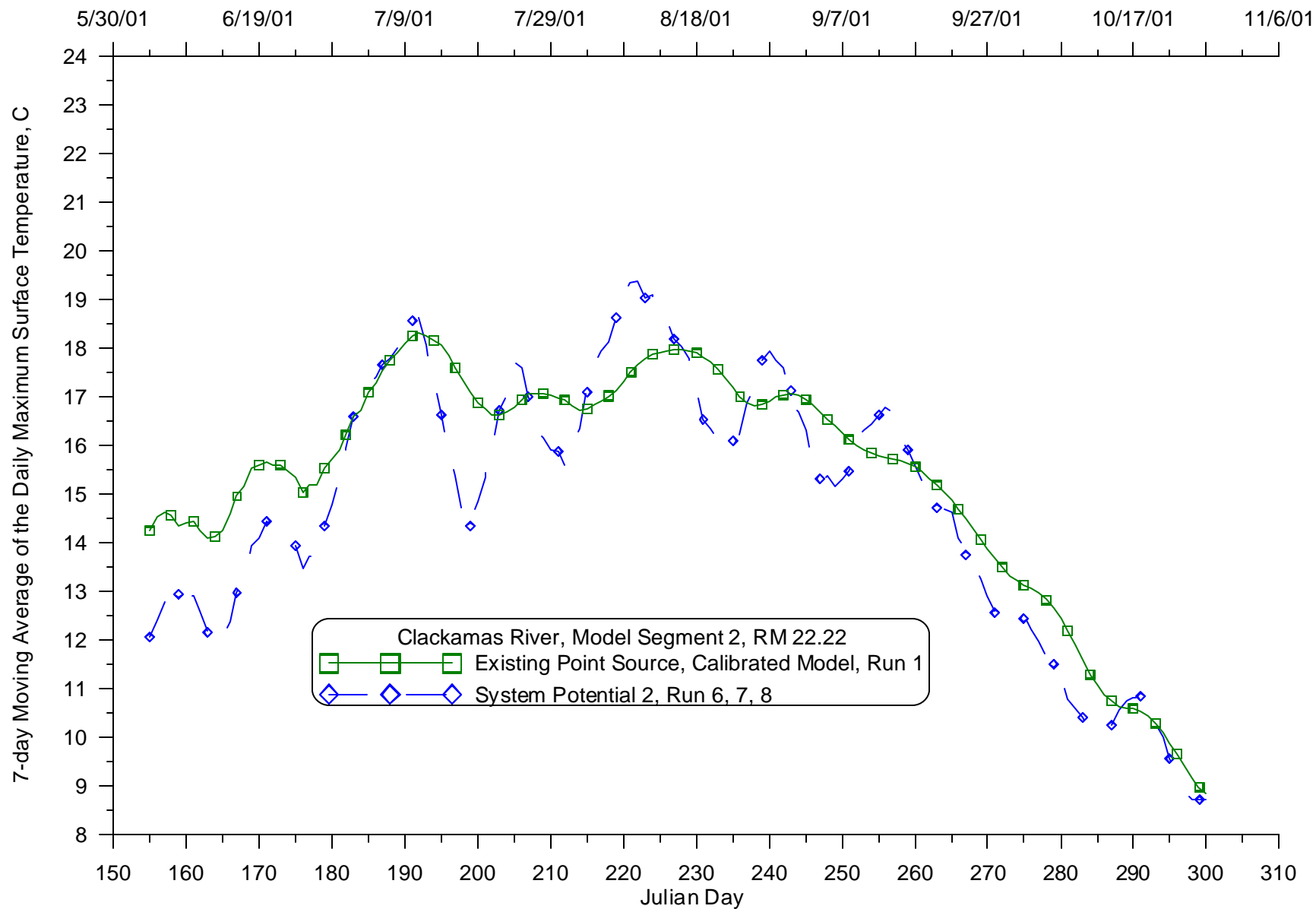
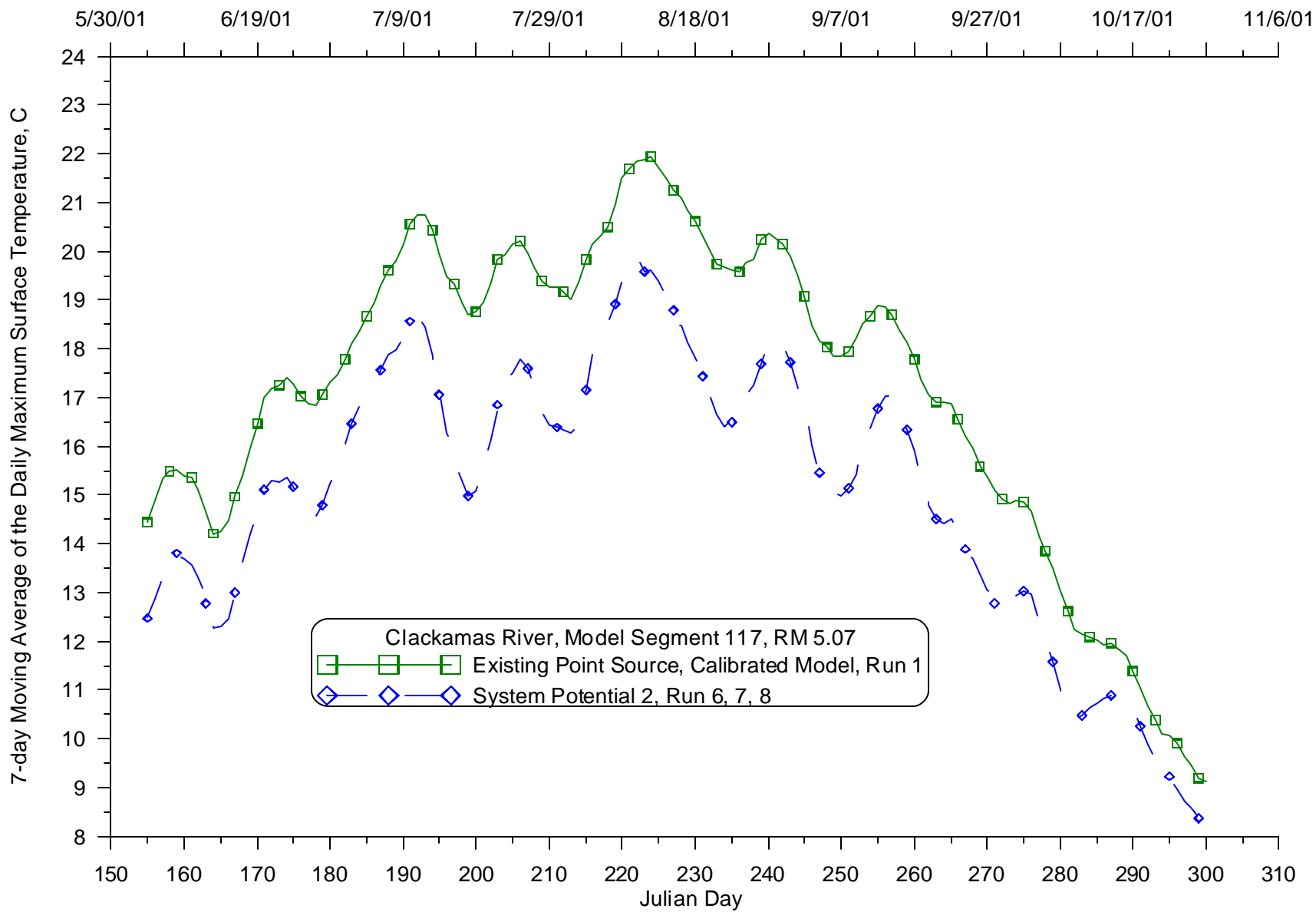


Figure 179: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 35.72



**Figure 180: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Clackamas River at RM 22.22**



**Figure 181: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Clackamas River at RM 5.07**

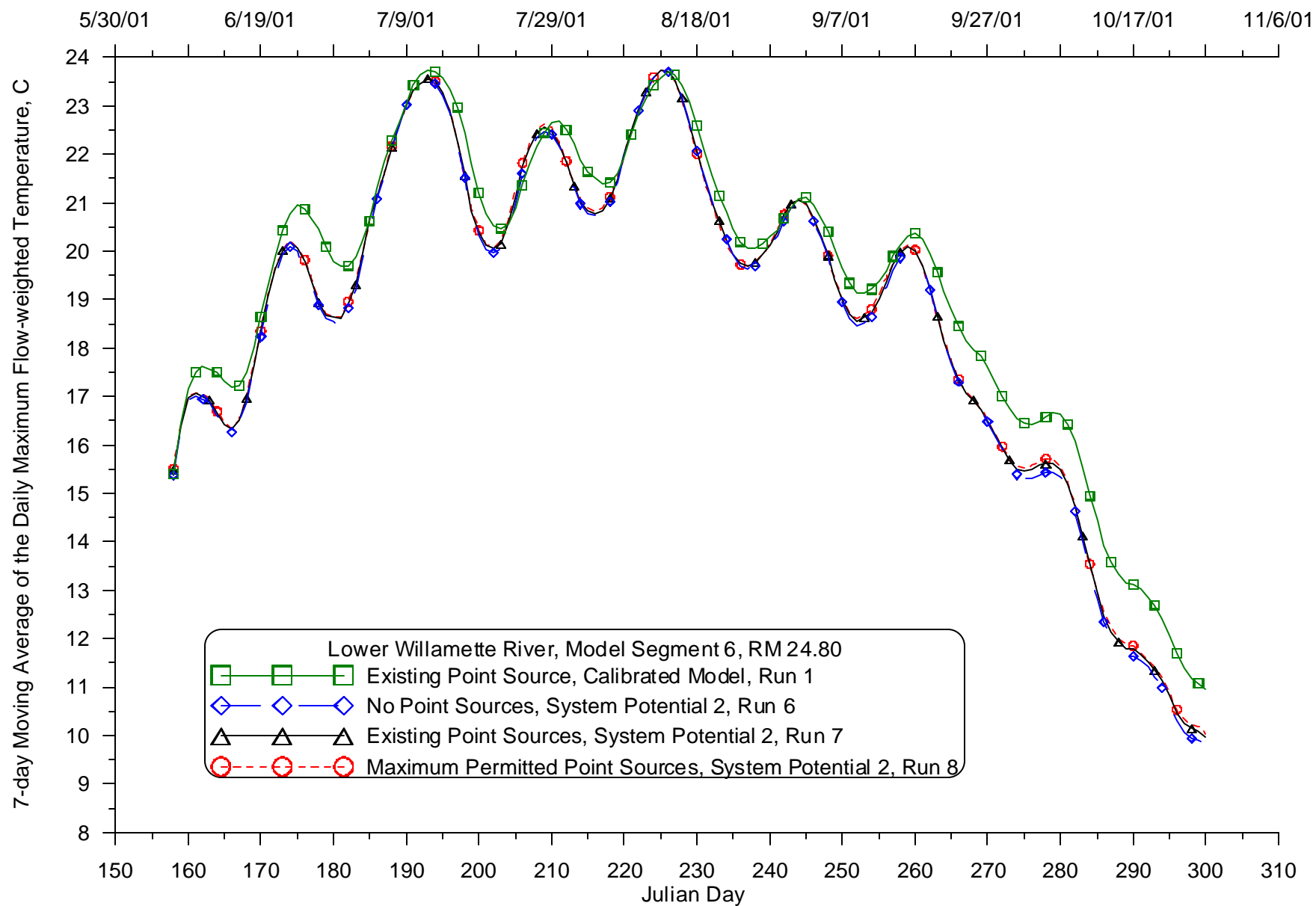


Figure 182: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 24.8

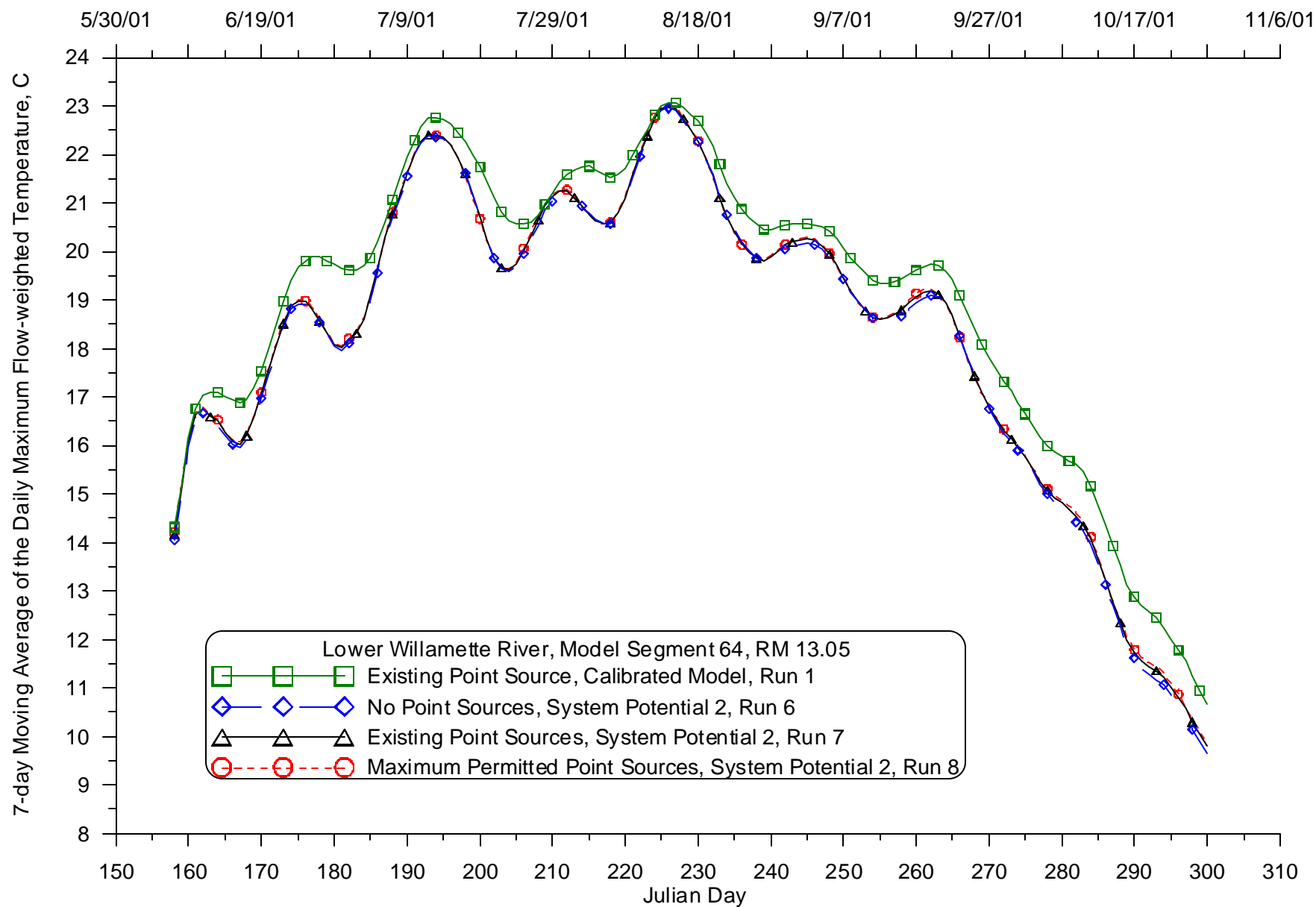


Figure 183: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 13.05



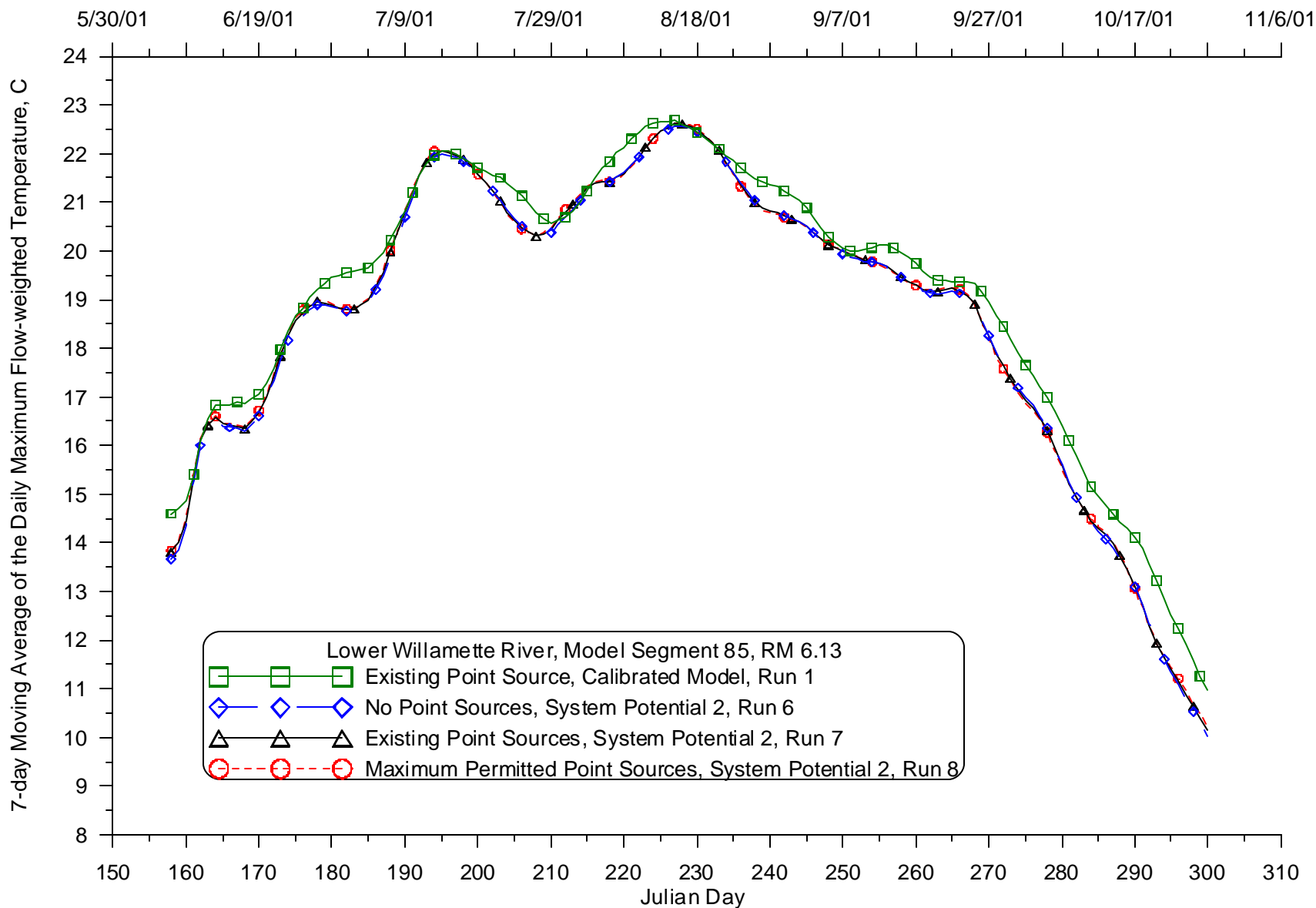


Figure 184: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2001 for the Willamette River at RM 6.13

**Daily seven day average flow**

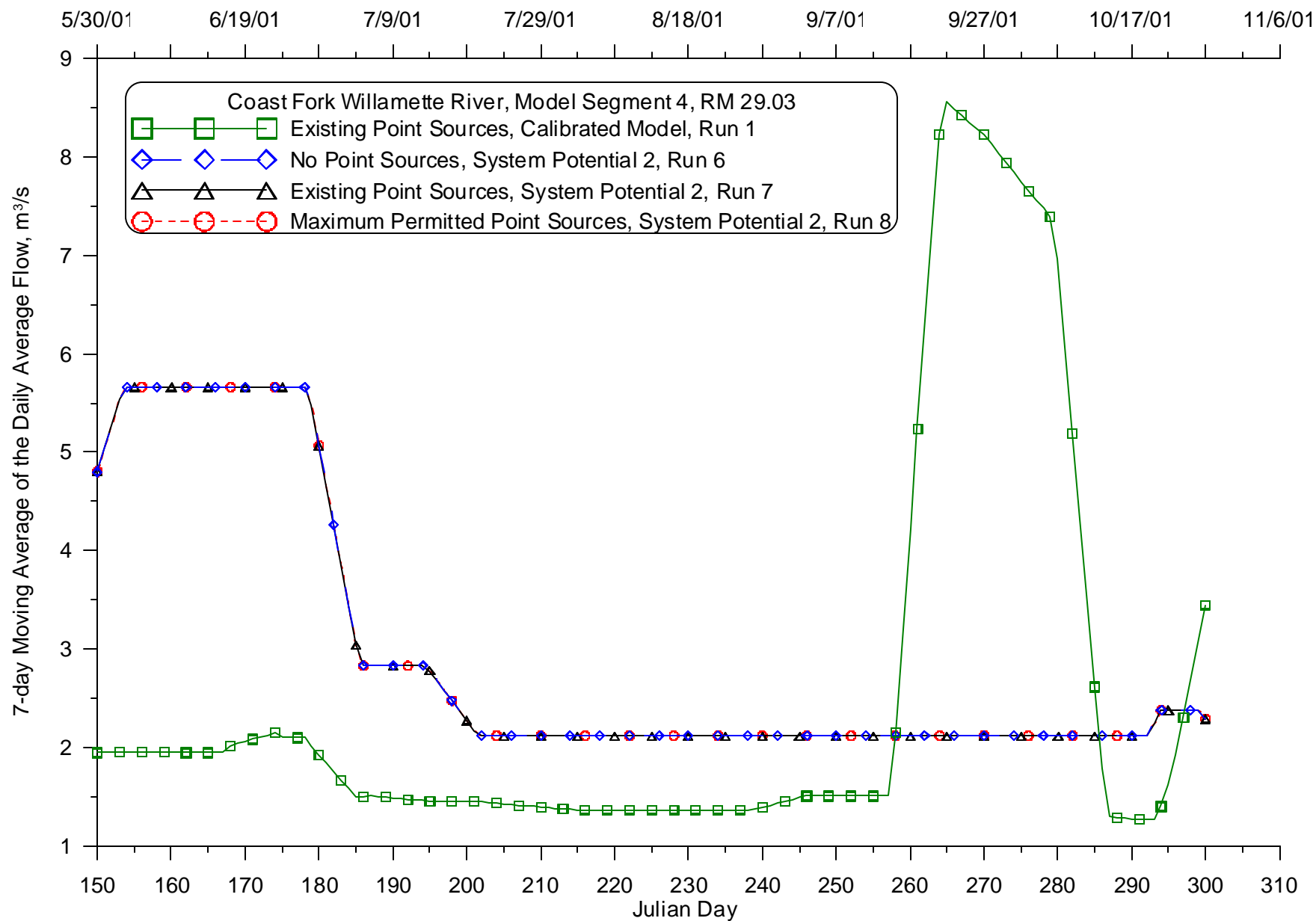


Figure 185: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Coast Fork Willamette River at RM 29.03

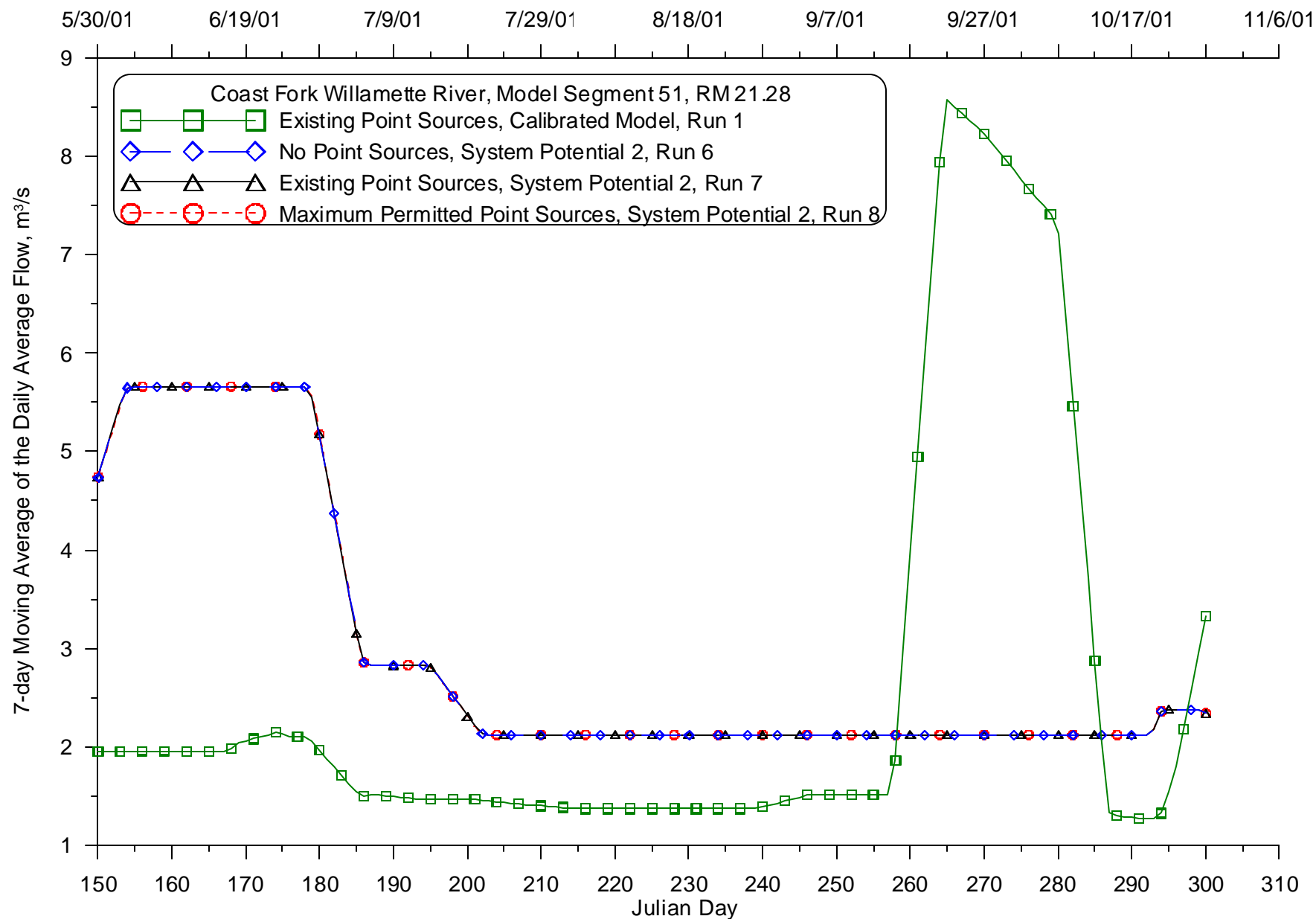


Figure 186: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Coast Fork Willamette River at RM 21.28

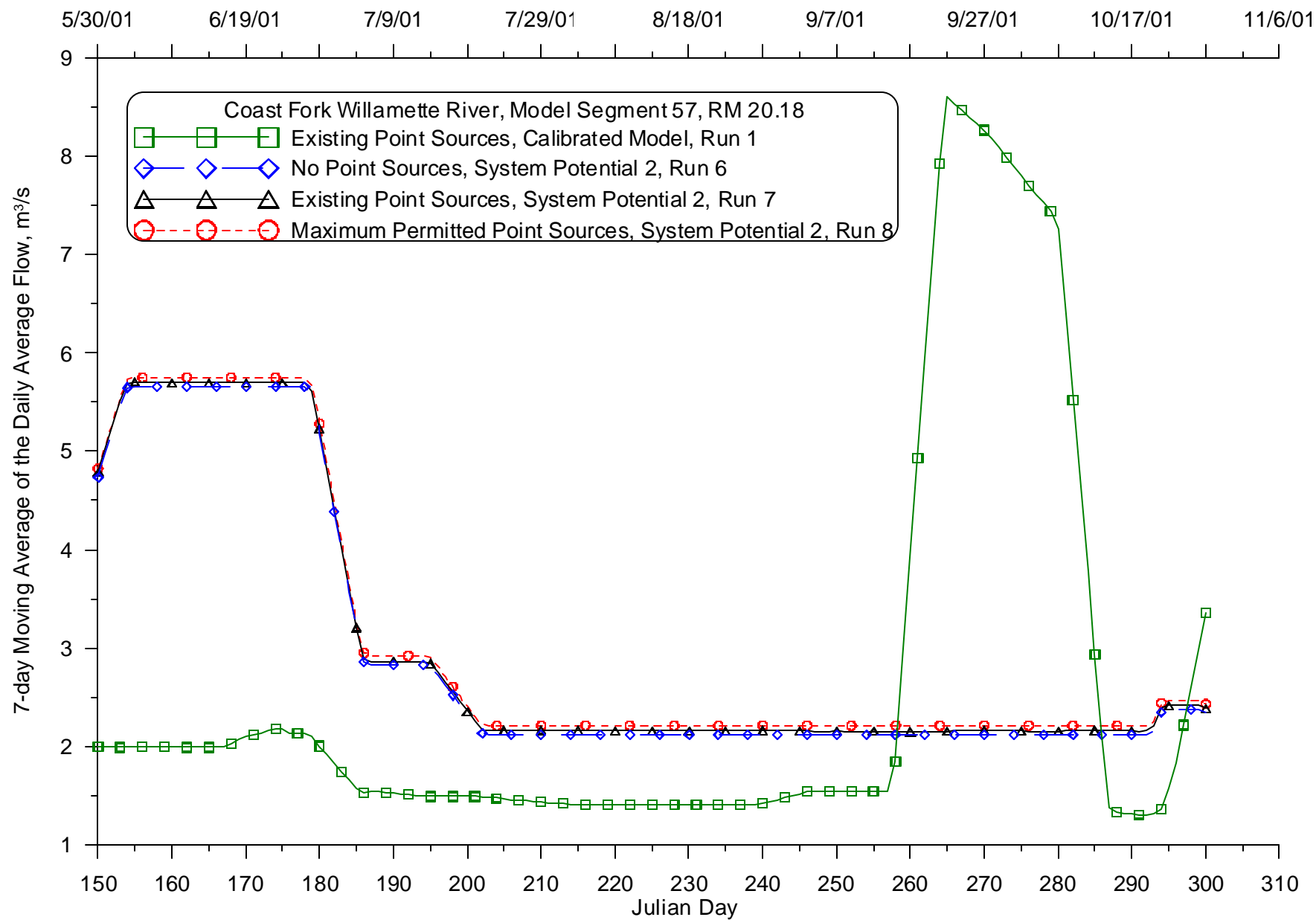


Figure 187: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Coast Fork Willamette River at RM 20.13

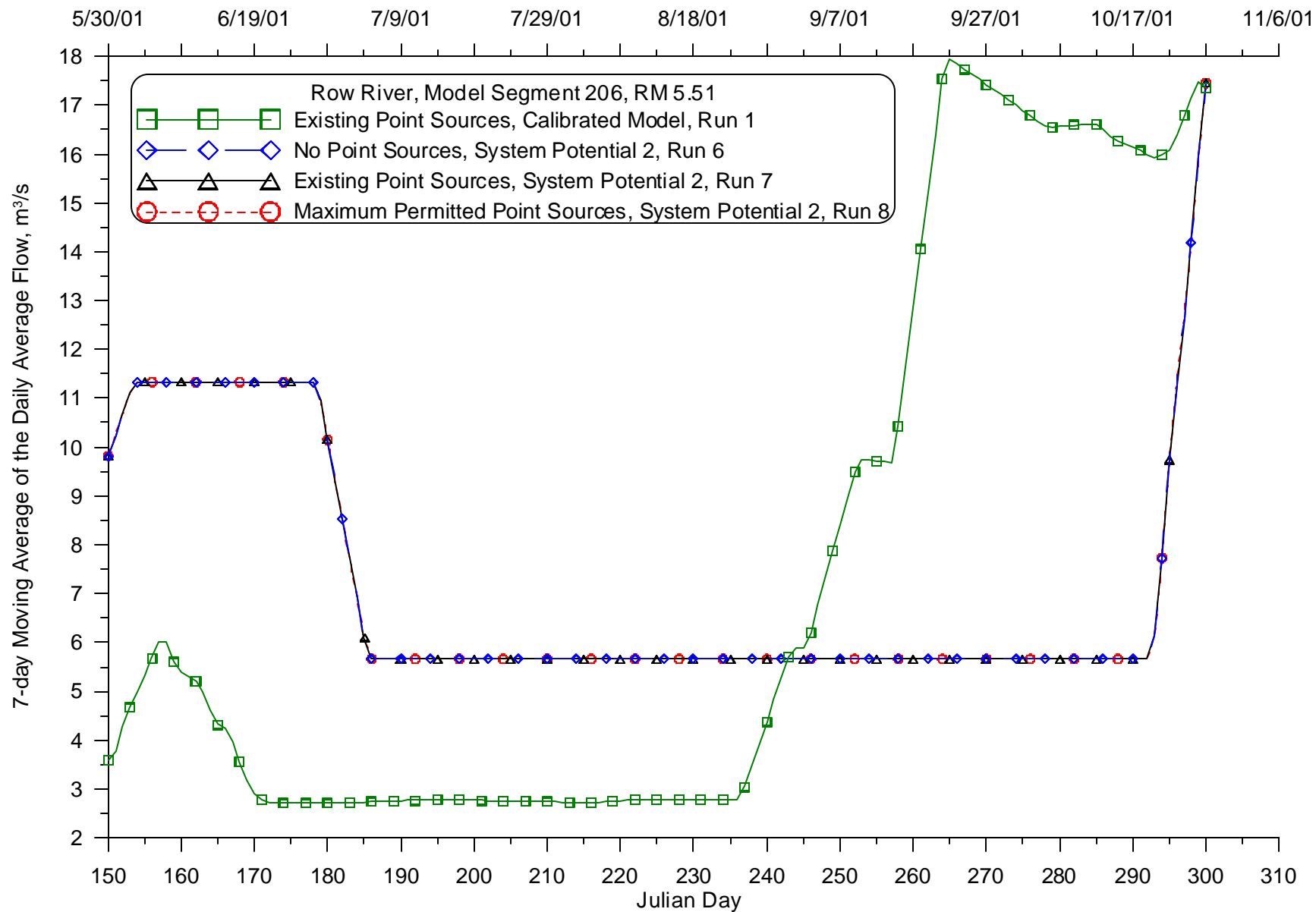
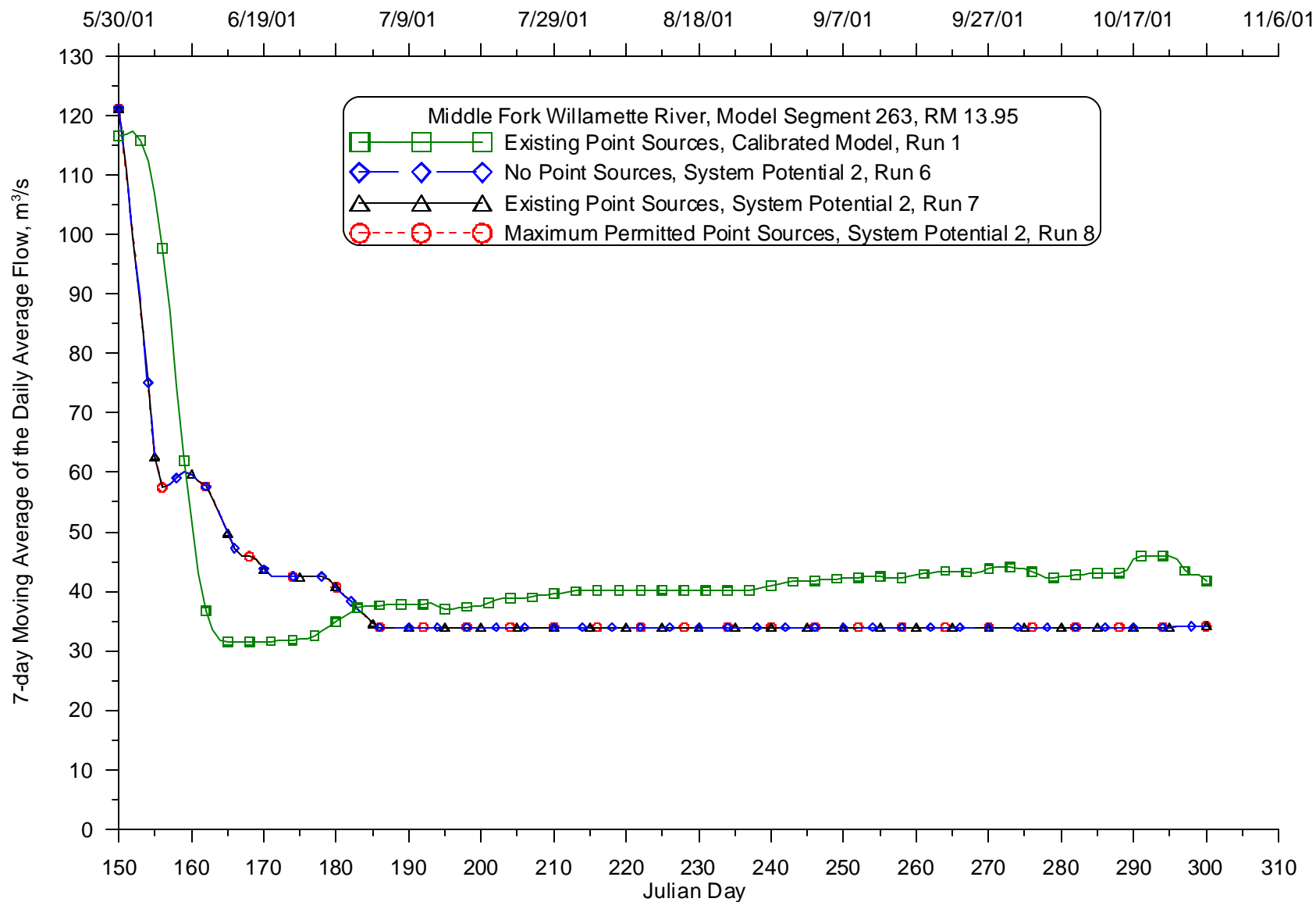
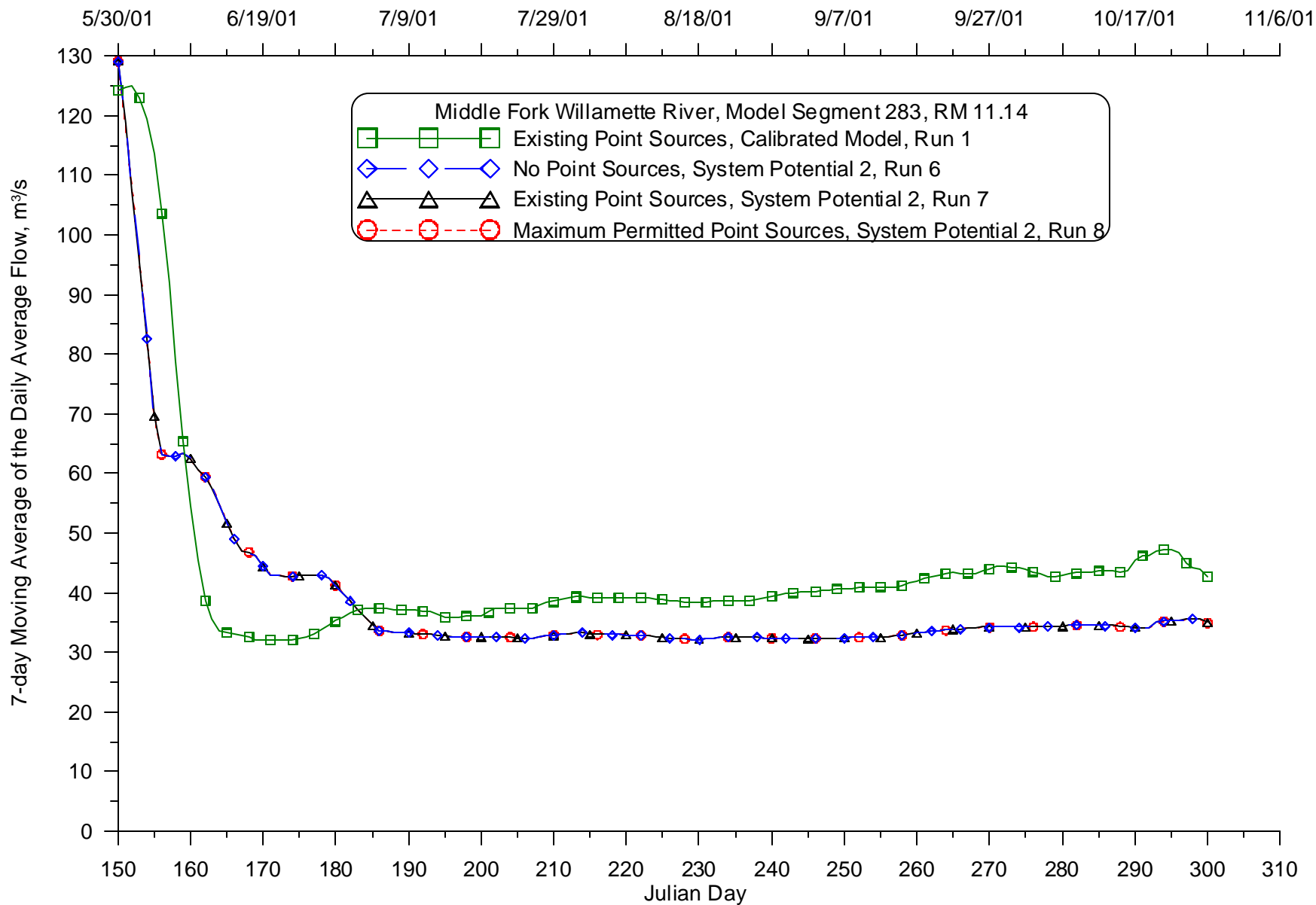


Figure 188: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Row River at RM 5.51



**Figure 189: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 190: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Middle Fork Willamette River at RM 11.14**



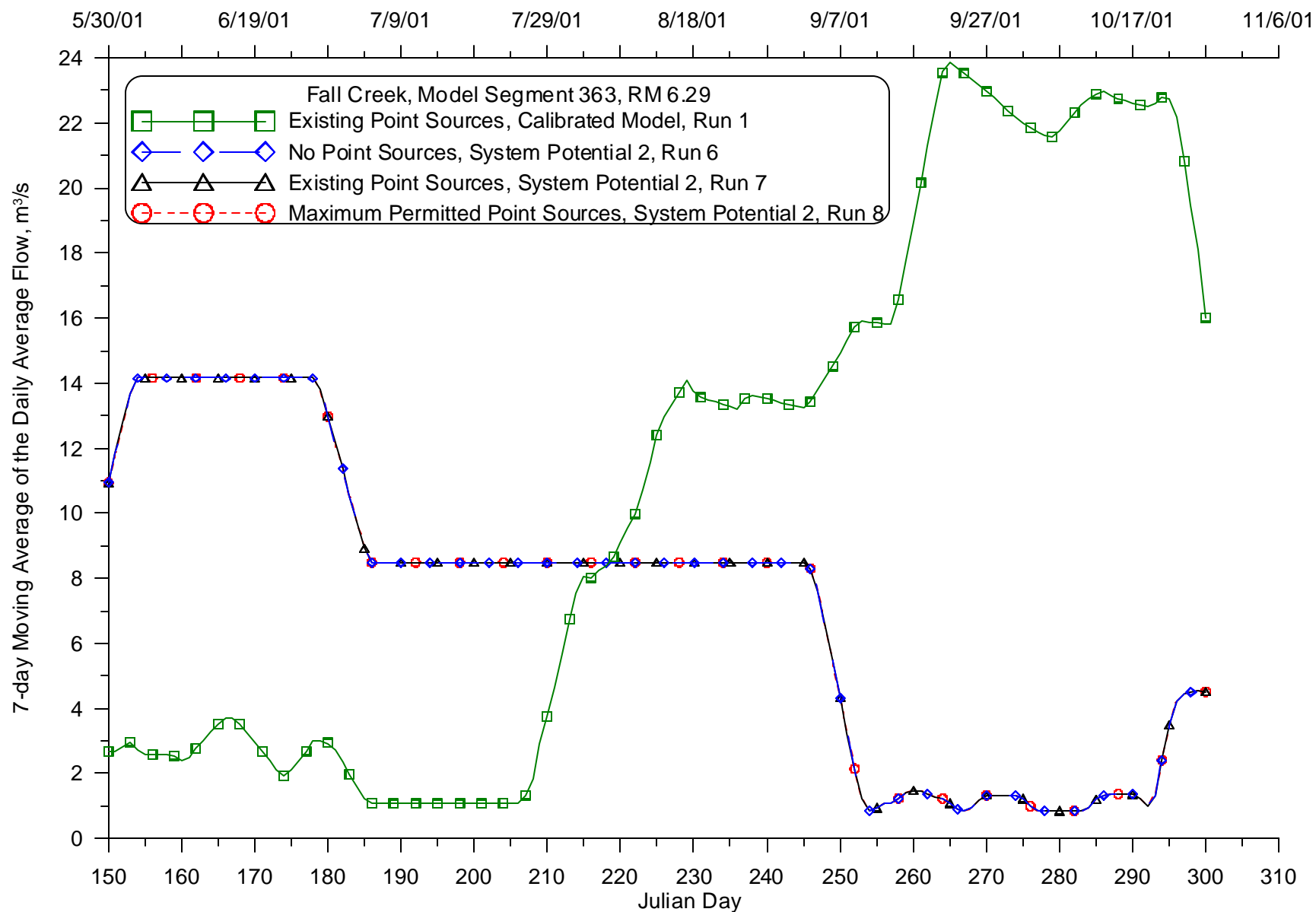
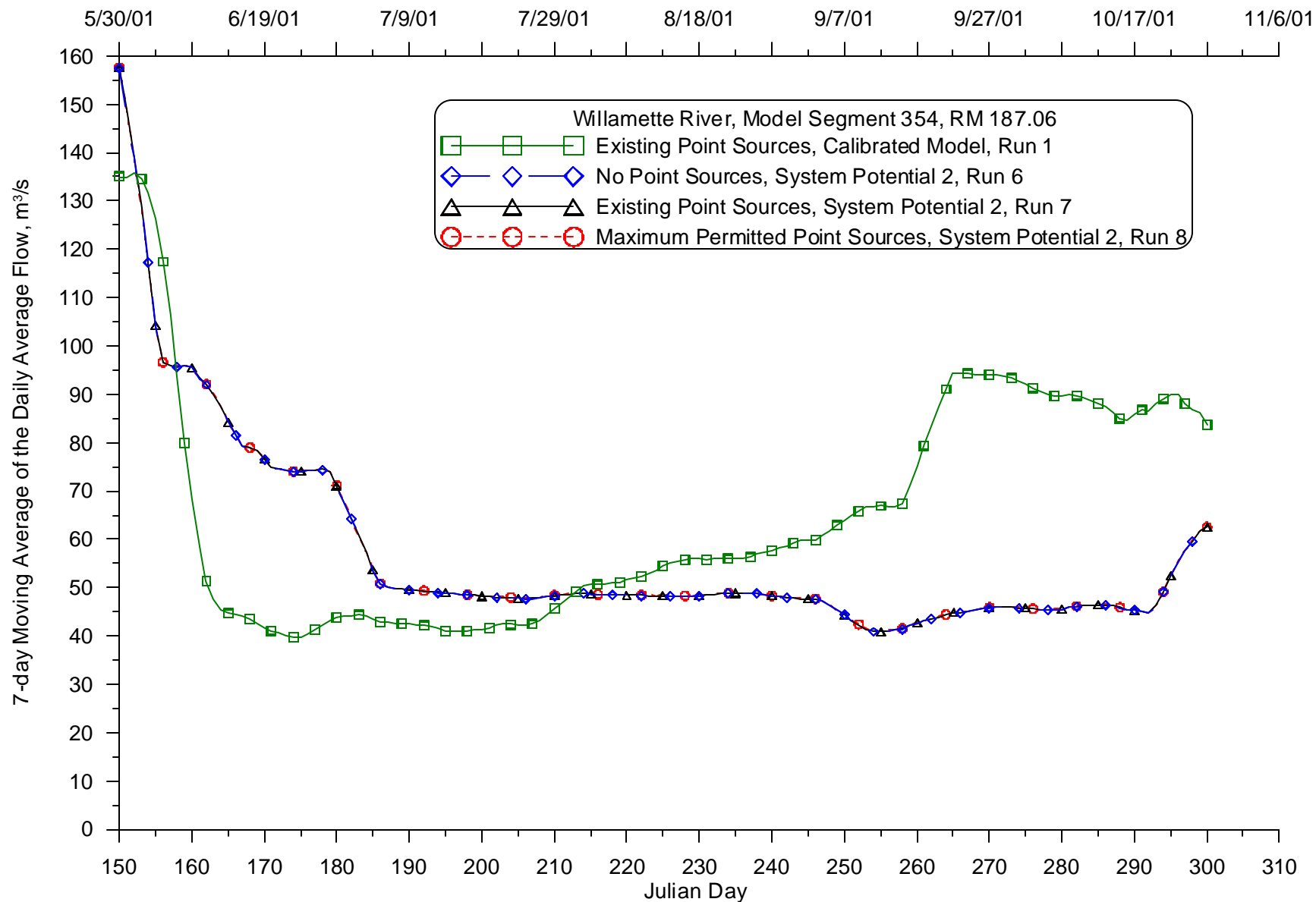


Figure 191: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Fall Creek at RM 6.29



**Figure 192: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 187.06**

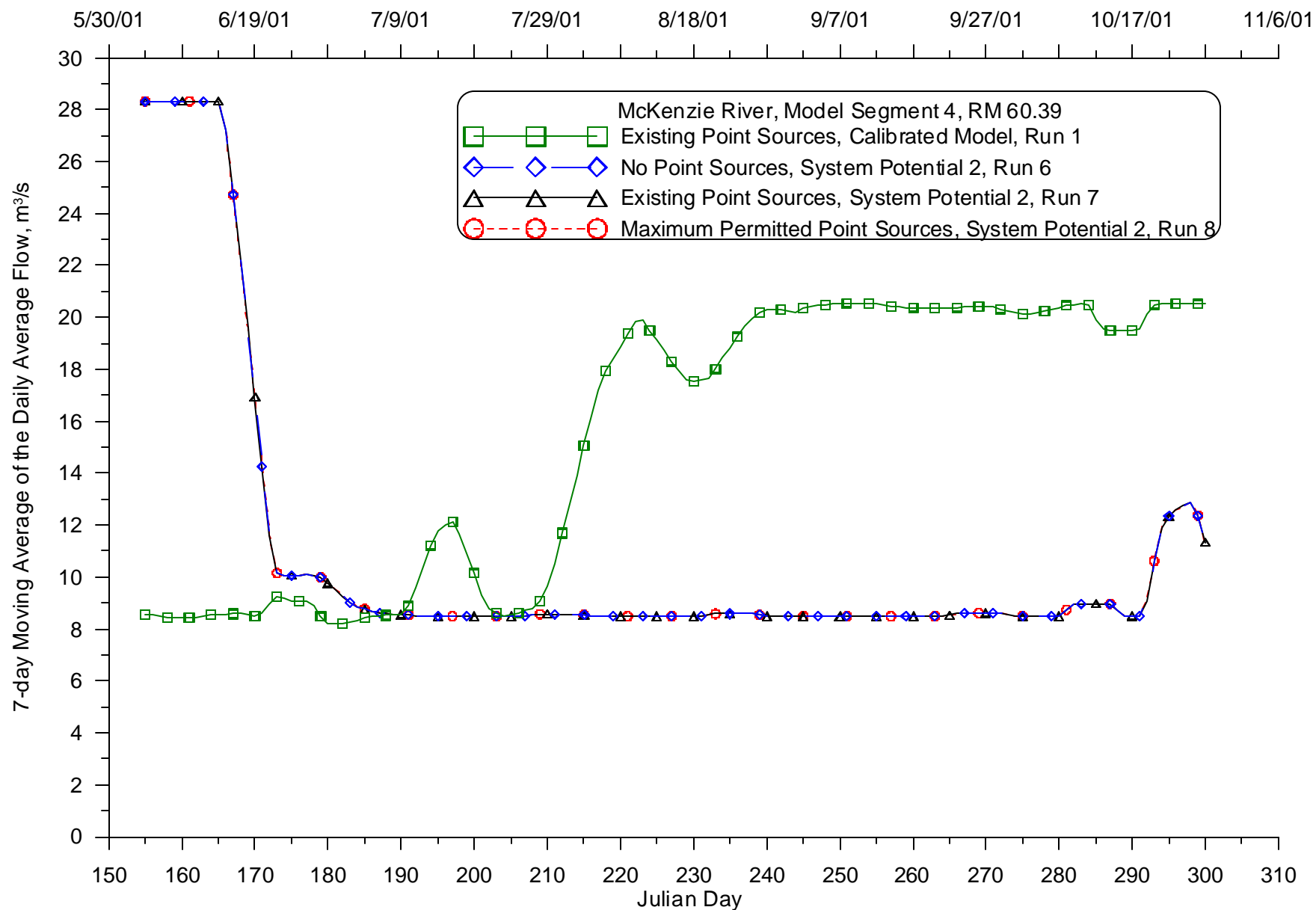
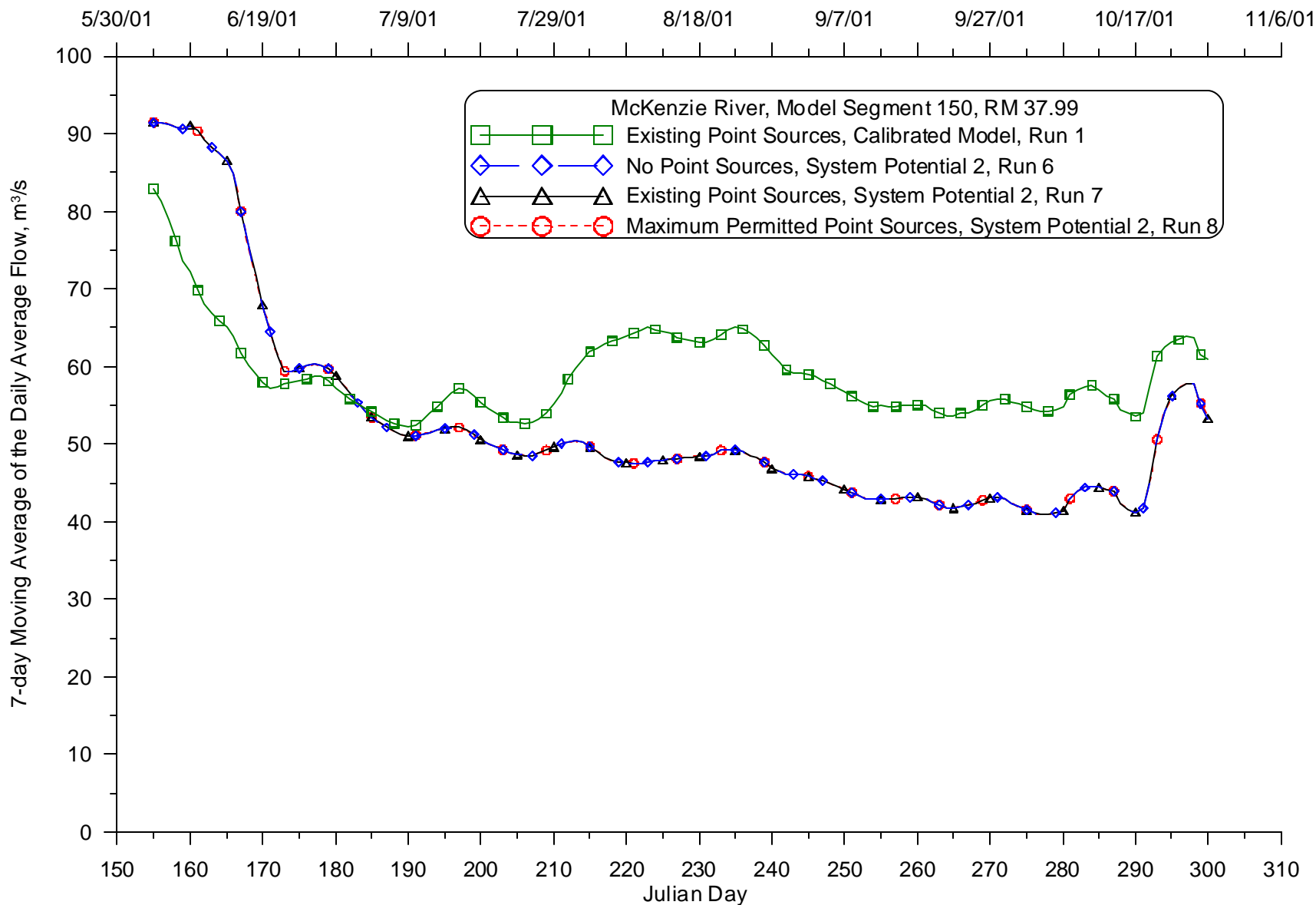
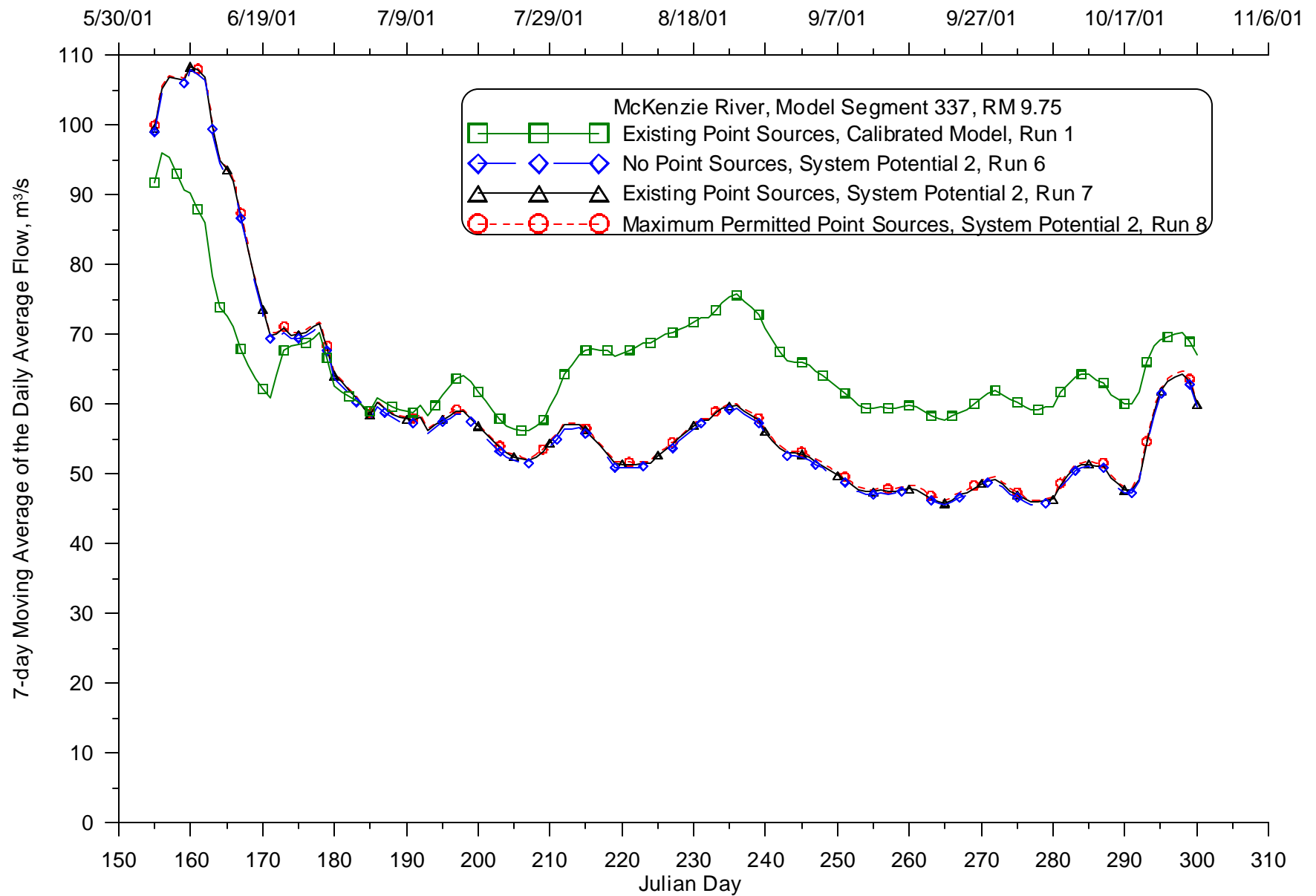


Figure 193: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the McKenzie River at RM 60.39



**Figure 194: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the McKenzie River at RM 37.99**



**Figure 195: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the McKenzie River at RM 9.75**

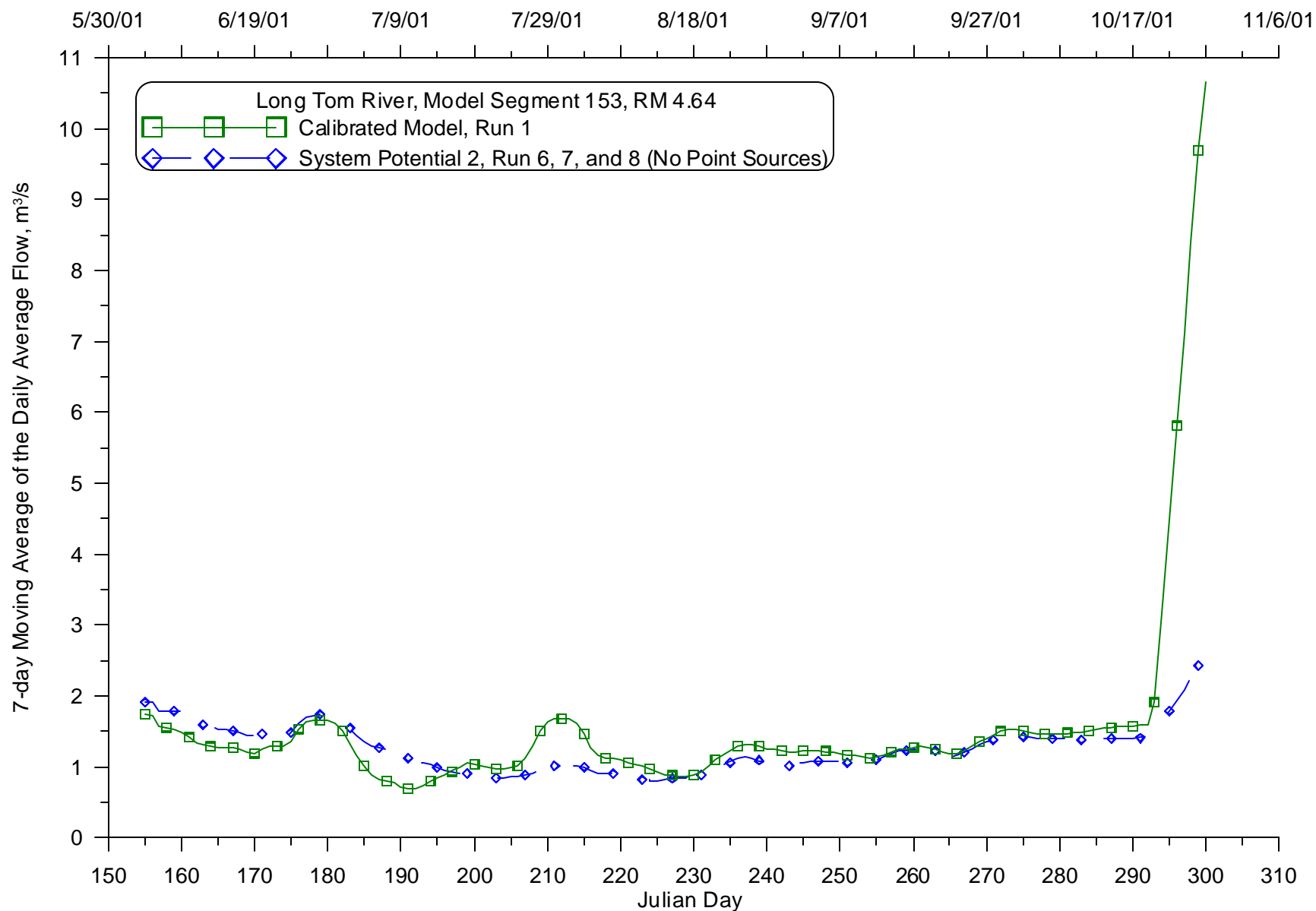
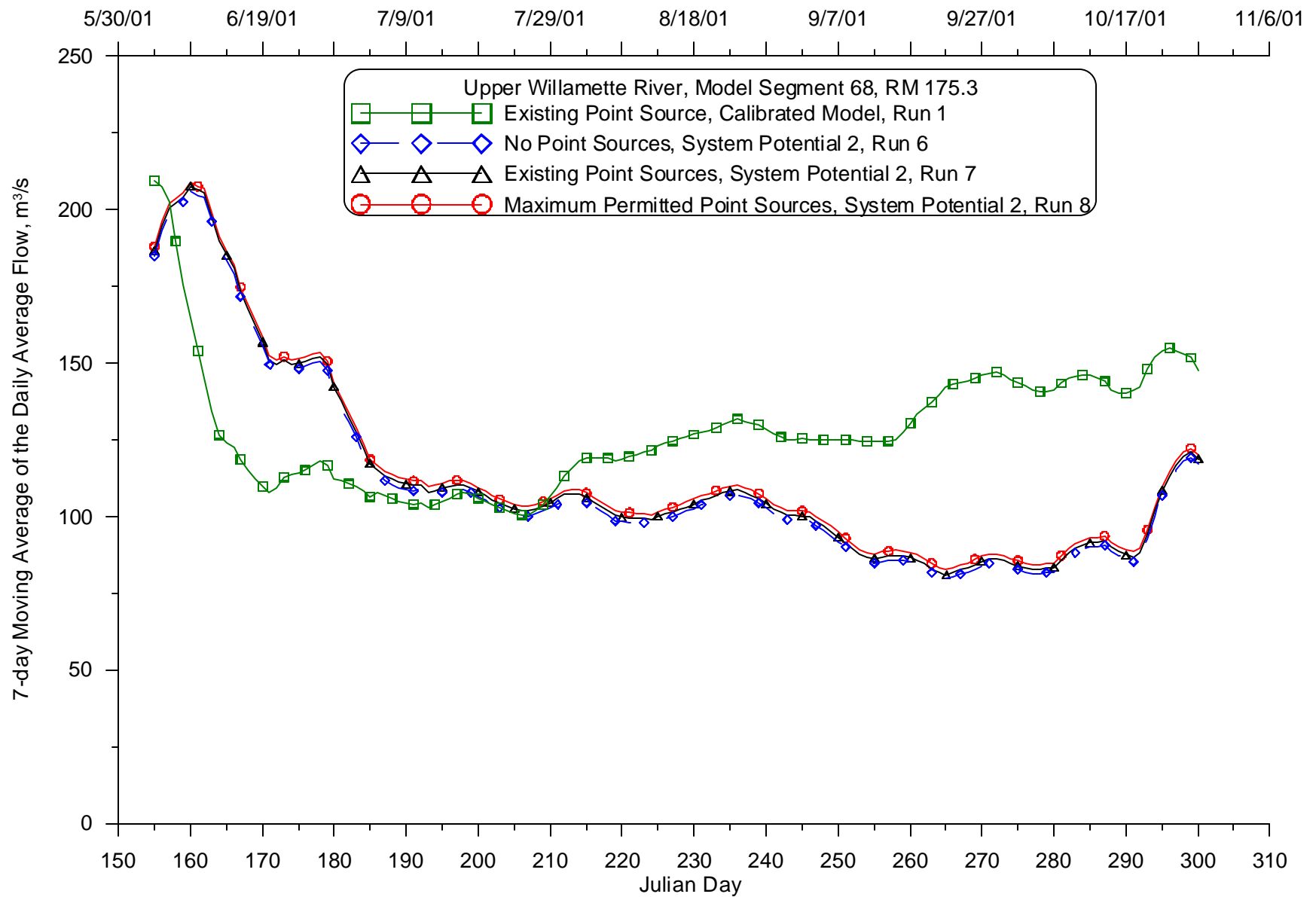


Figure 196: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Long Tom River at RM 4.64



**Figure 197: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 175.3**

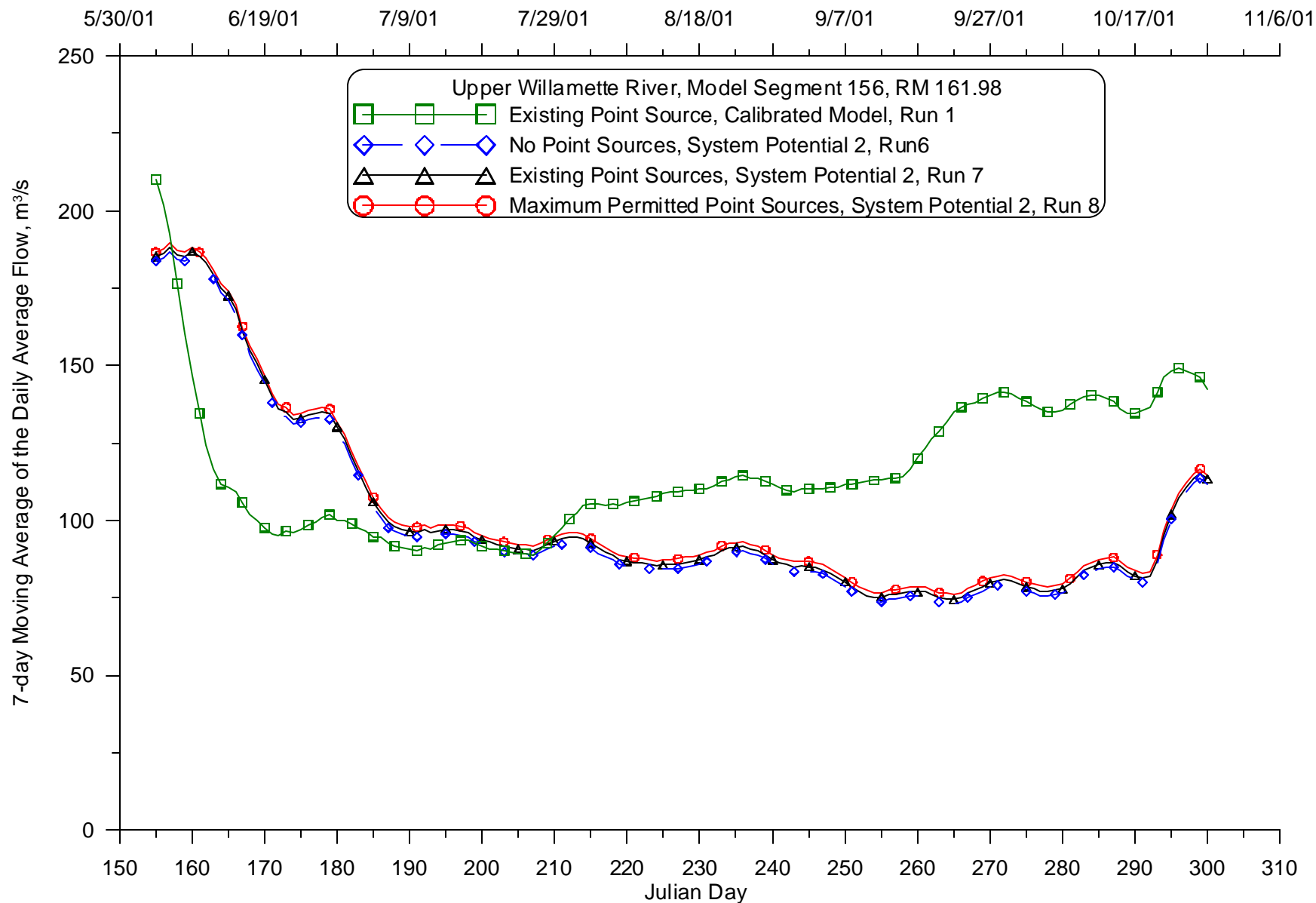
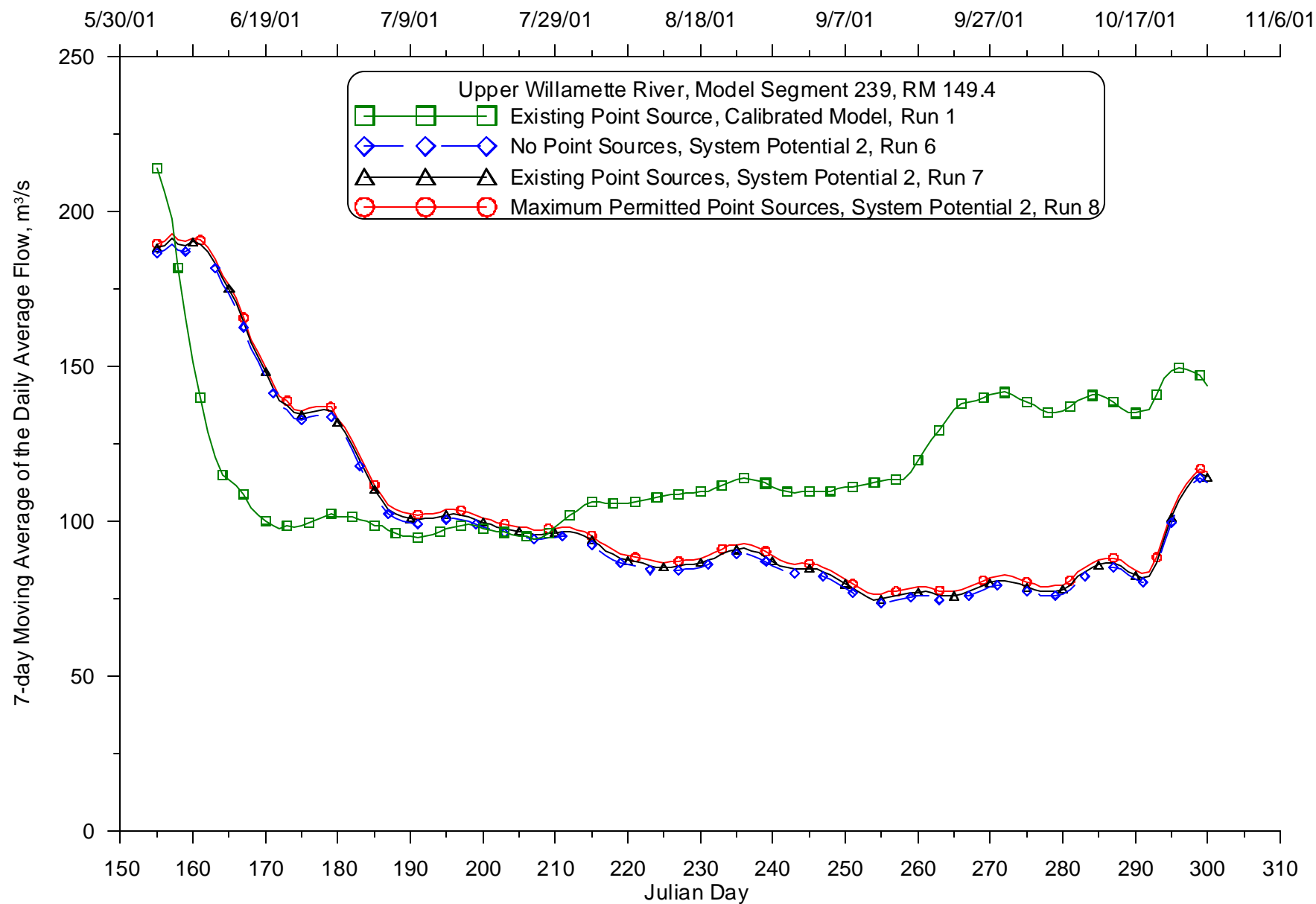
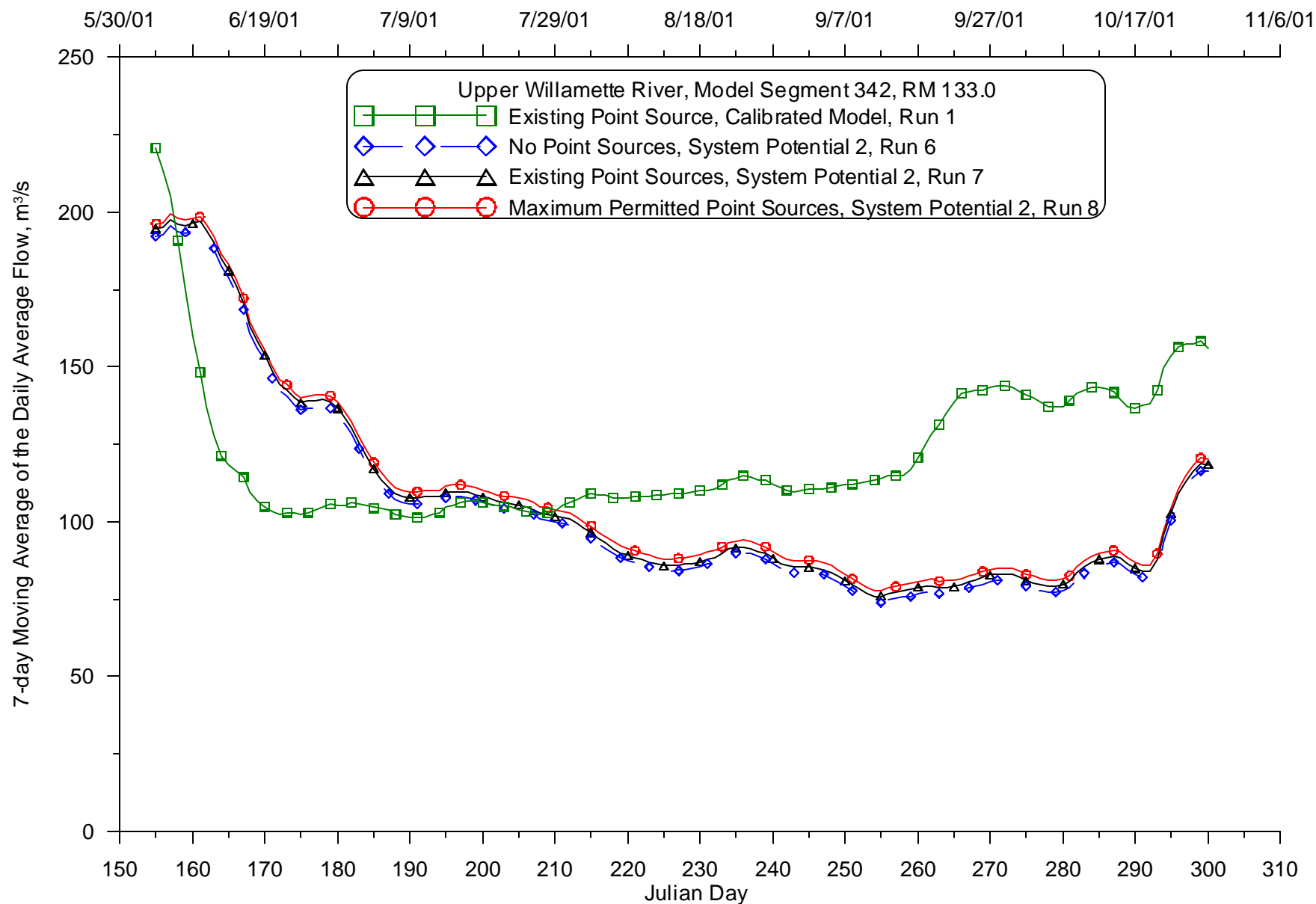


Figure 198: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 161.98

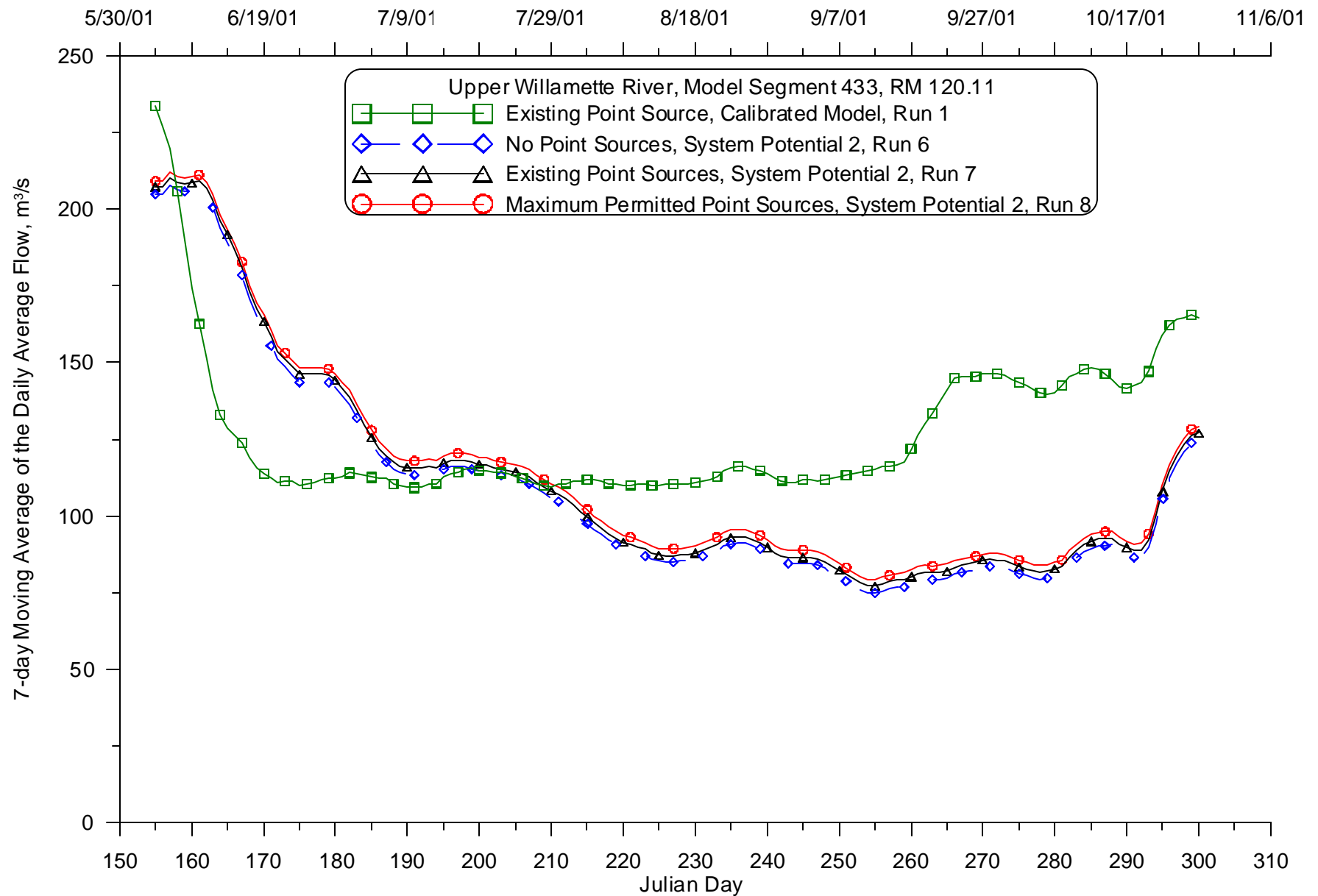




**Figure 199: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 149.4**



**Figure 200: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 133**



**Figure 201: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 120.11**

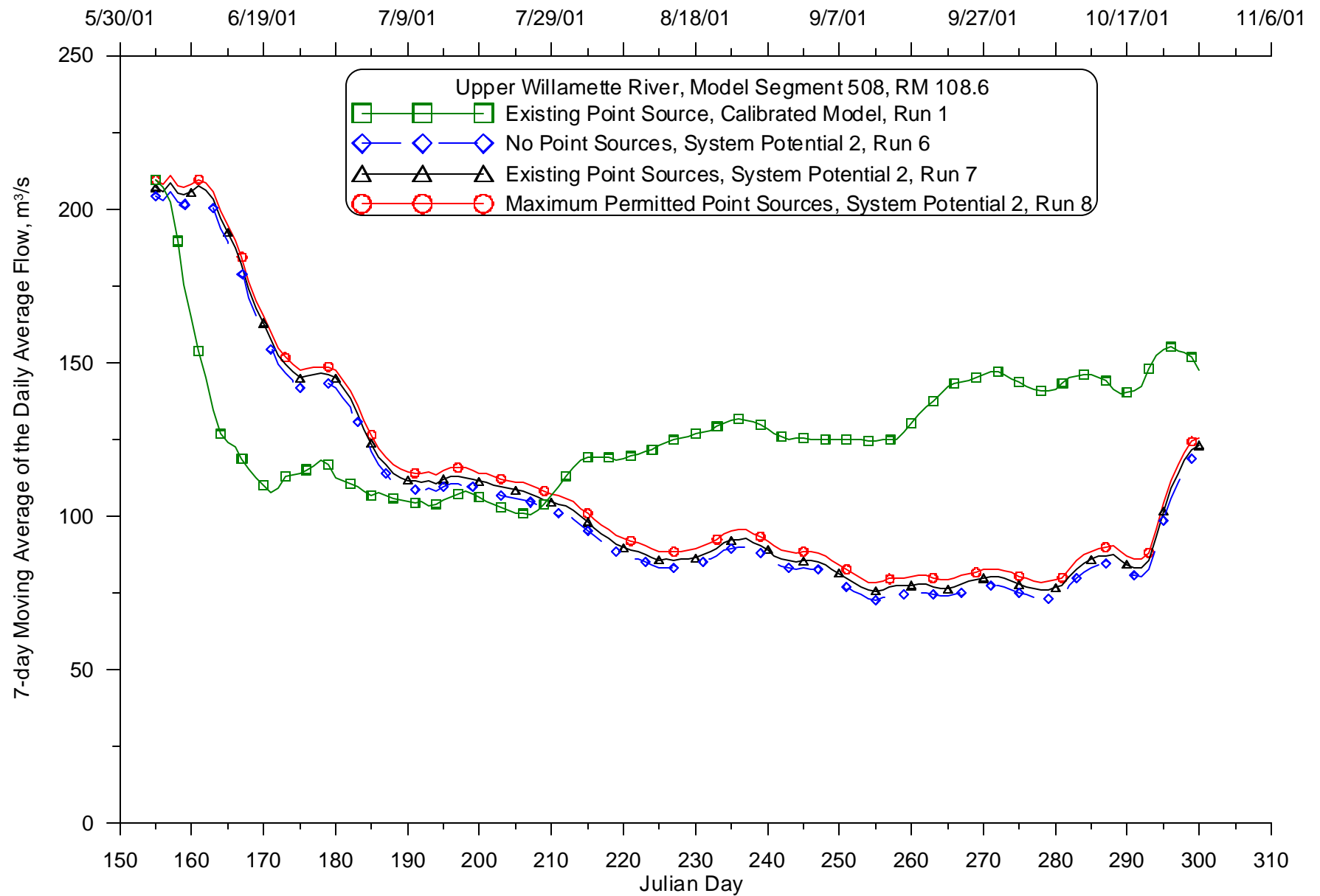
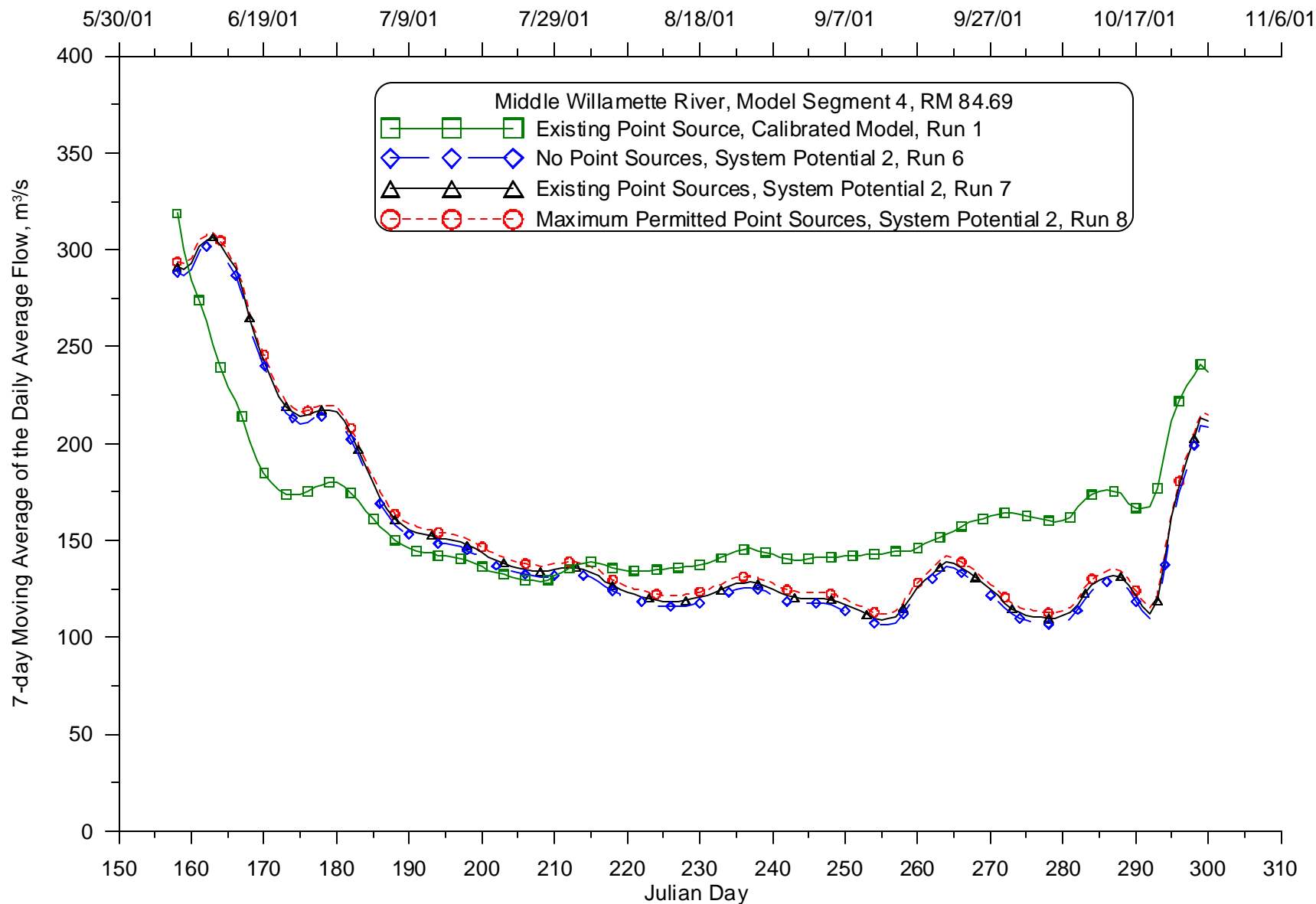
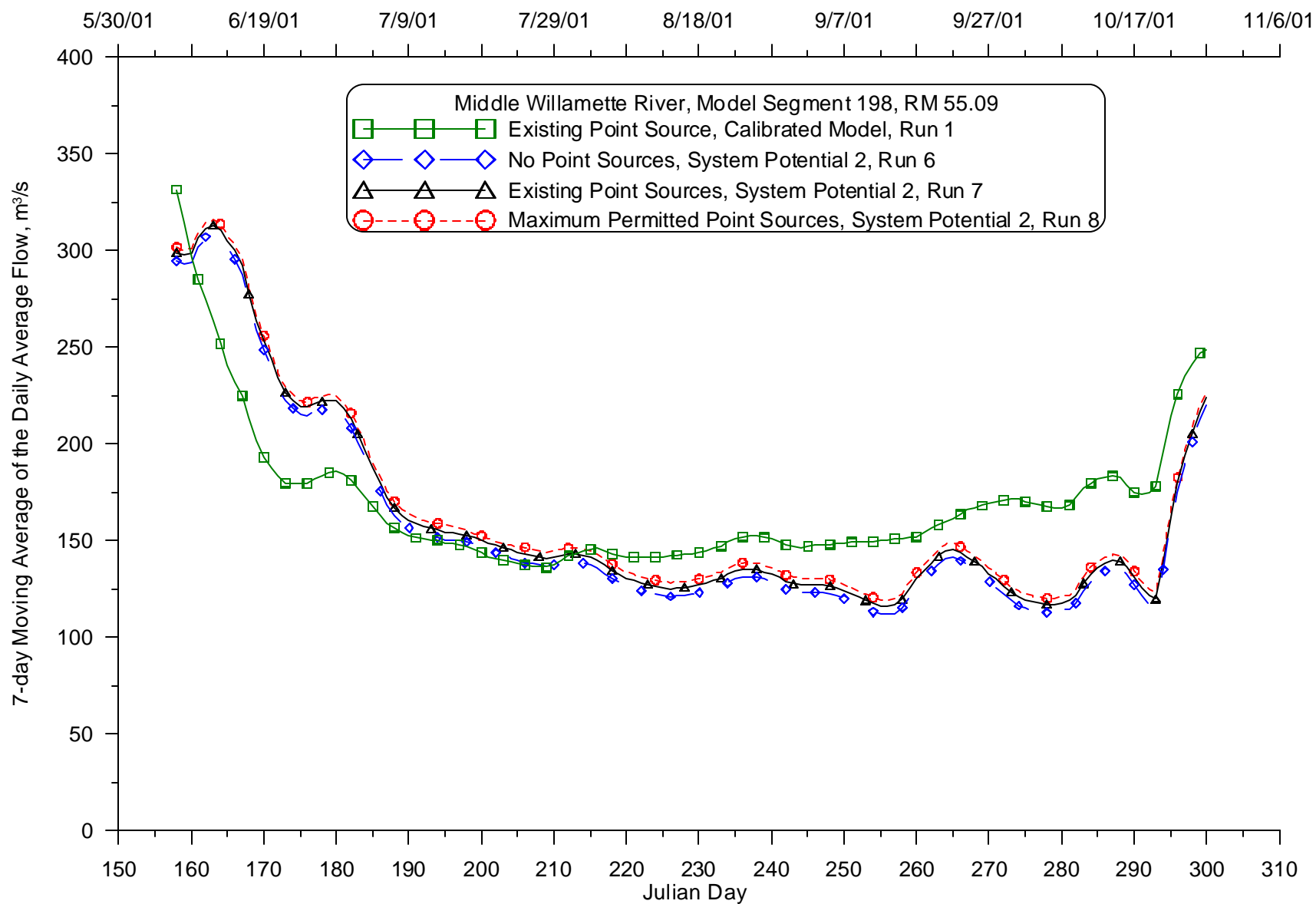


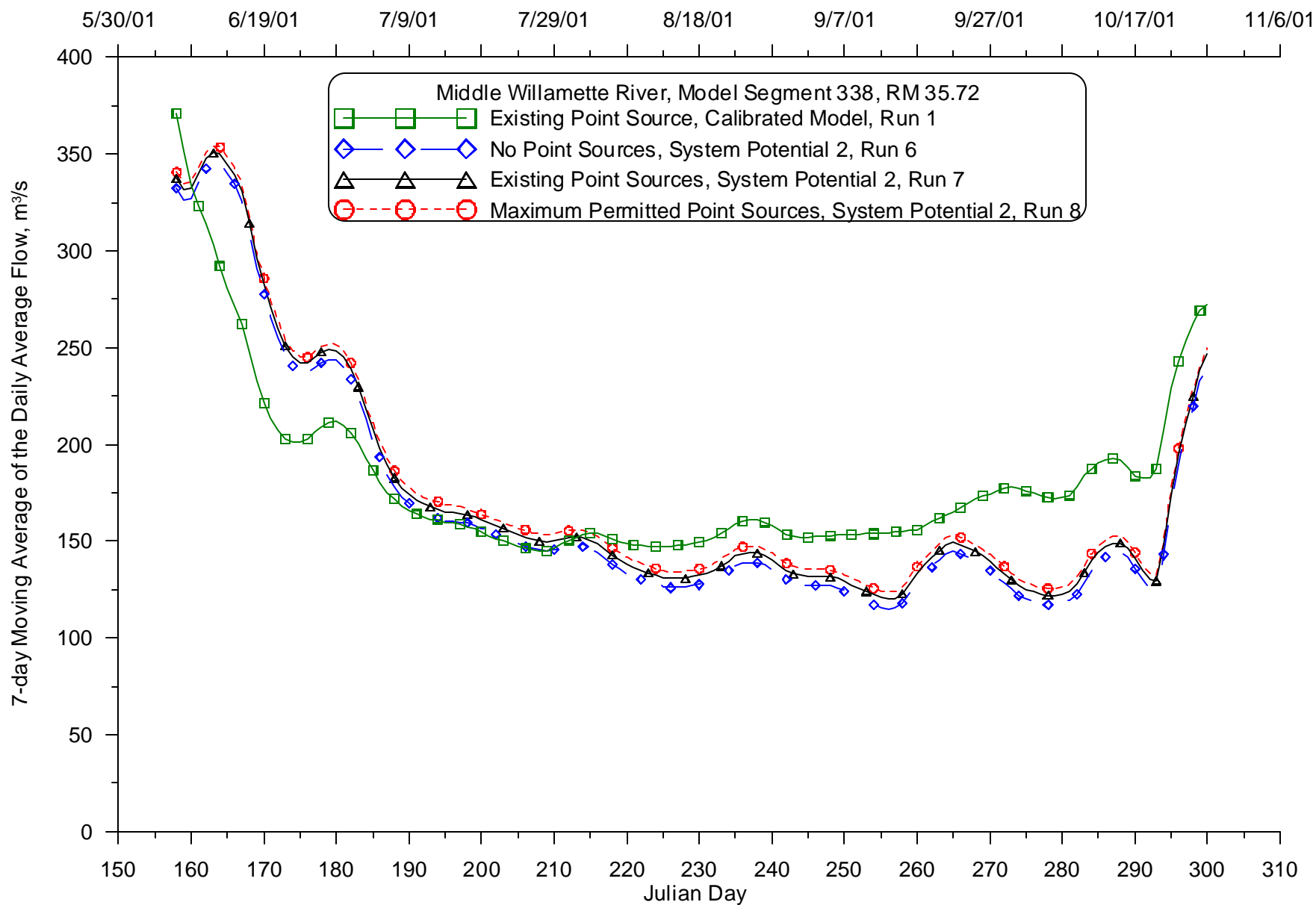
Figure 202: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 108.6



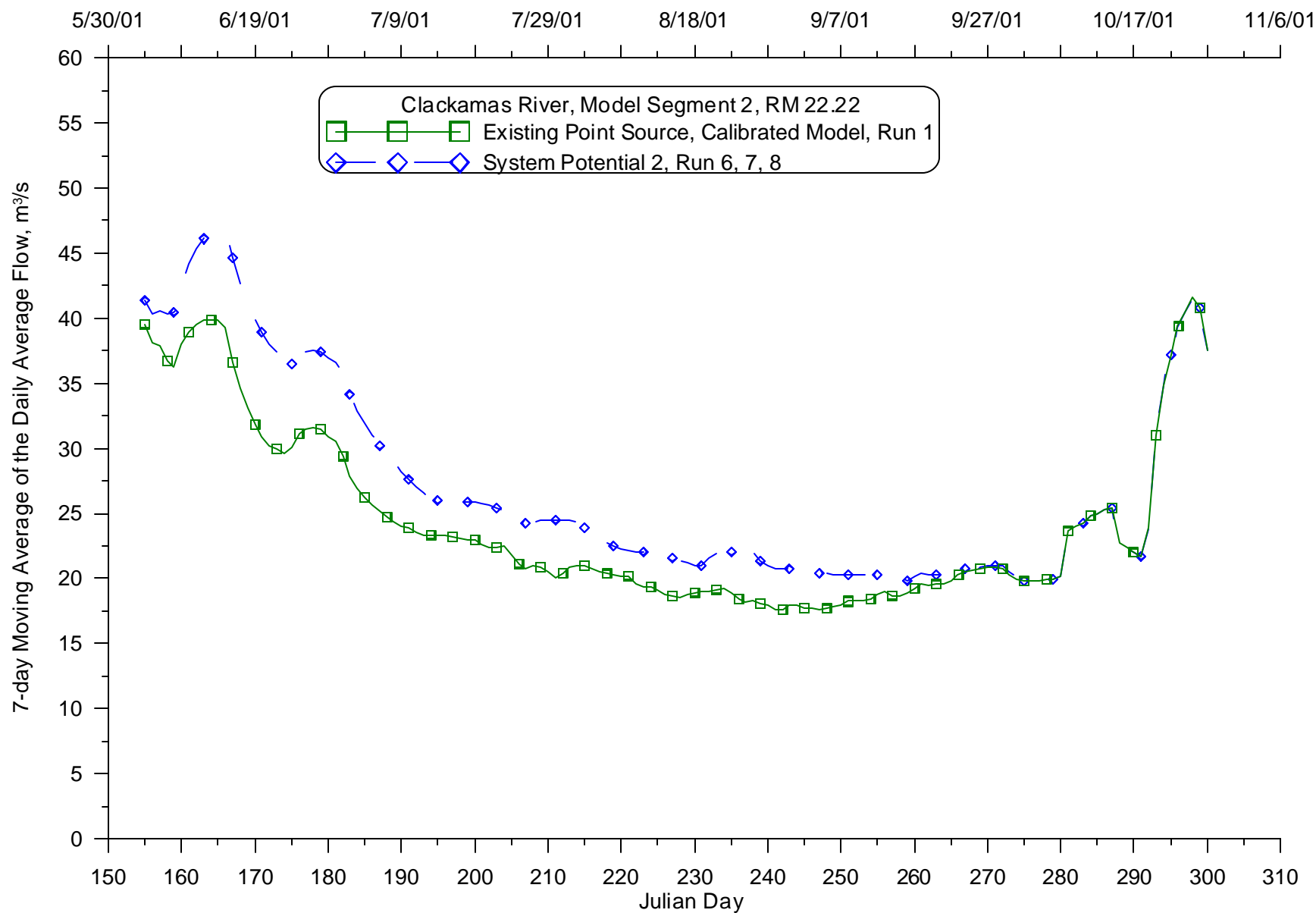
**Figure 203: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 84.69**



**Figure 204: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 55.09**

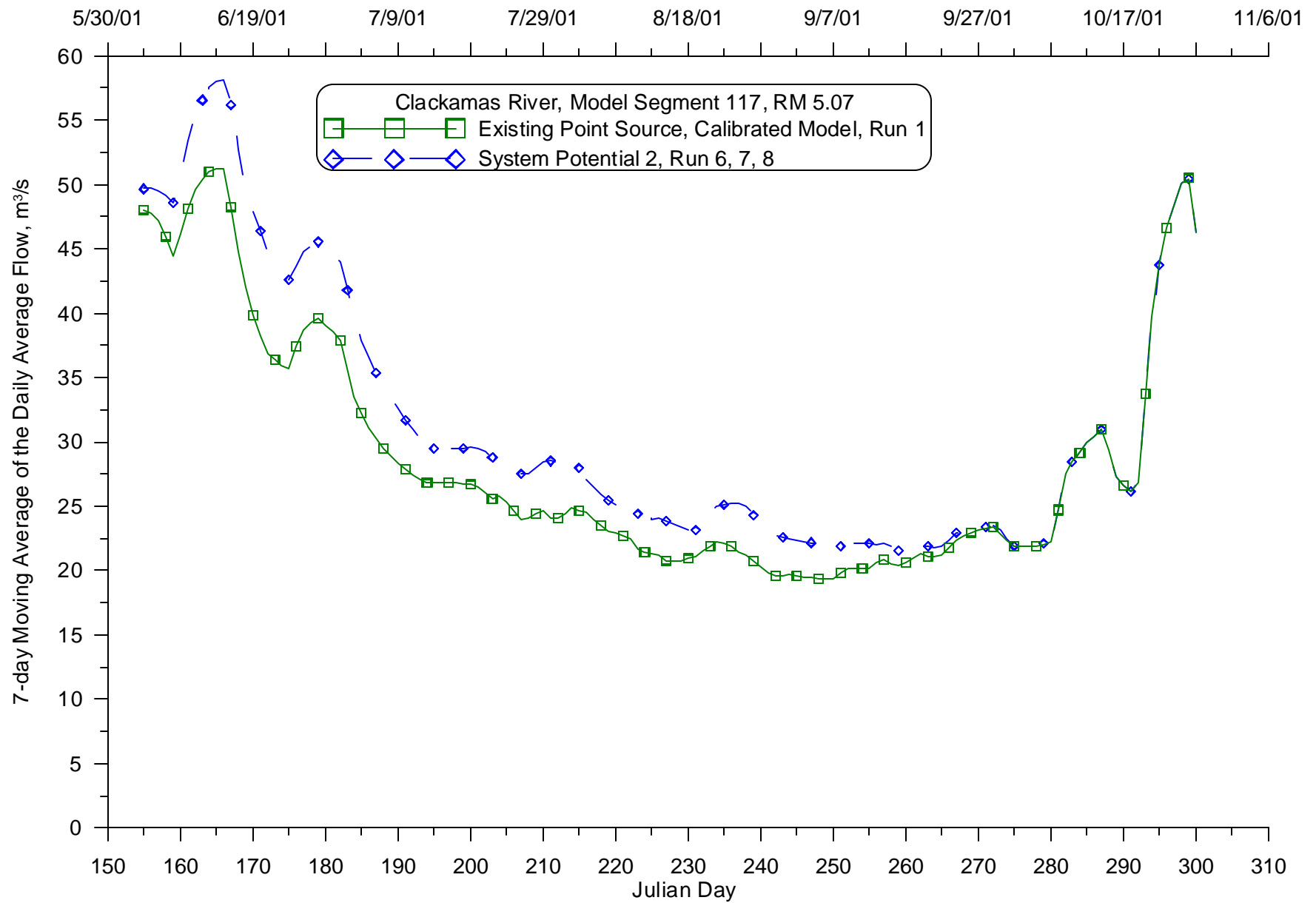


**Figure 205: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 35.72**



**Figure 206: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Clackamas River at RM 22.22**





**Figure 207: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Clackamas River at RM 5.07**

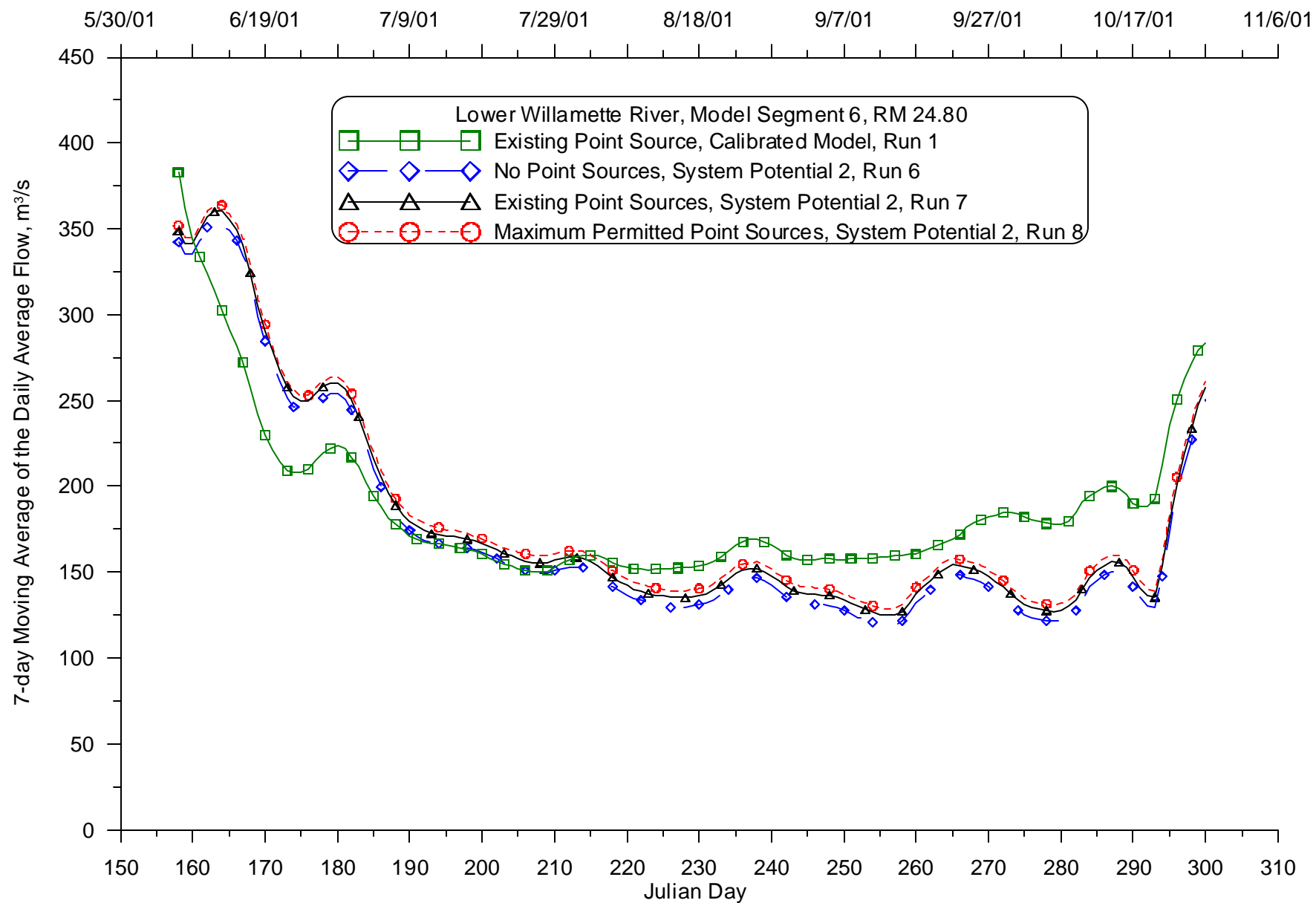
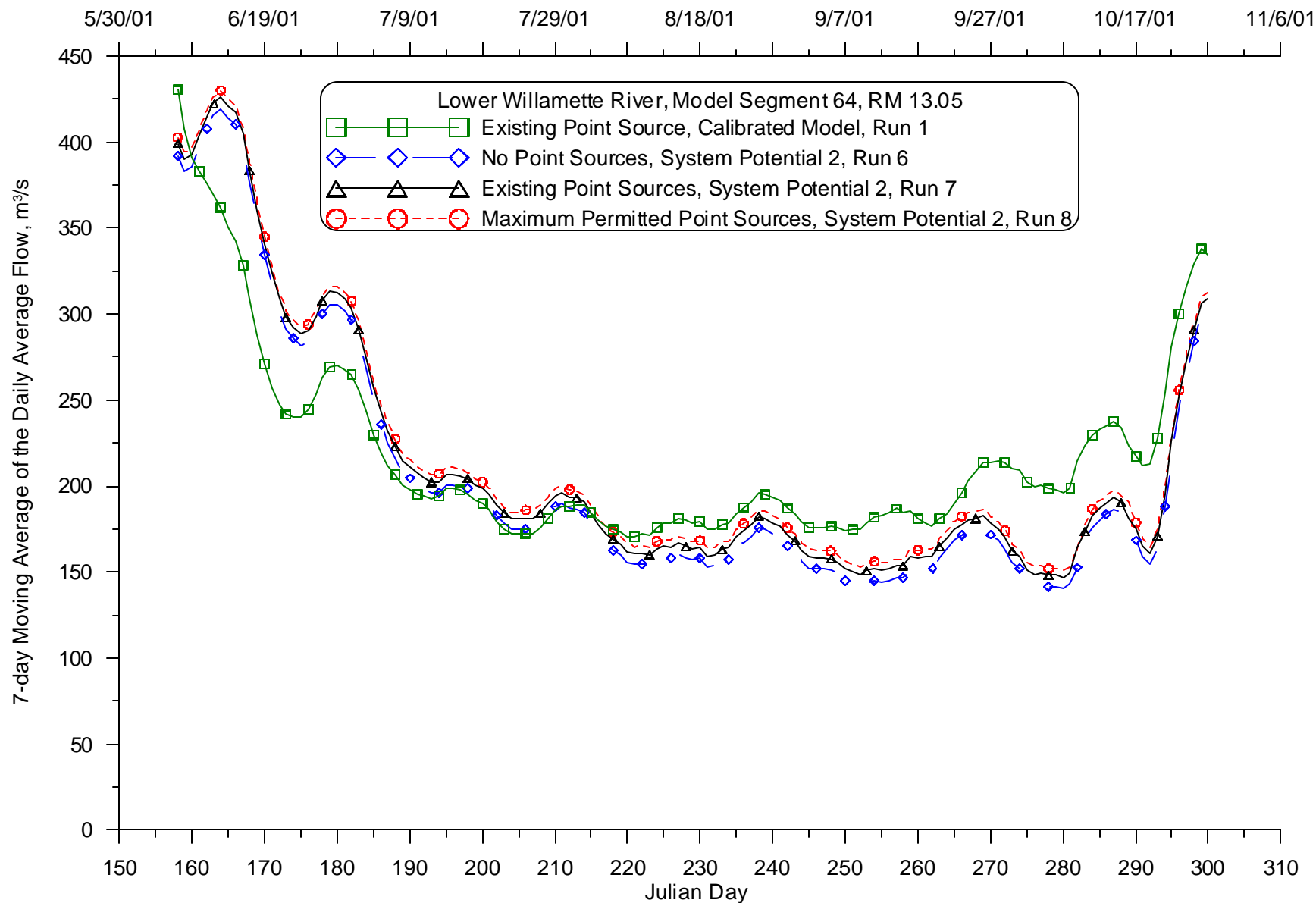
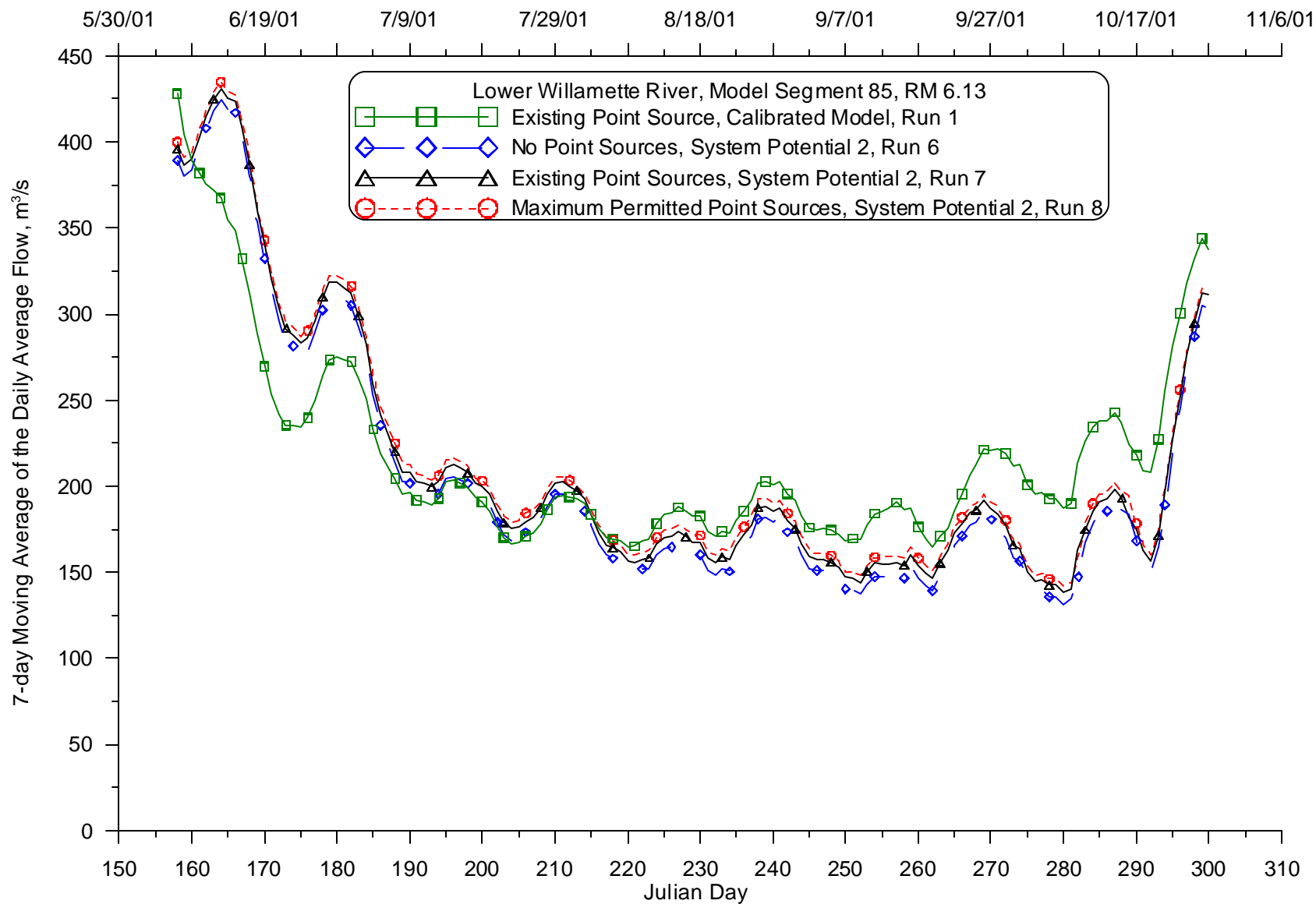


Figure 208: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 24.80



**Figure 209: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 13.05**

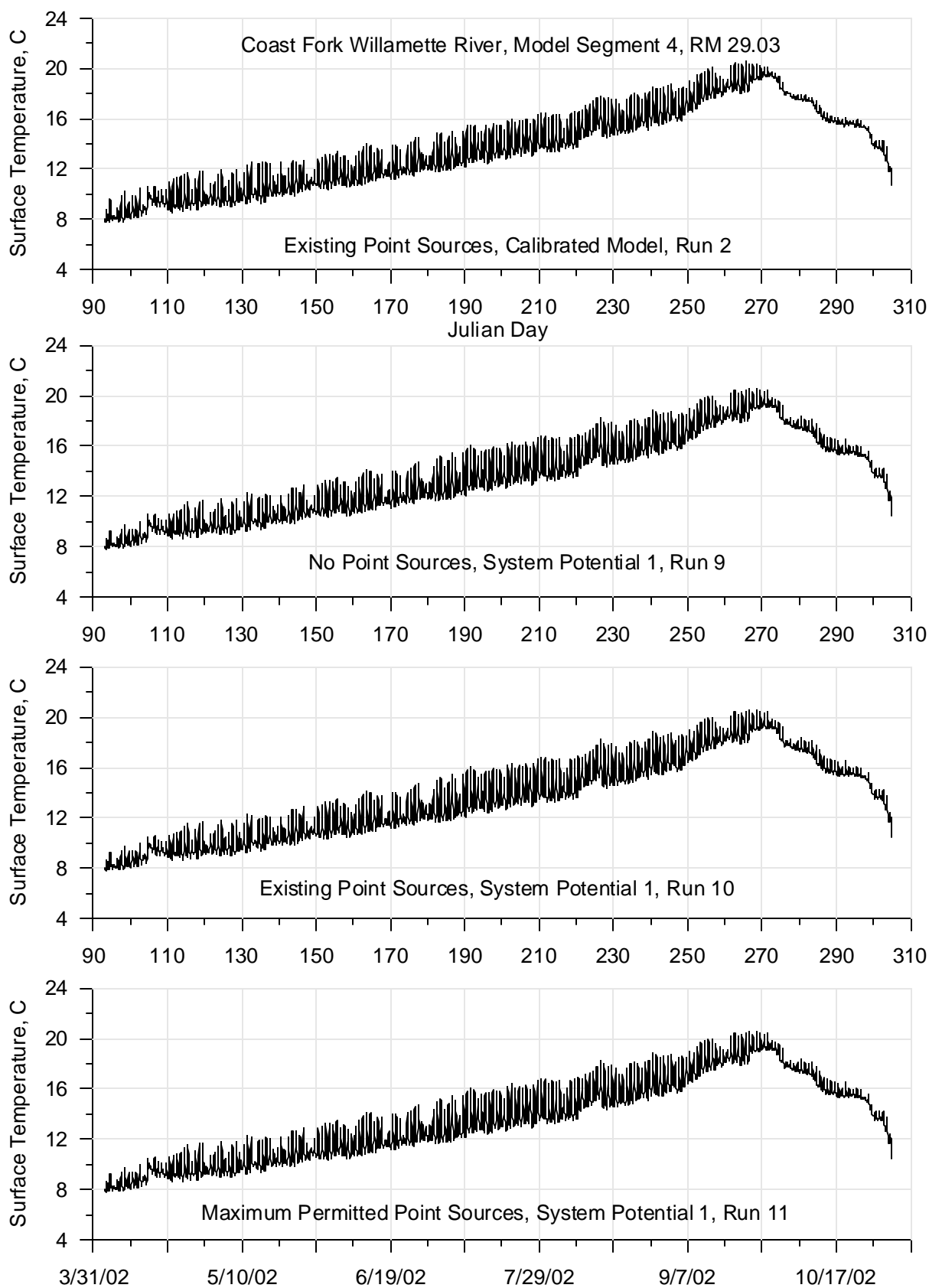


**Figure 210: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2001 for the Willamette River at RM 6.13**

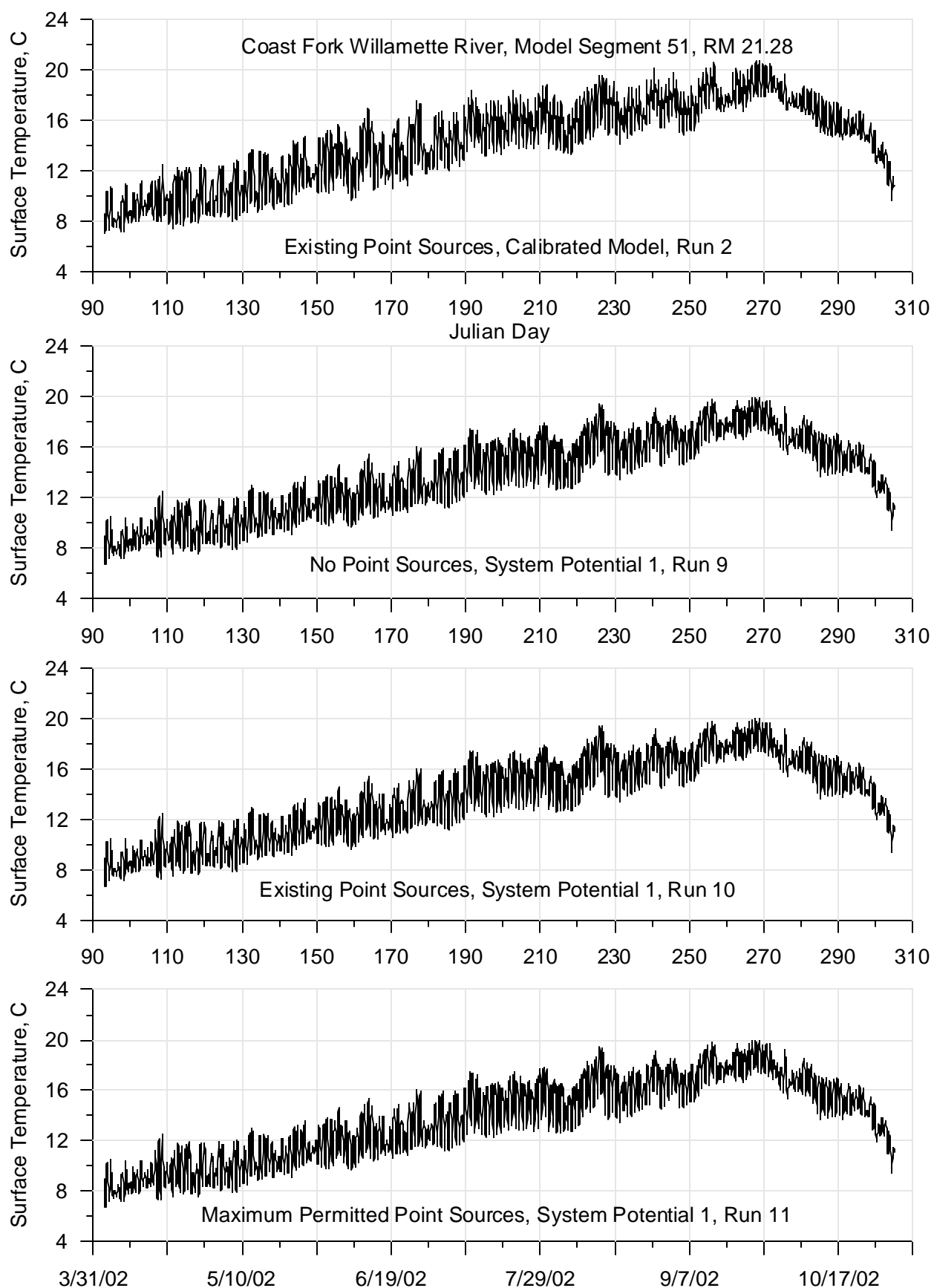
## ***System Potential 1, 2002***

System Potential 1 (ODEQ, 2003) was run for the summer of 2002 for three scenarios with varying discharges from the large point sources in the Willamette River system. The point sources were simulated as having no discharge, their current discharge in 2001, and their maximum permitted discharge. These results were then compared with the results of the calibrated model in a series of time series plots. There are four types of time series output for each of the 21 locations identified above in Table 2: continuous temperature, continuous flow, the seven-day moving average of the daily maximum temperature, and the seven-day average of daily average flow.

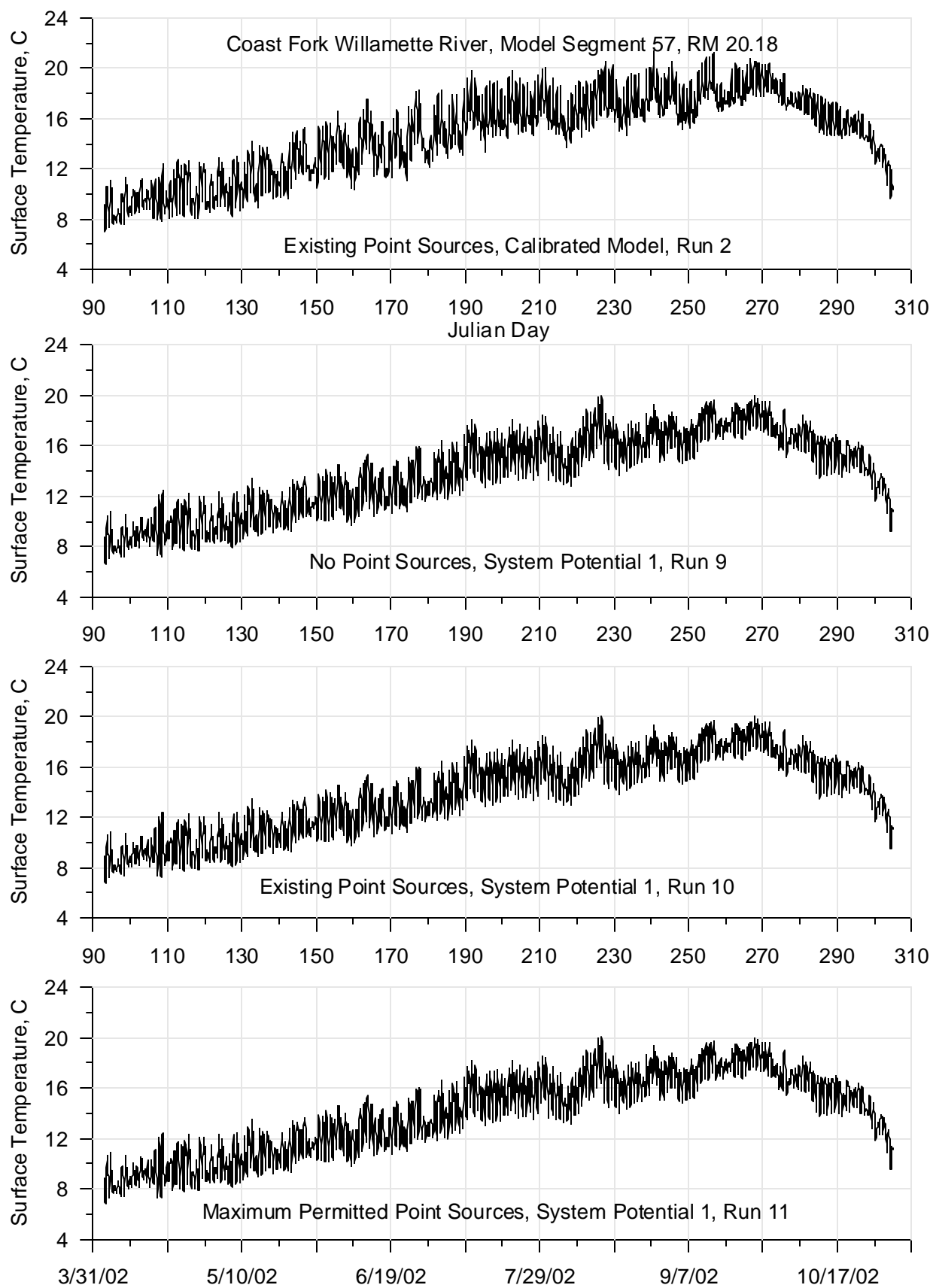
### **Continuous Temperature**



**Figure 211: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Coast Fork Willamette River at RM 29.03**

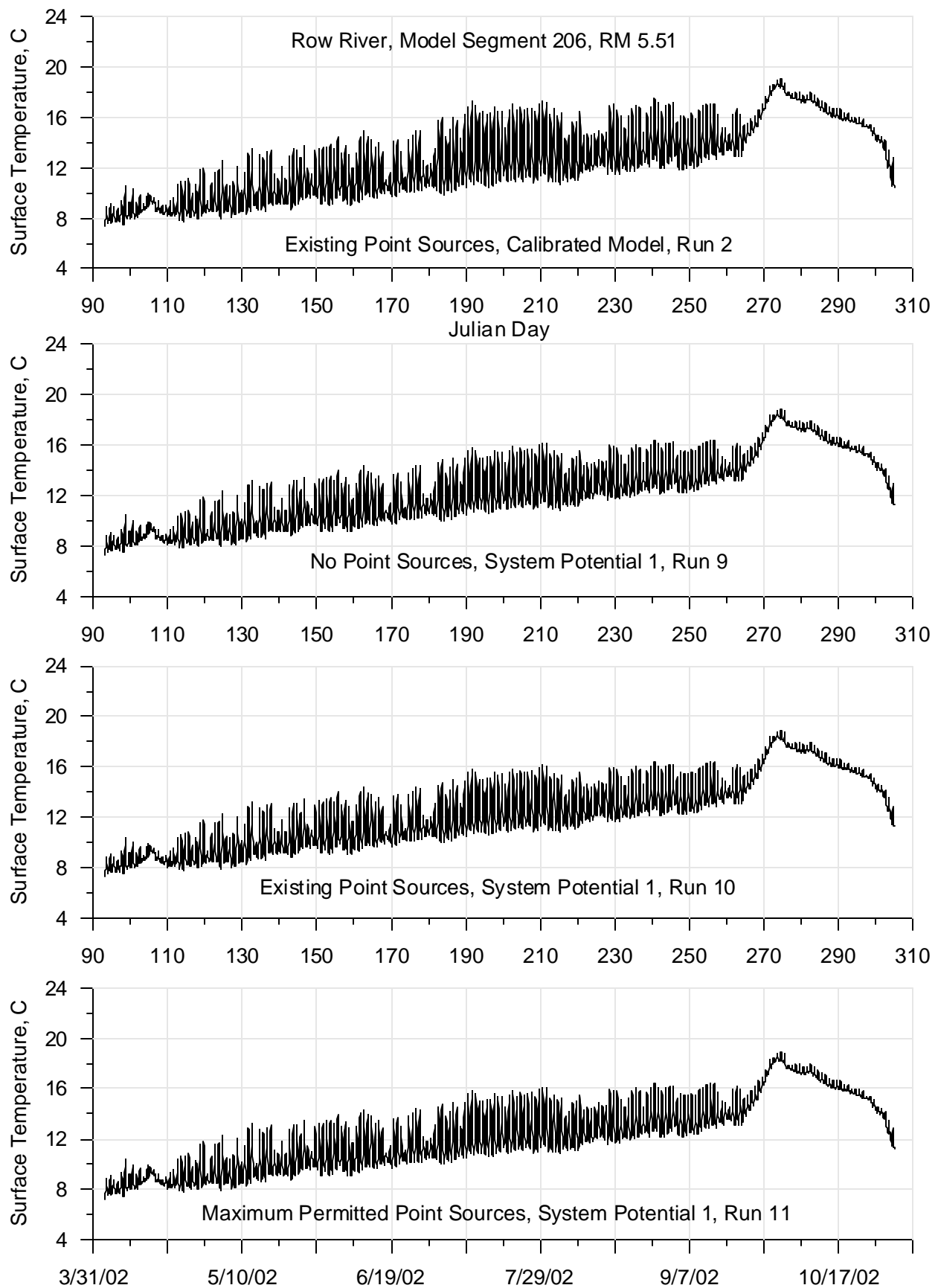


**Figure 212: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Coast Fork Willamette River at RM 21.28**

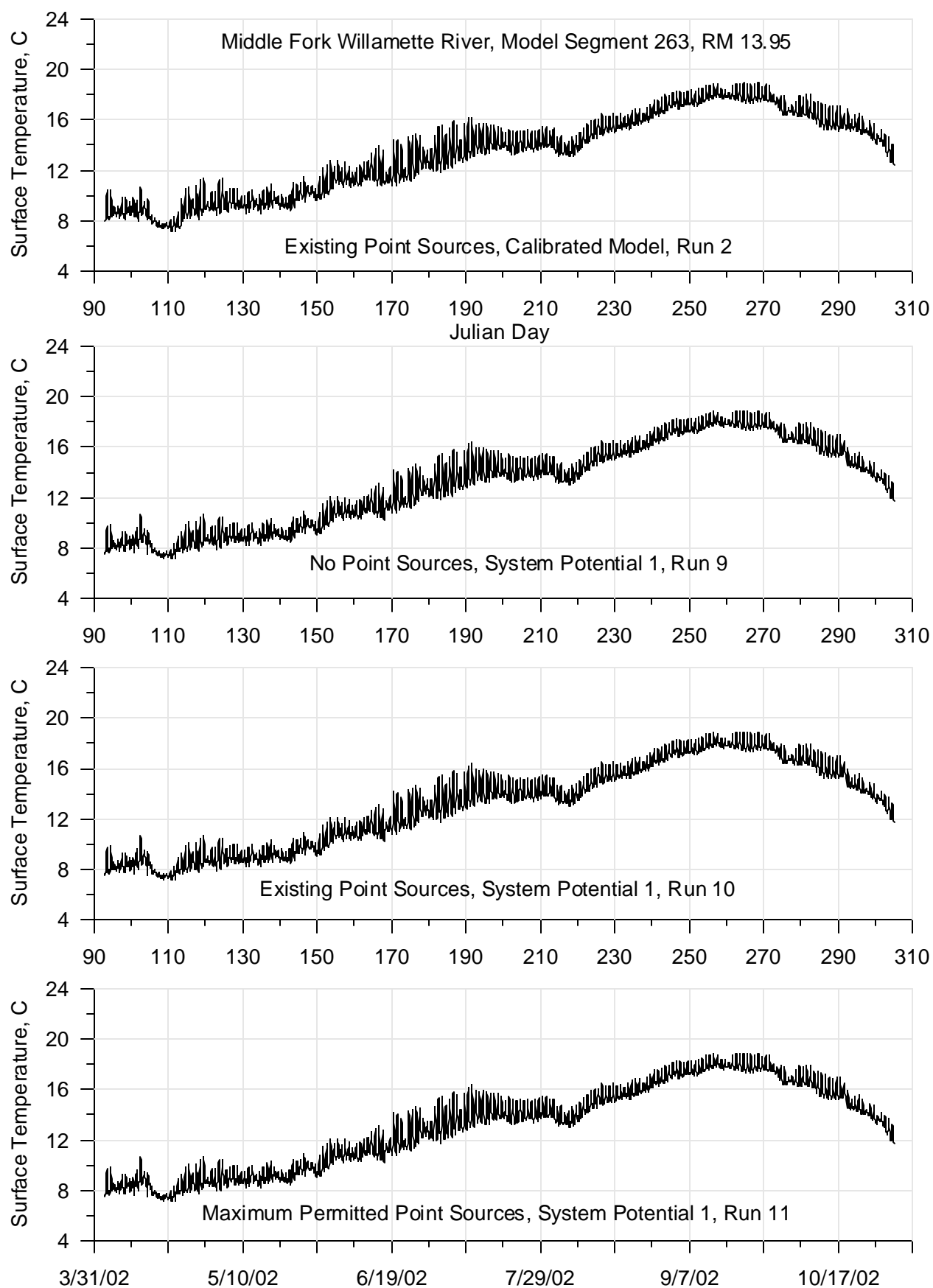


**Figure 213: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Coast Fork Willamette River at RM 20.18**

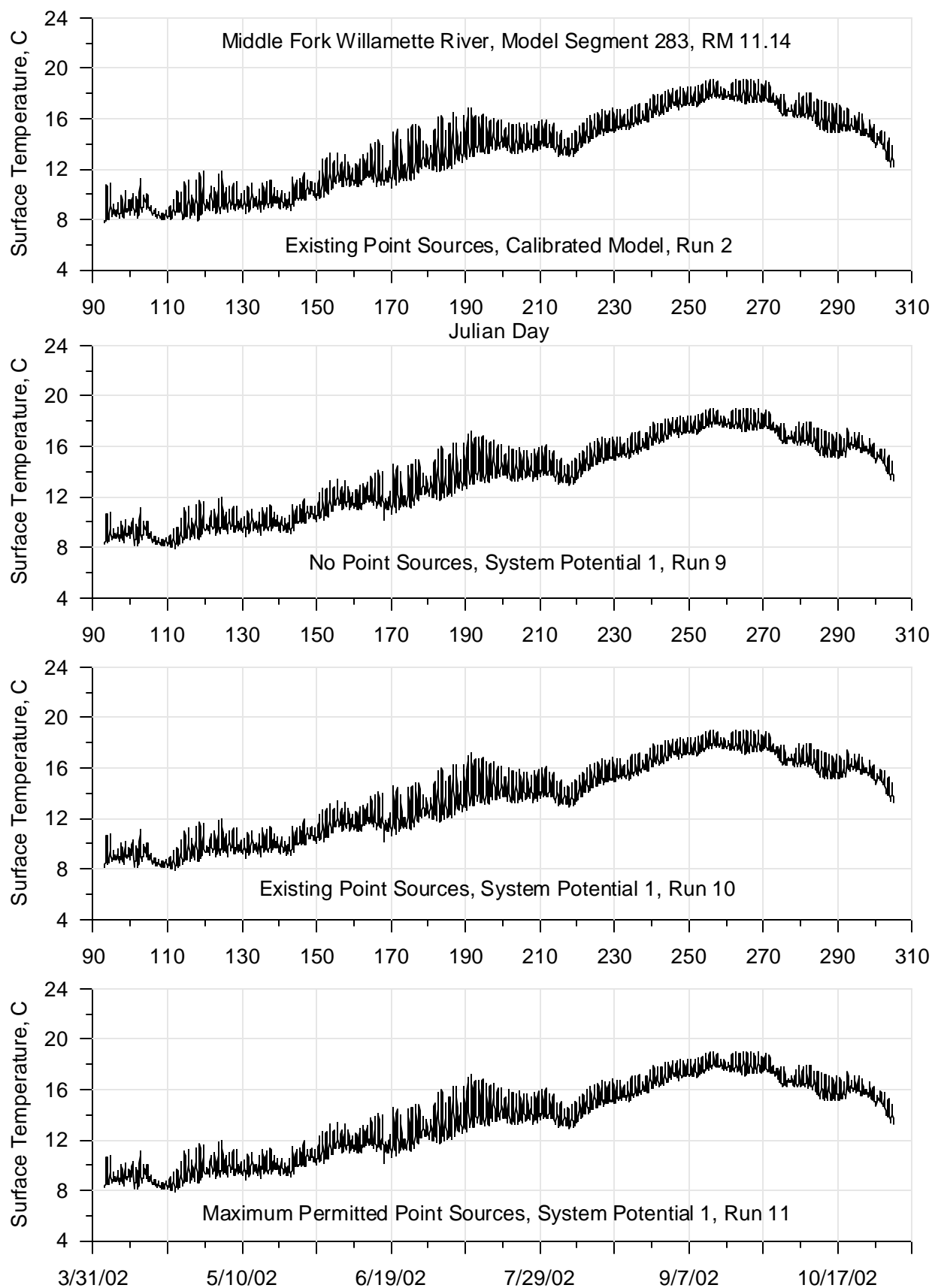




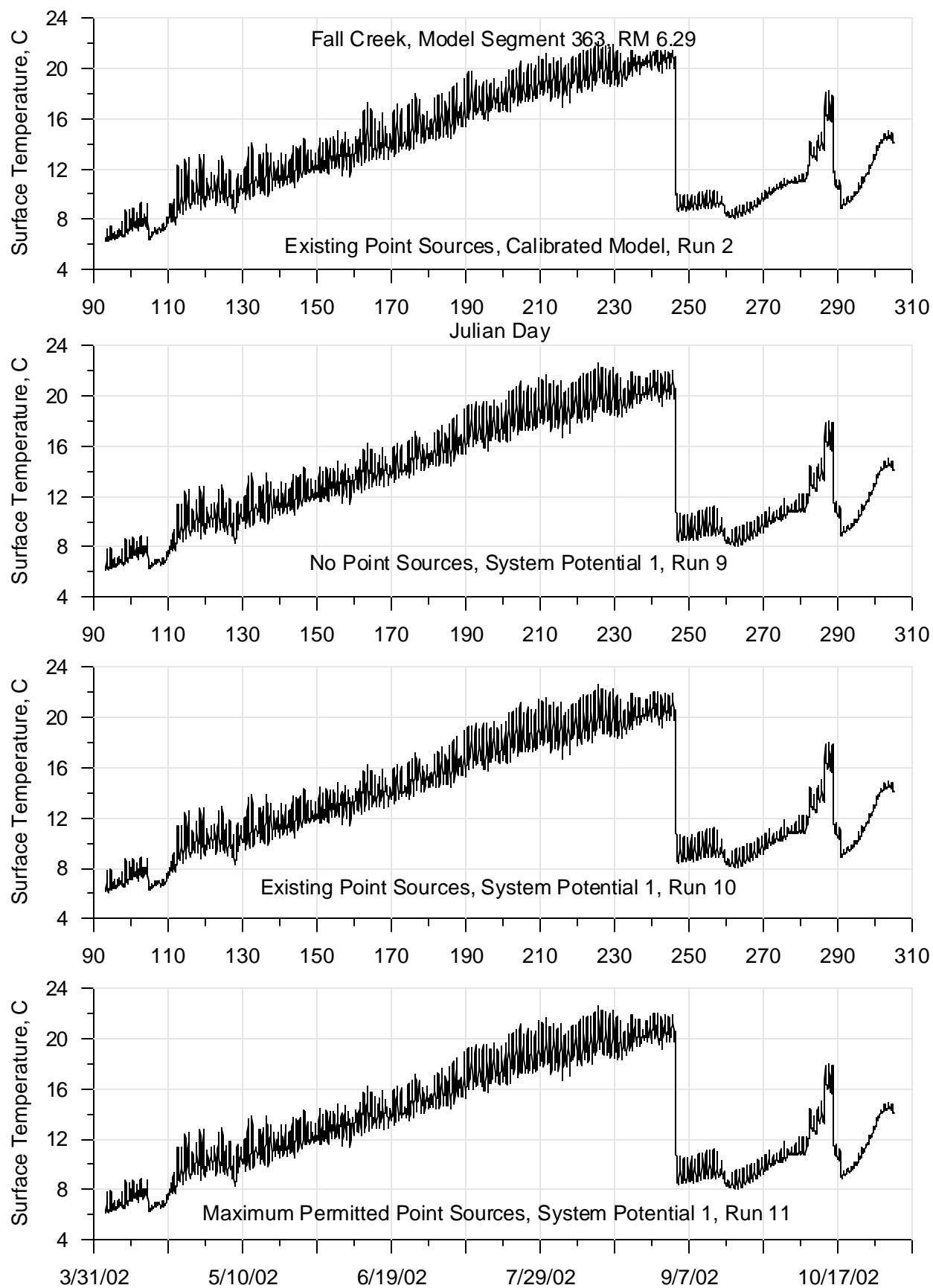
**Figure 214: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Row River at RM 5.51**



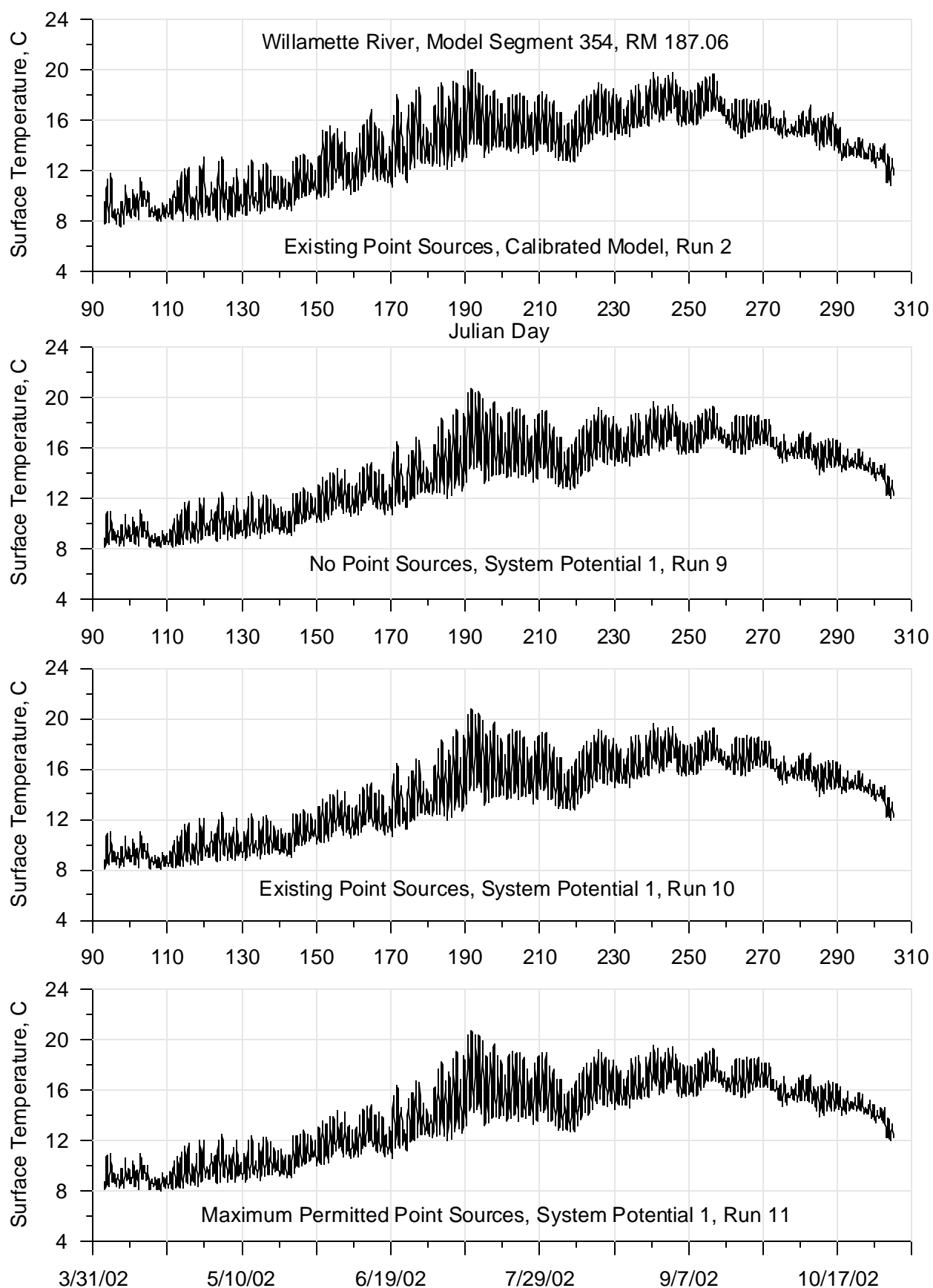
**Figure 215: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Middle Fork Willamette River at RM 13.95**



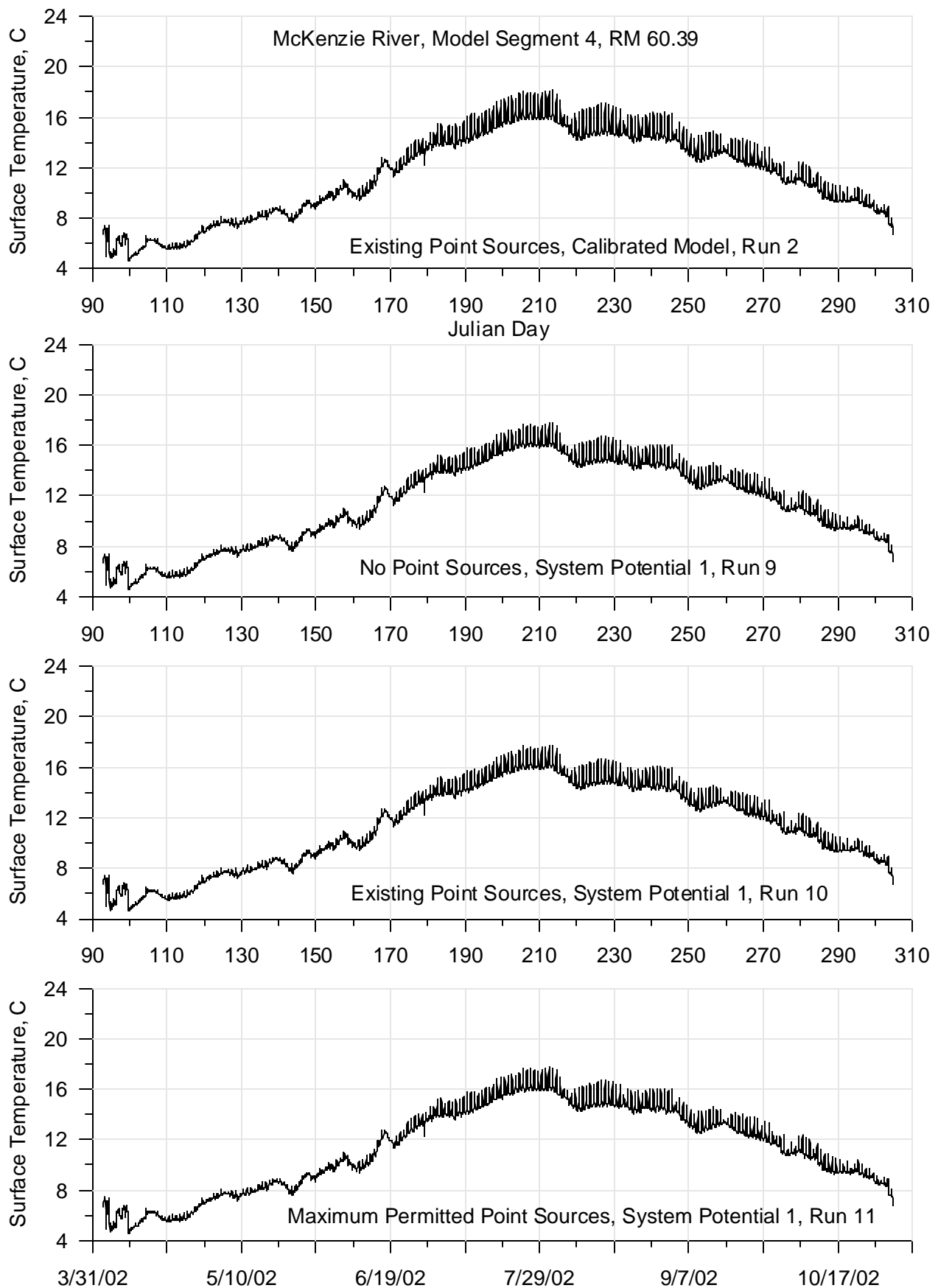
**Figure 216: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Middle Fork Willamette River at RM 11.14**



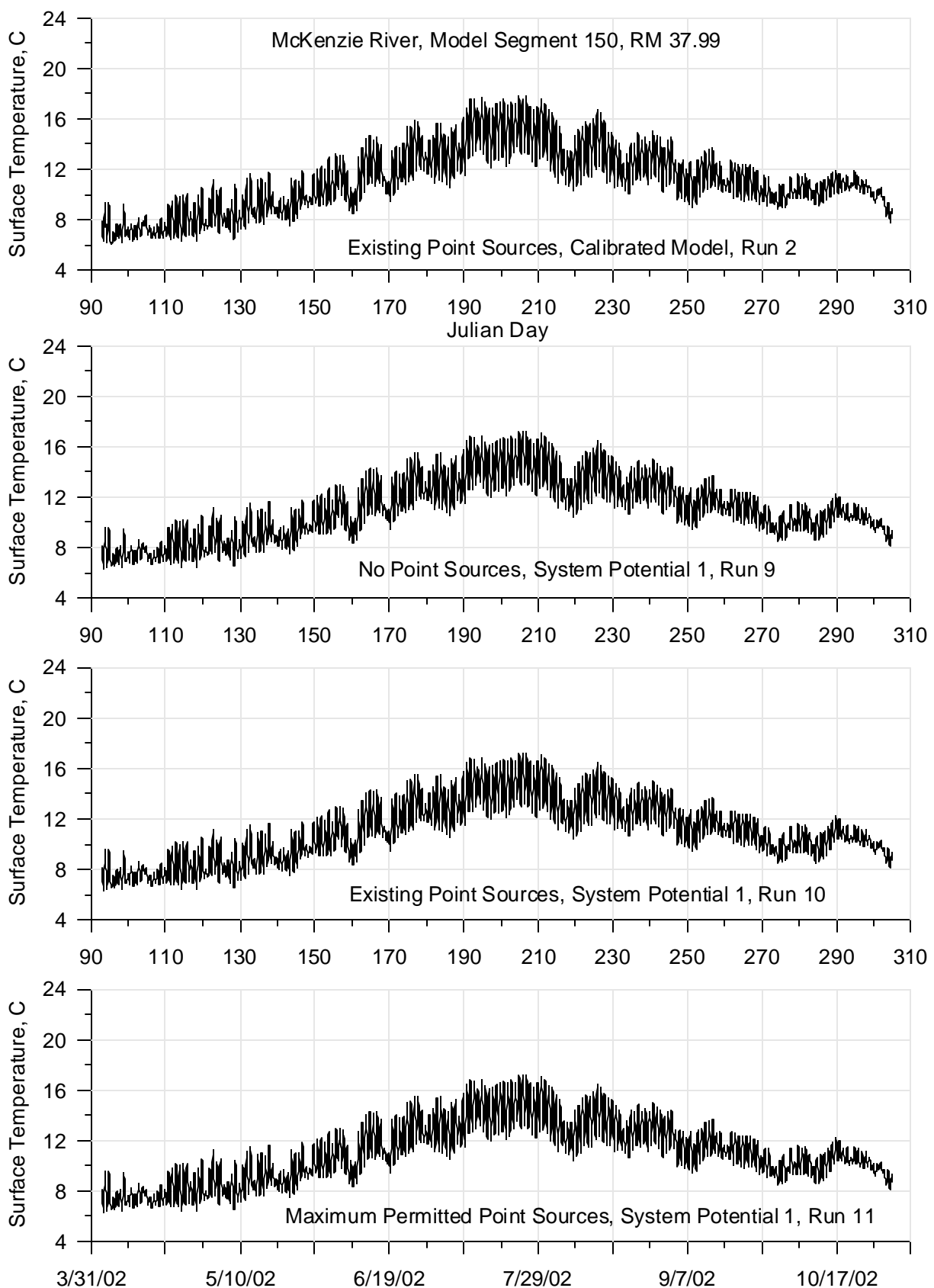
**Figure 217: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Fall Creek at RM 6.29**



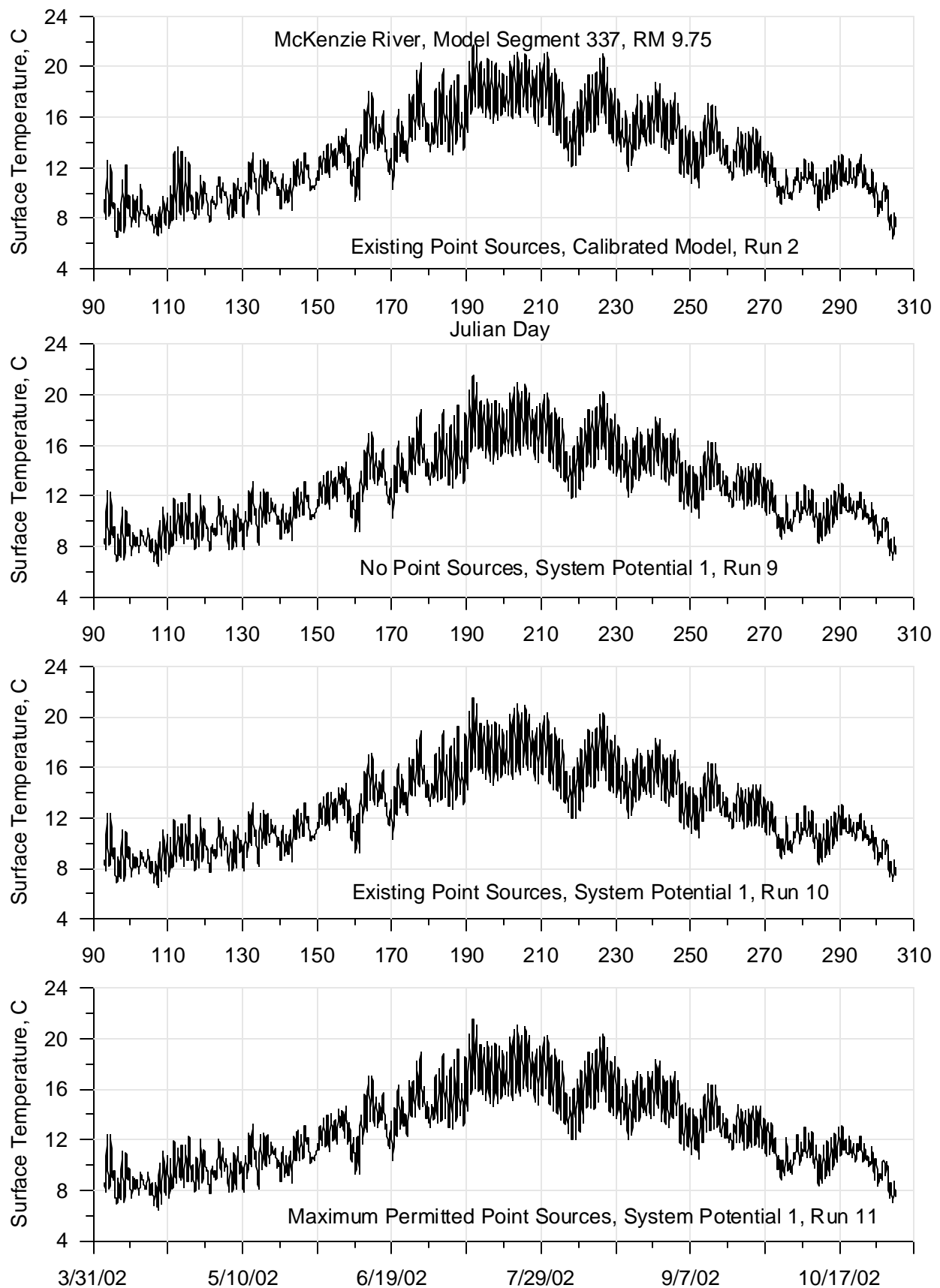
**Figure 218: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 187.06**



**Figure 219: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the McKenzie River at RM 60.39**

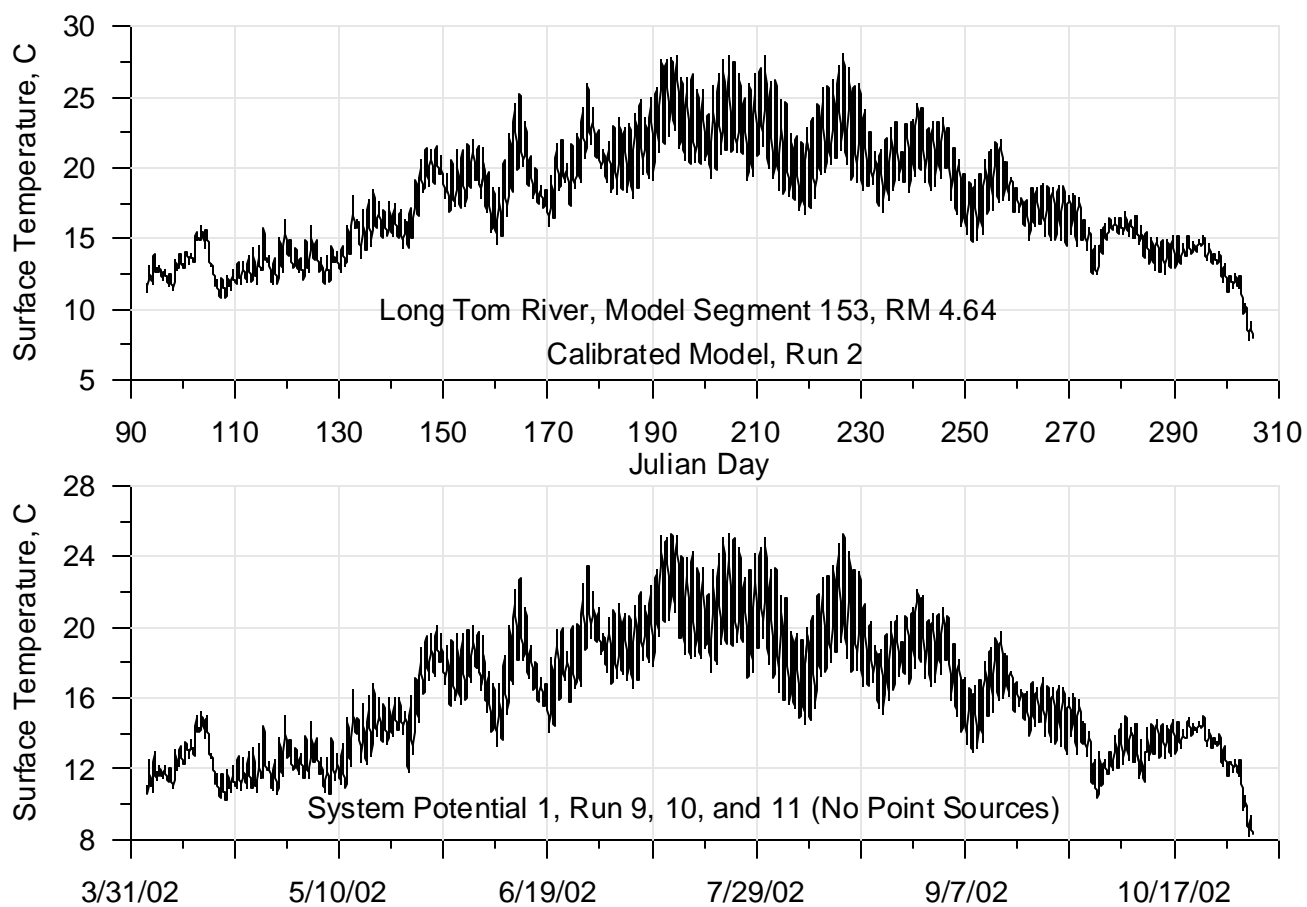


**Figure 220: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the McKenzie River at RM 37.99**

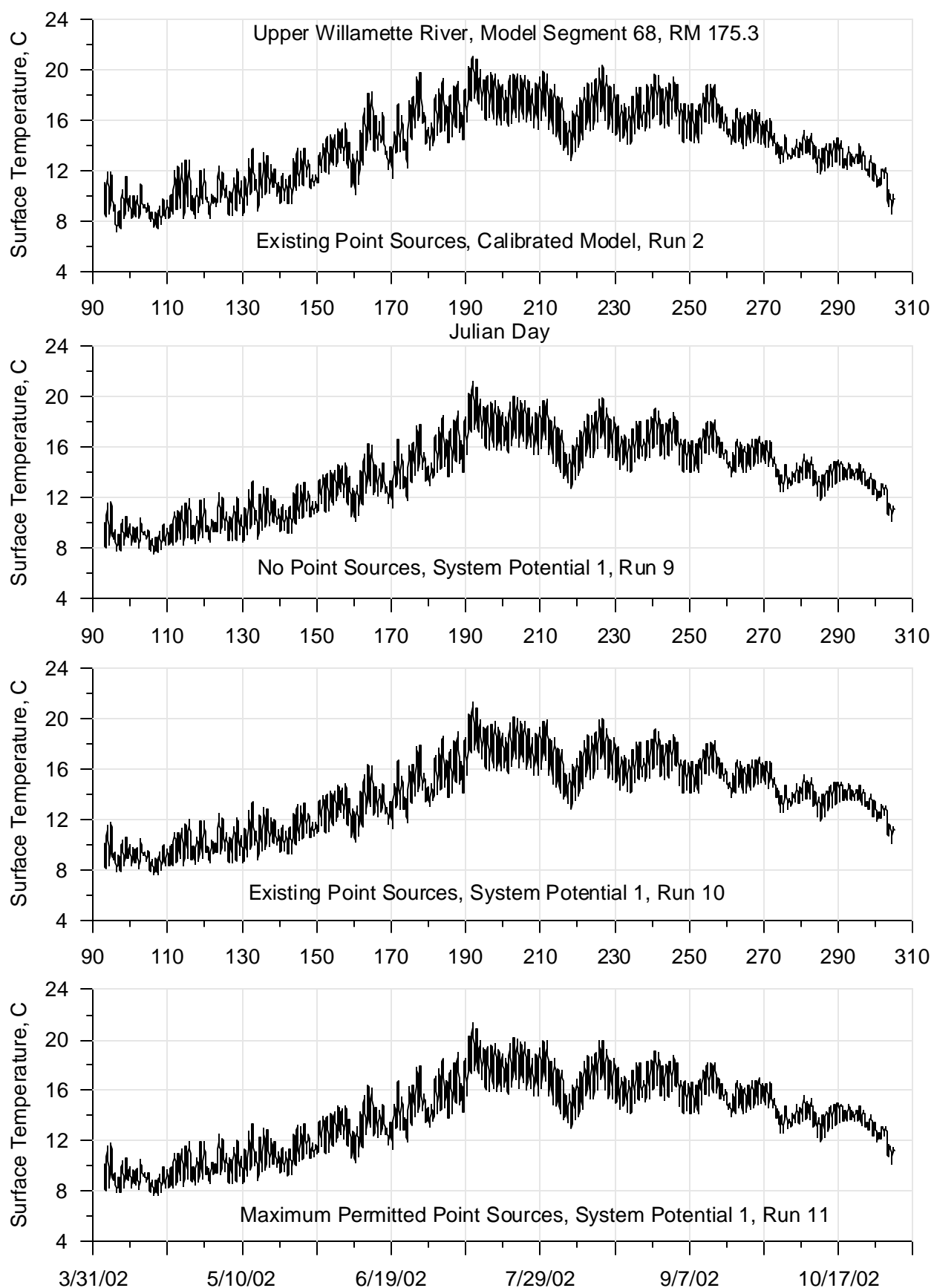


**Figure 221: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the McKenzie River at RM 9.75**

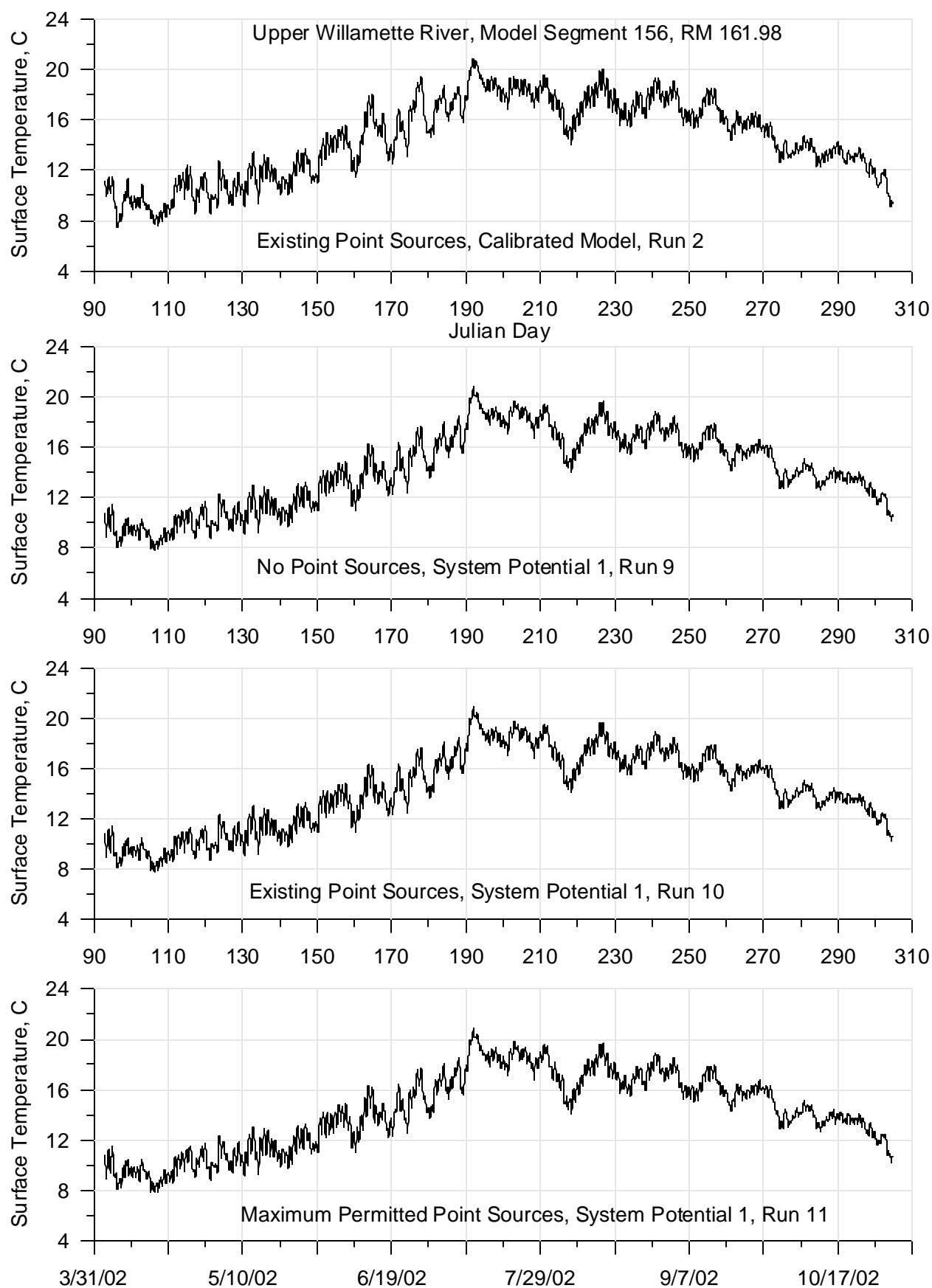




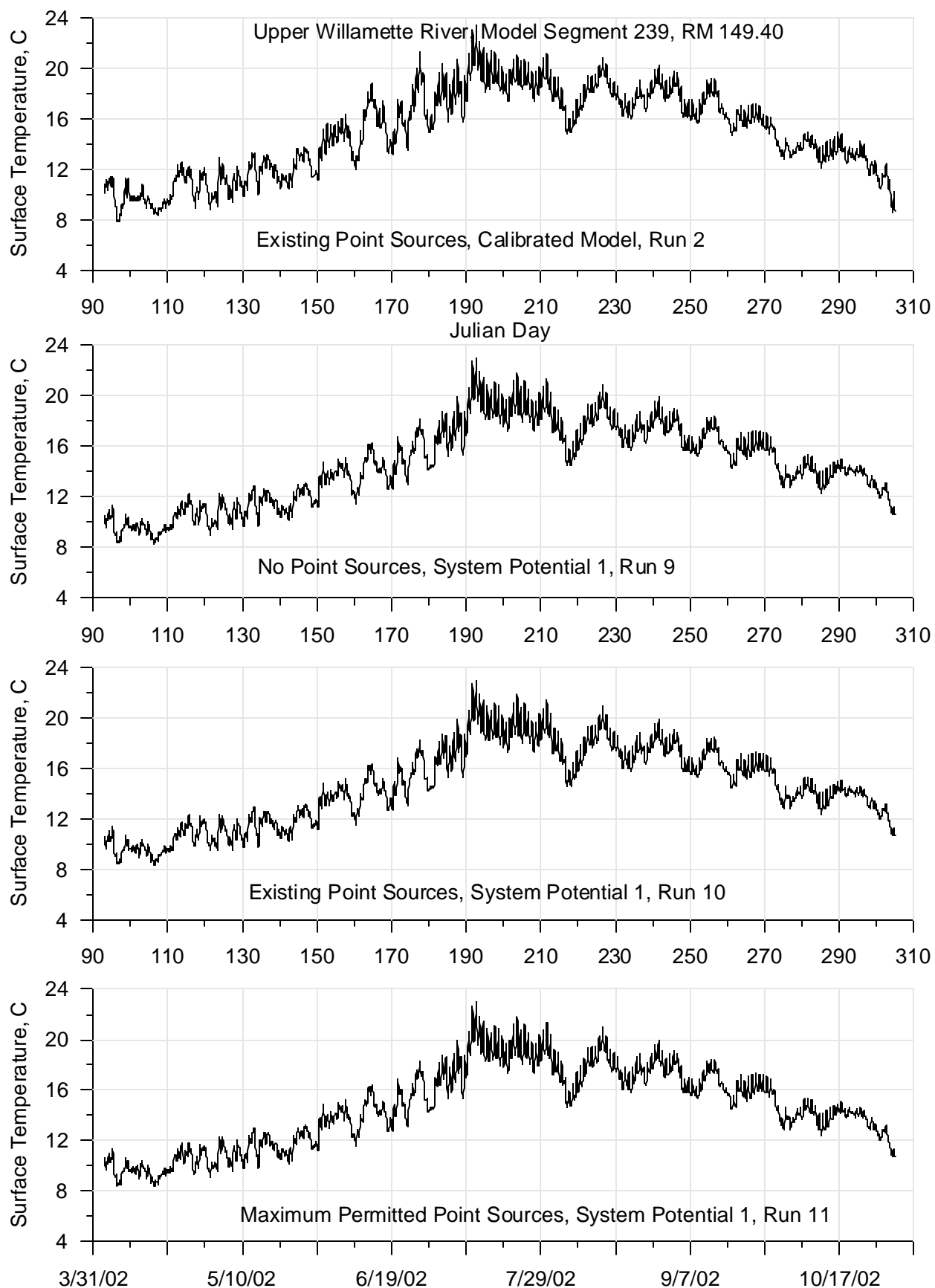
**Figure 222: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Long Tom River at RM 4.64**



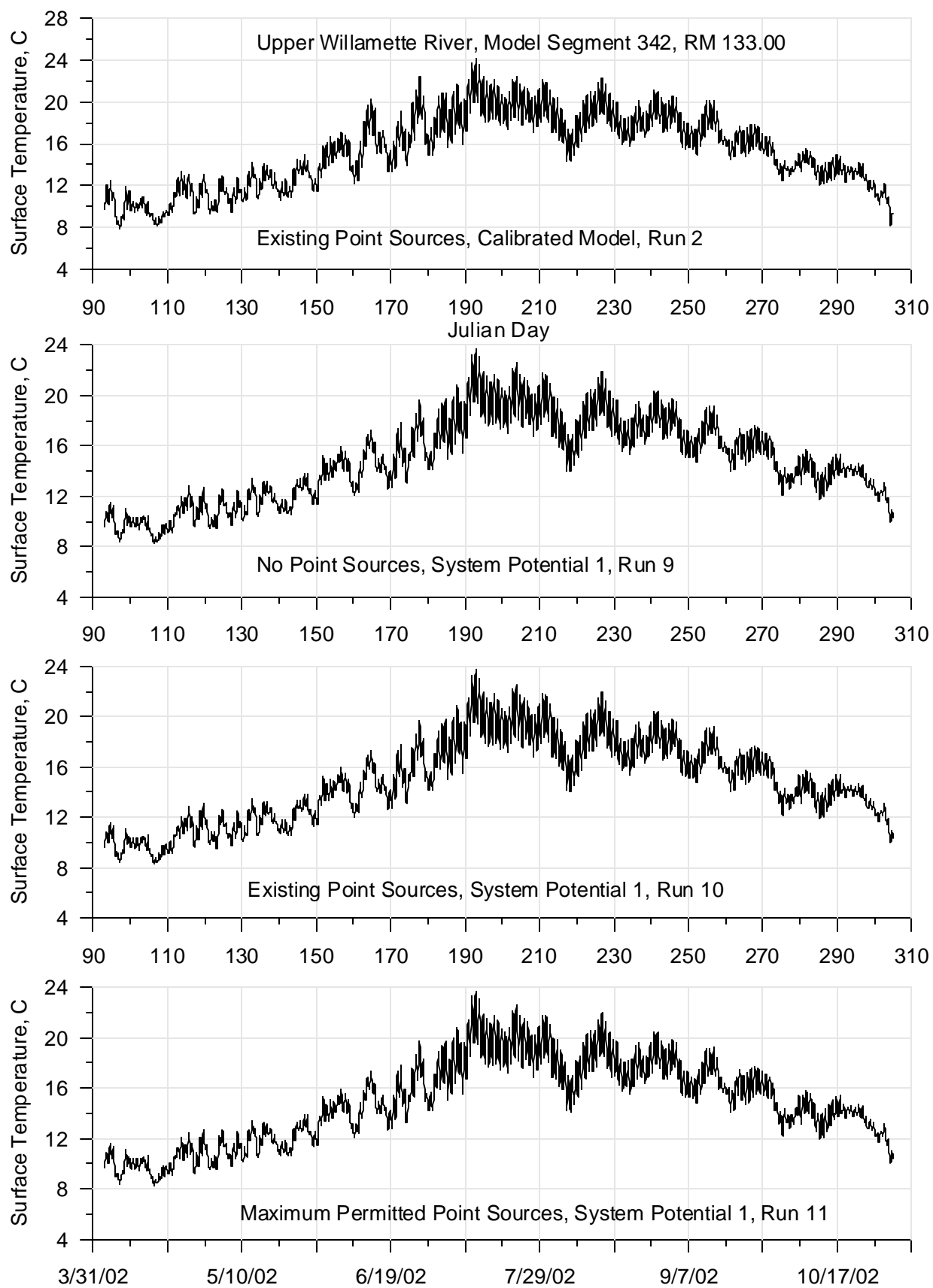
**Figure 223: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 175.3**



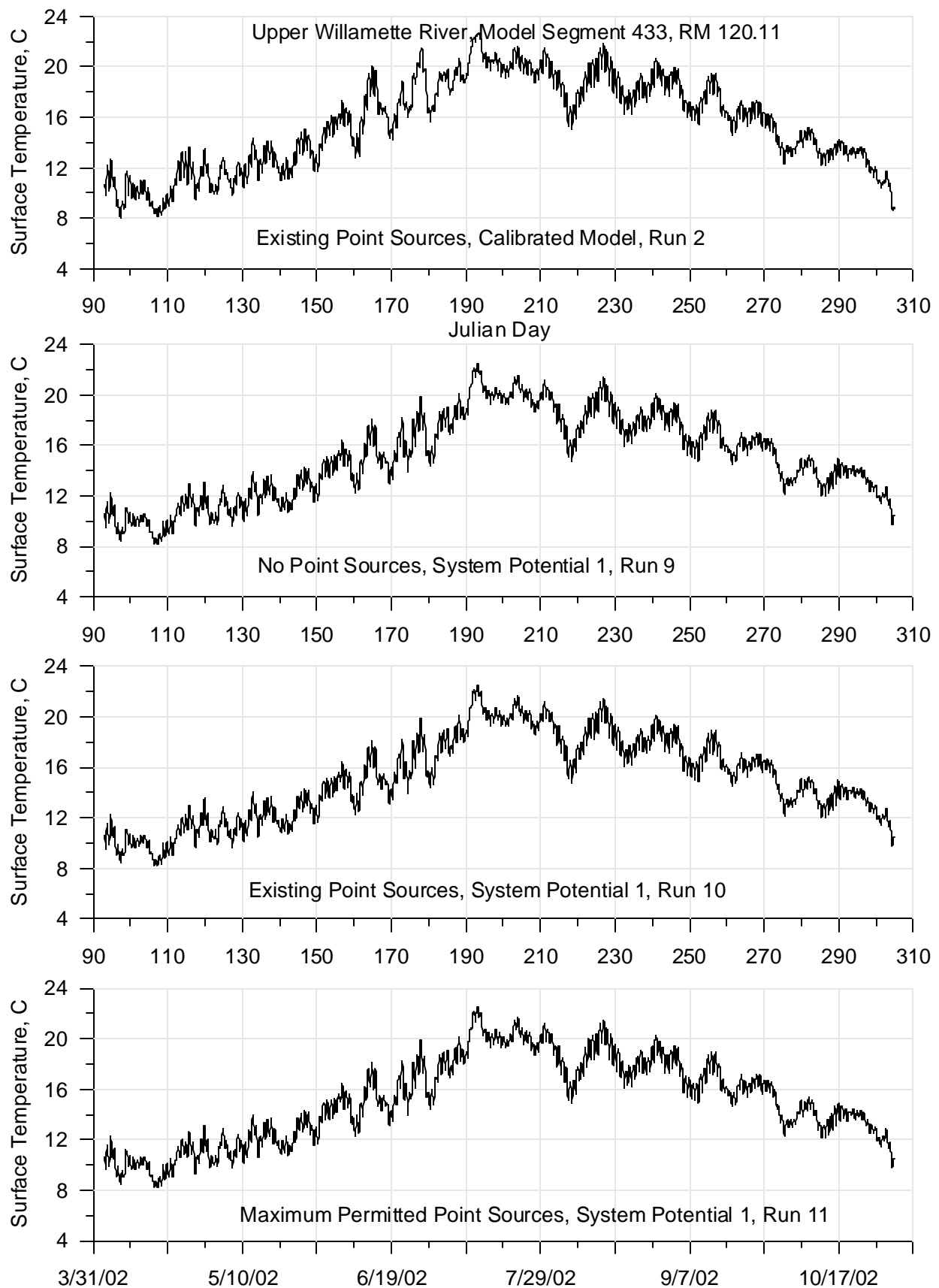
**Figure 224: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 161.98**



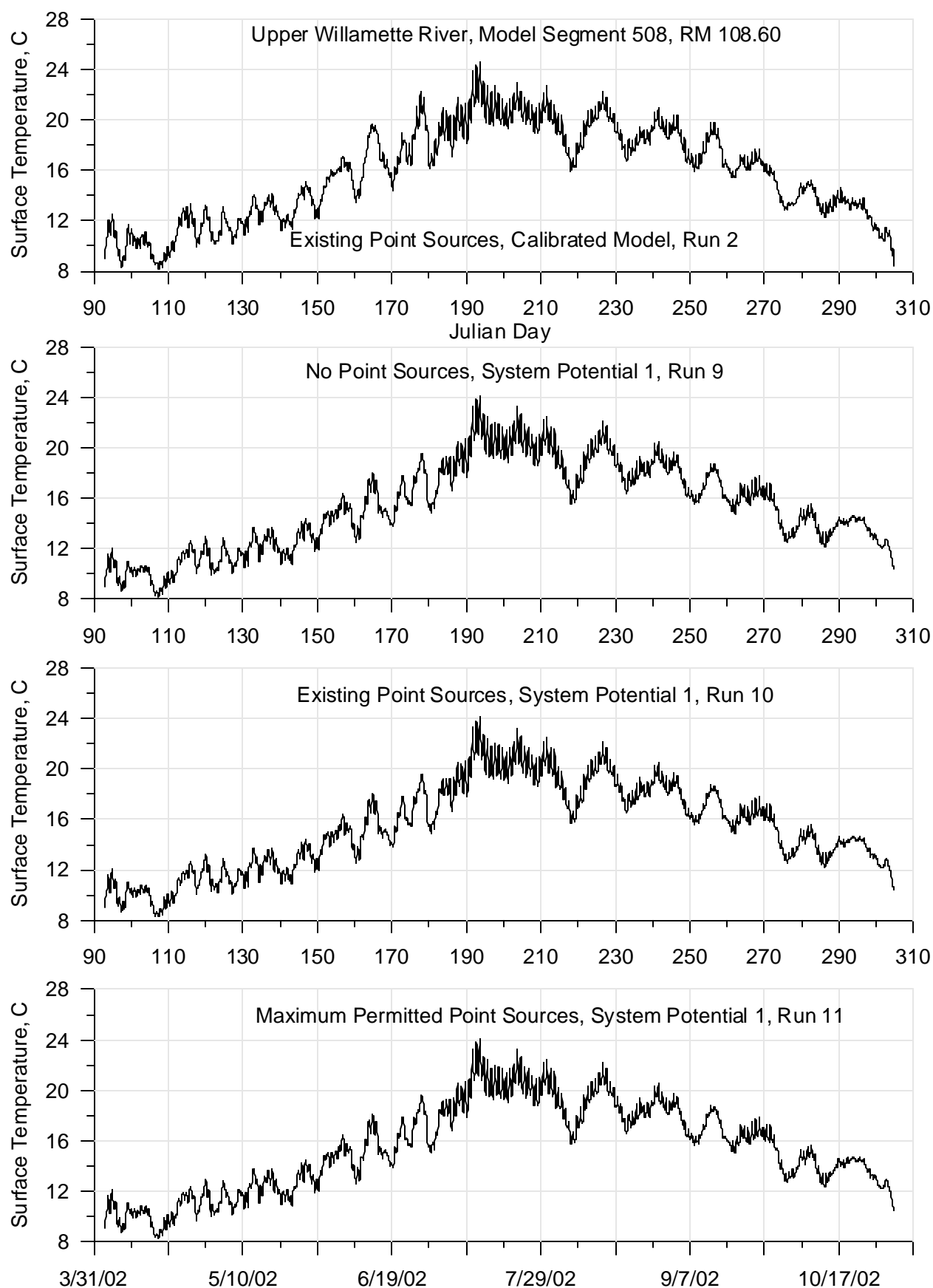
**Figure 225: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 149.4**



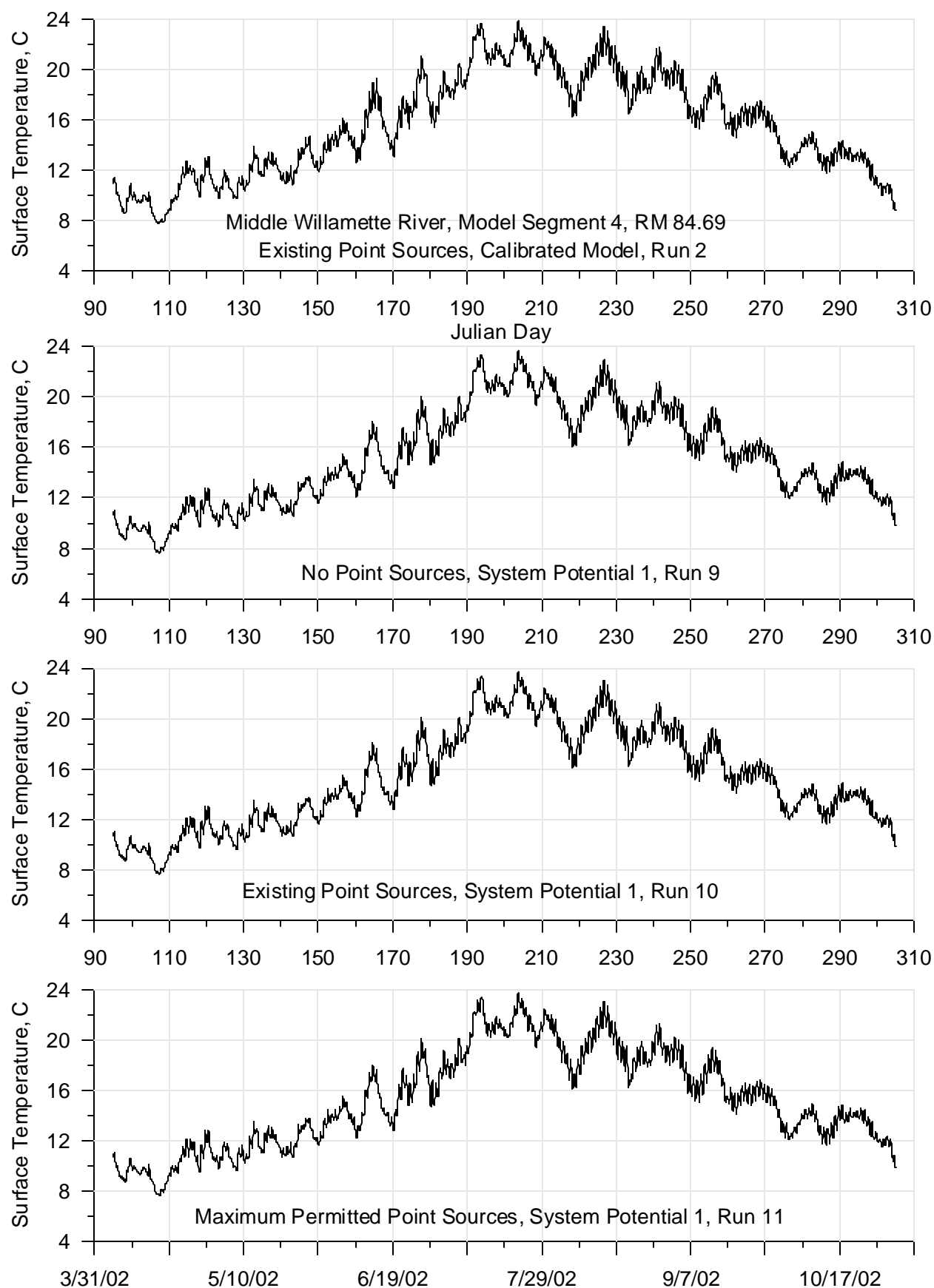
**Figure 226: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 133**



**Figure 227: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 120.11**

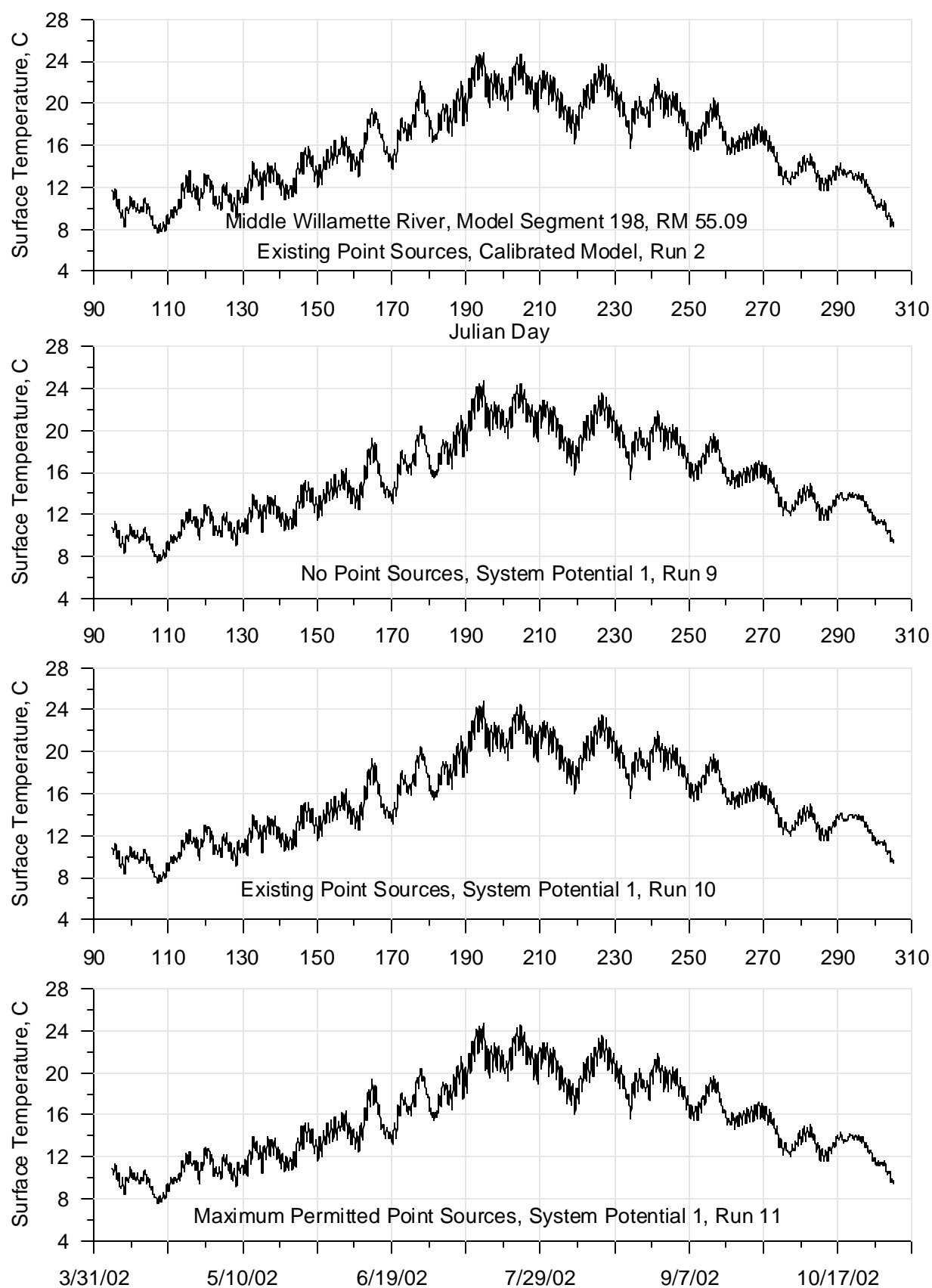


**Figure 228: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 108.6**

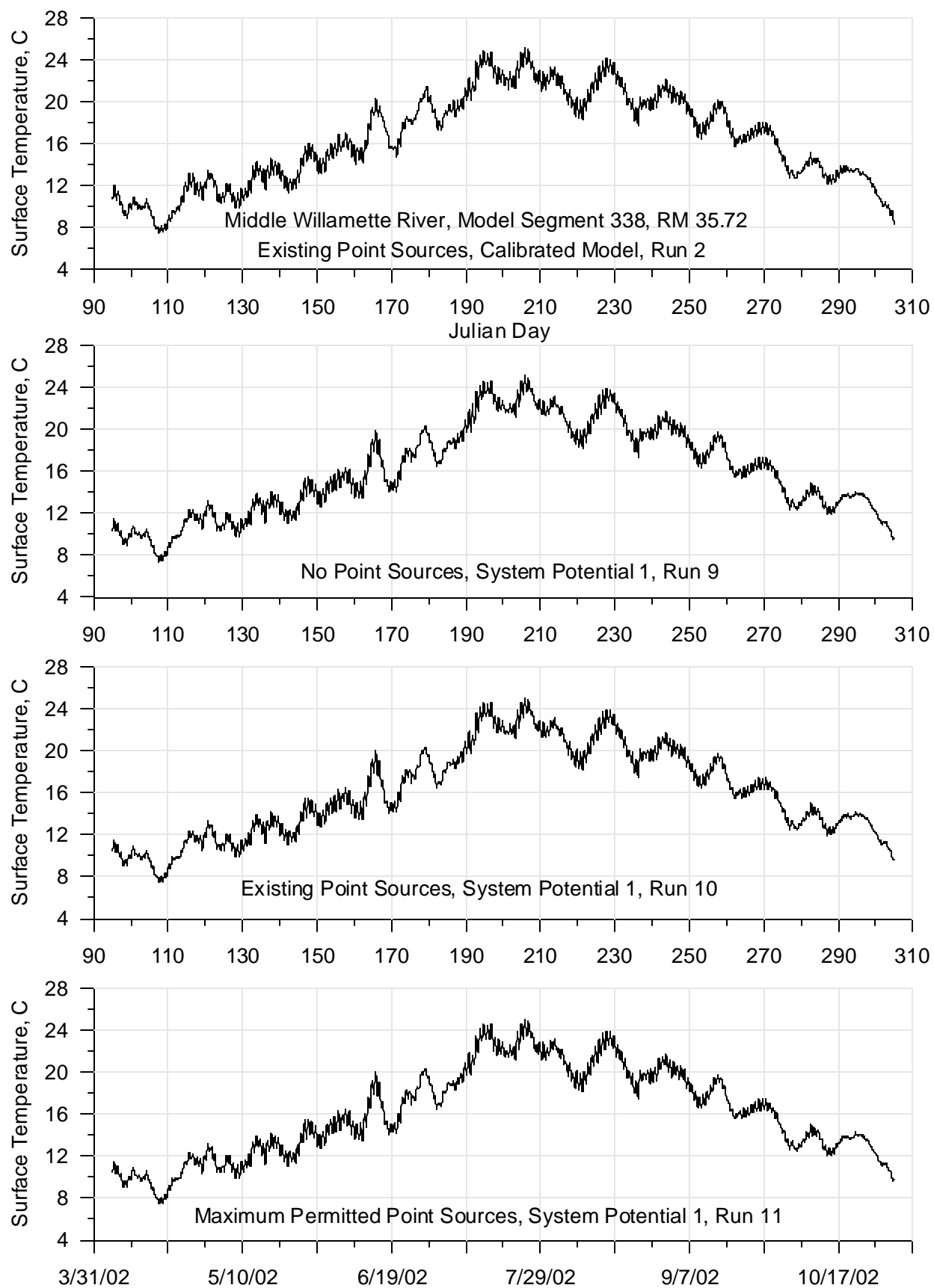


**Figure 229: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 84.69**

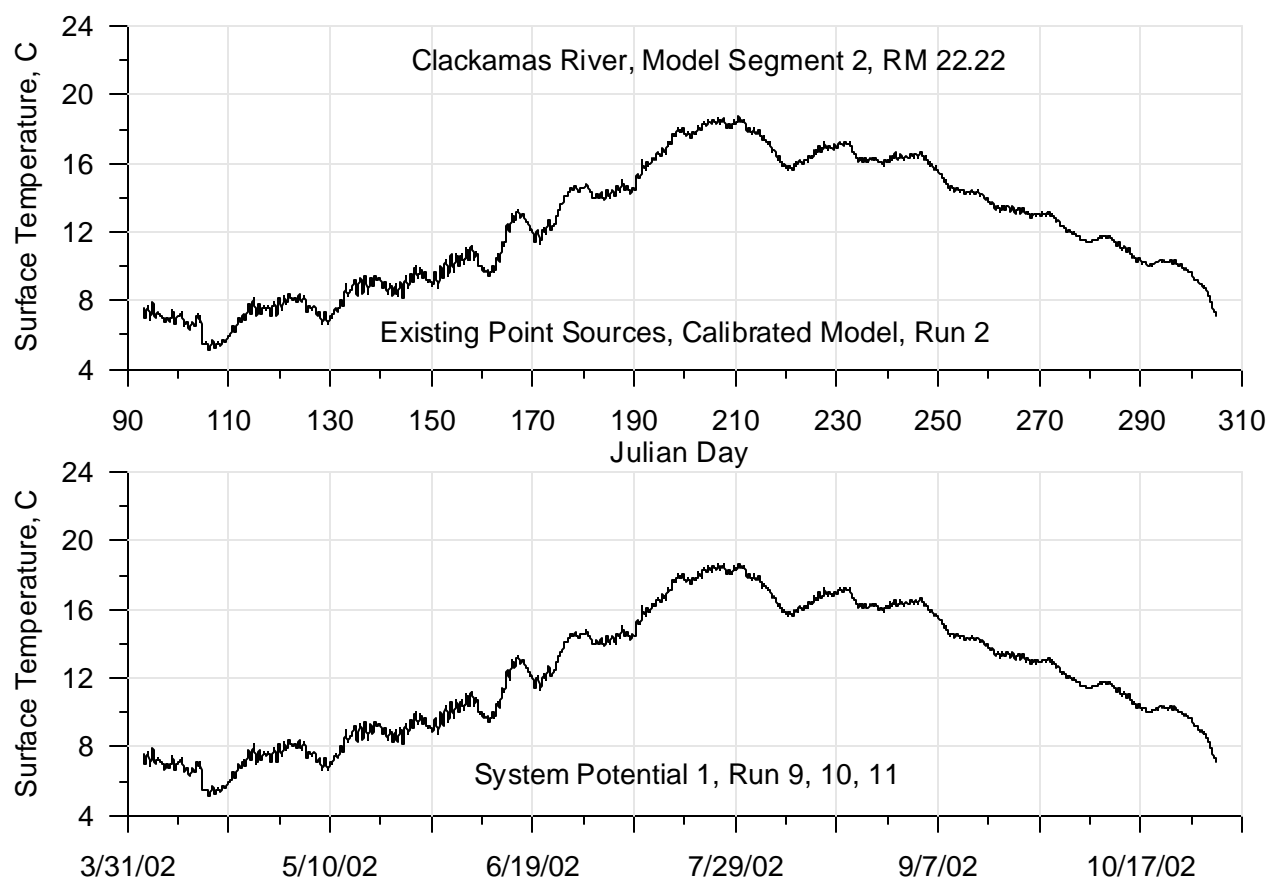




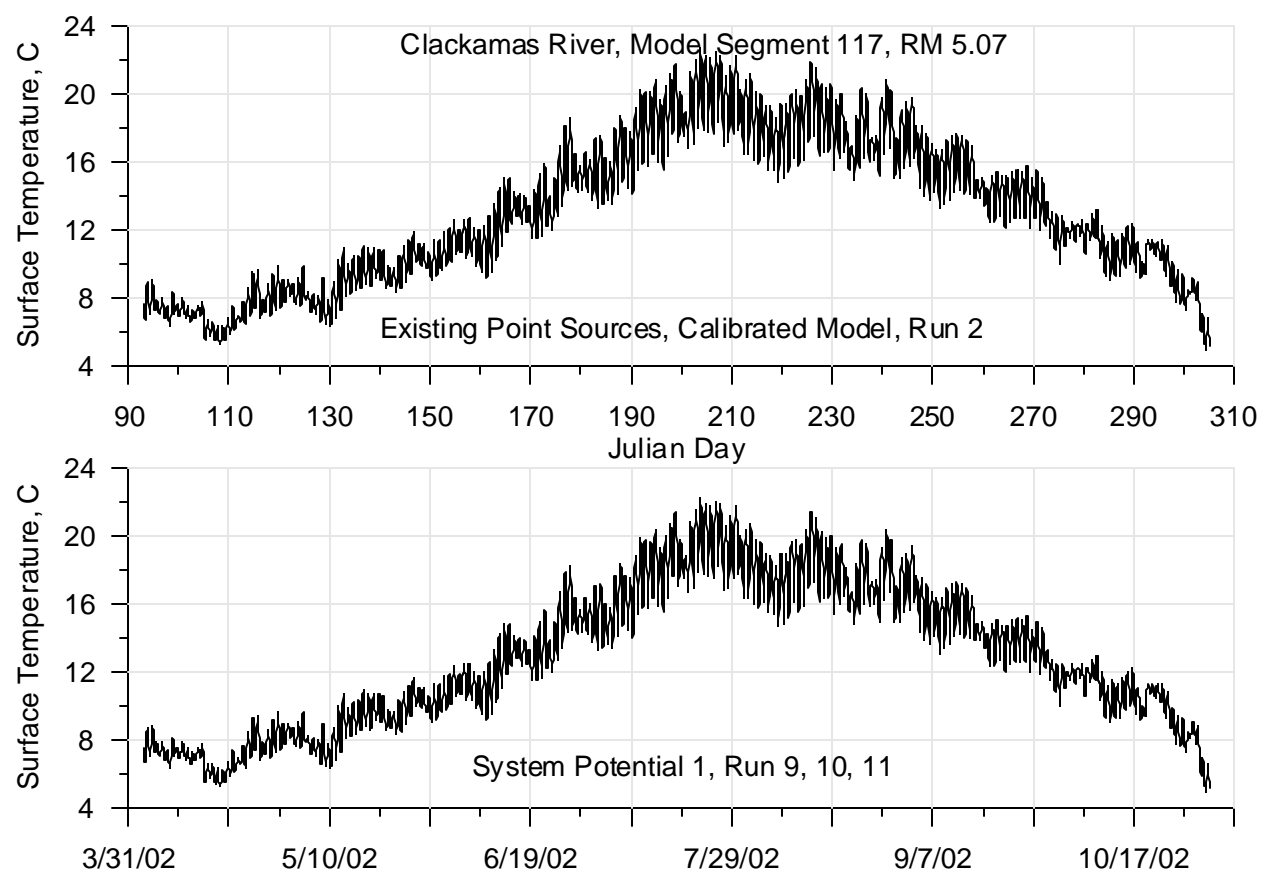
**Figure 230: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 55.09**



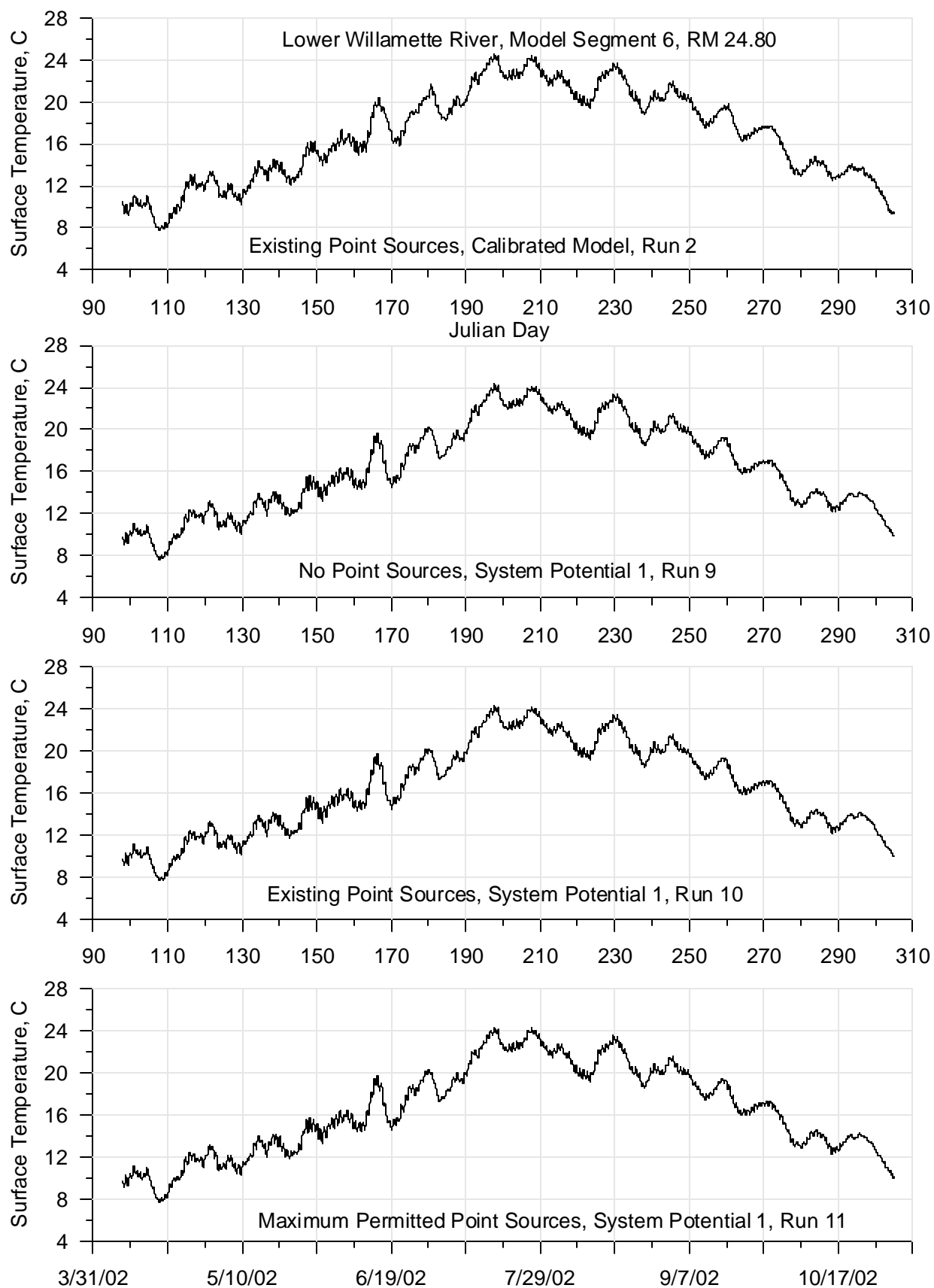
**Figure 231: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 35.72**



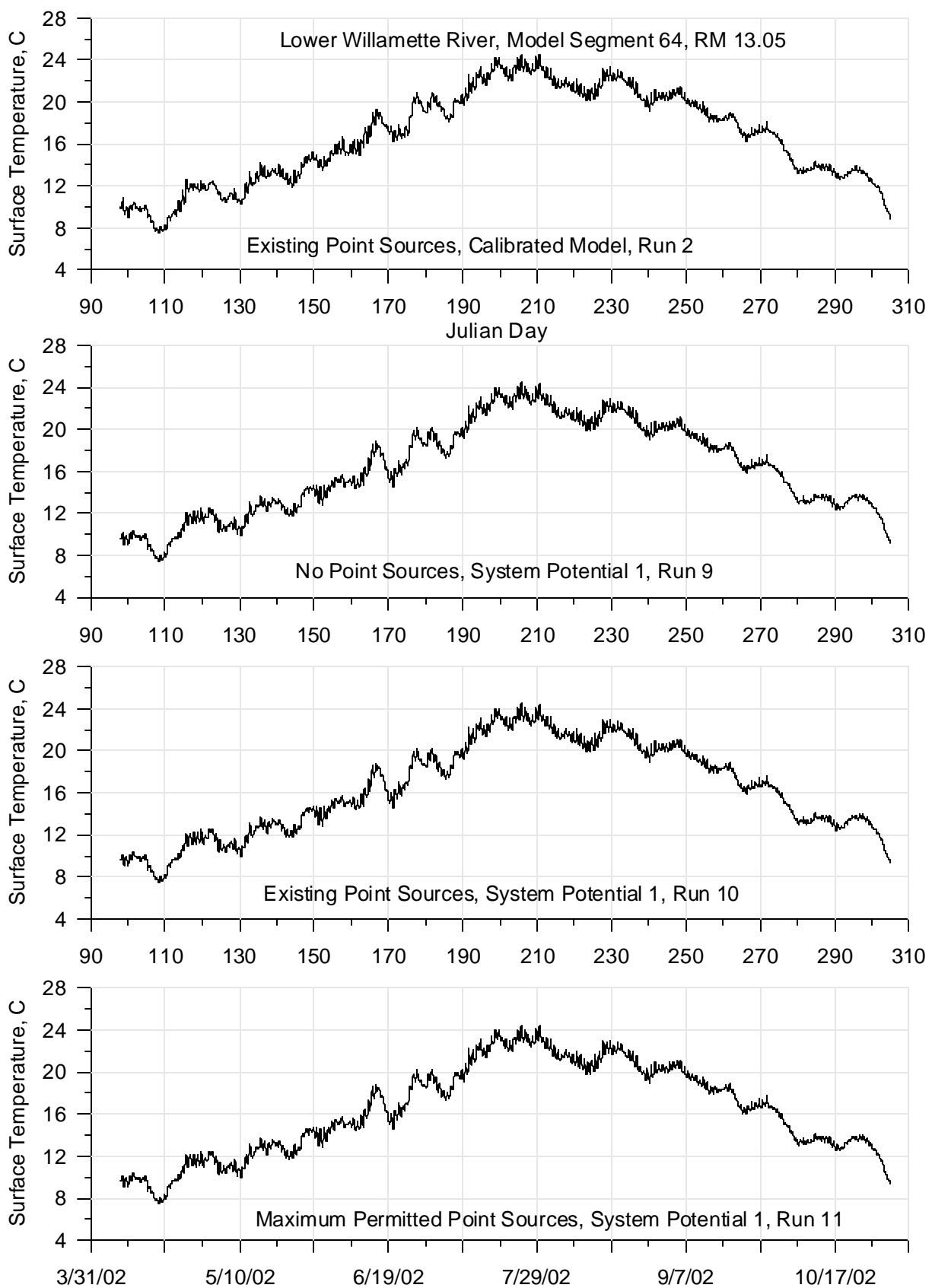
**Figure 232: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Clackamas River at RM 22.22**



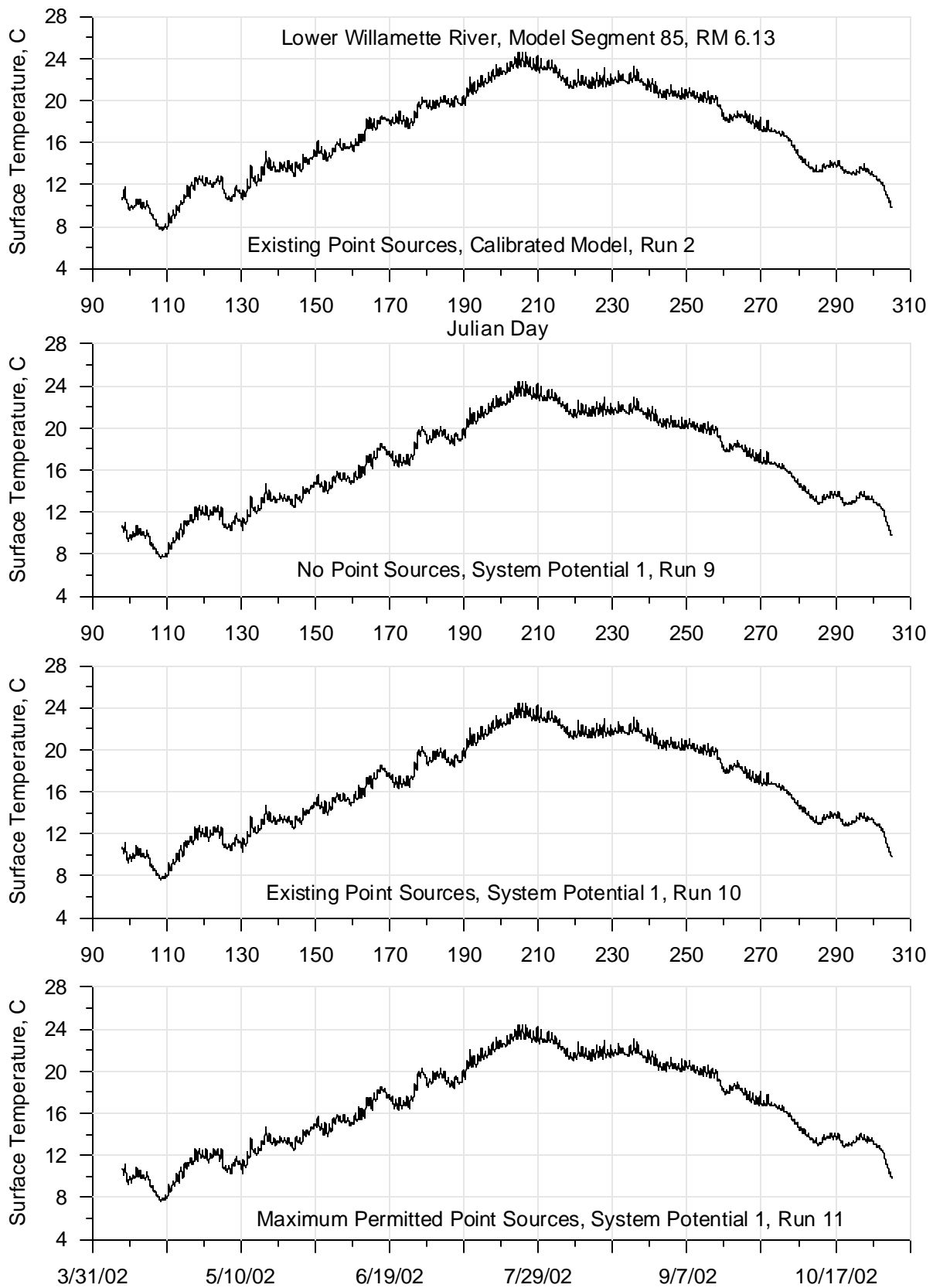
**Figure 233: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Clackamas River at RM 5.07**



**Figure 234: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 24.8**



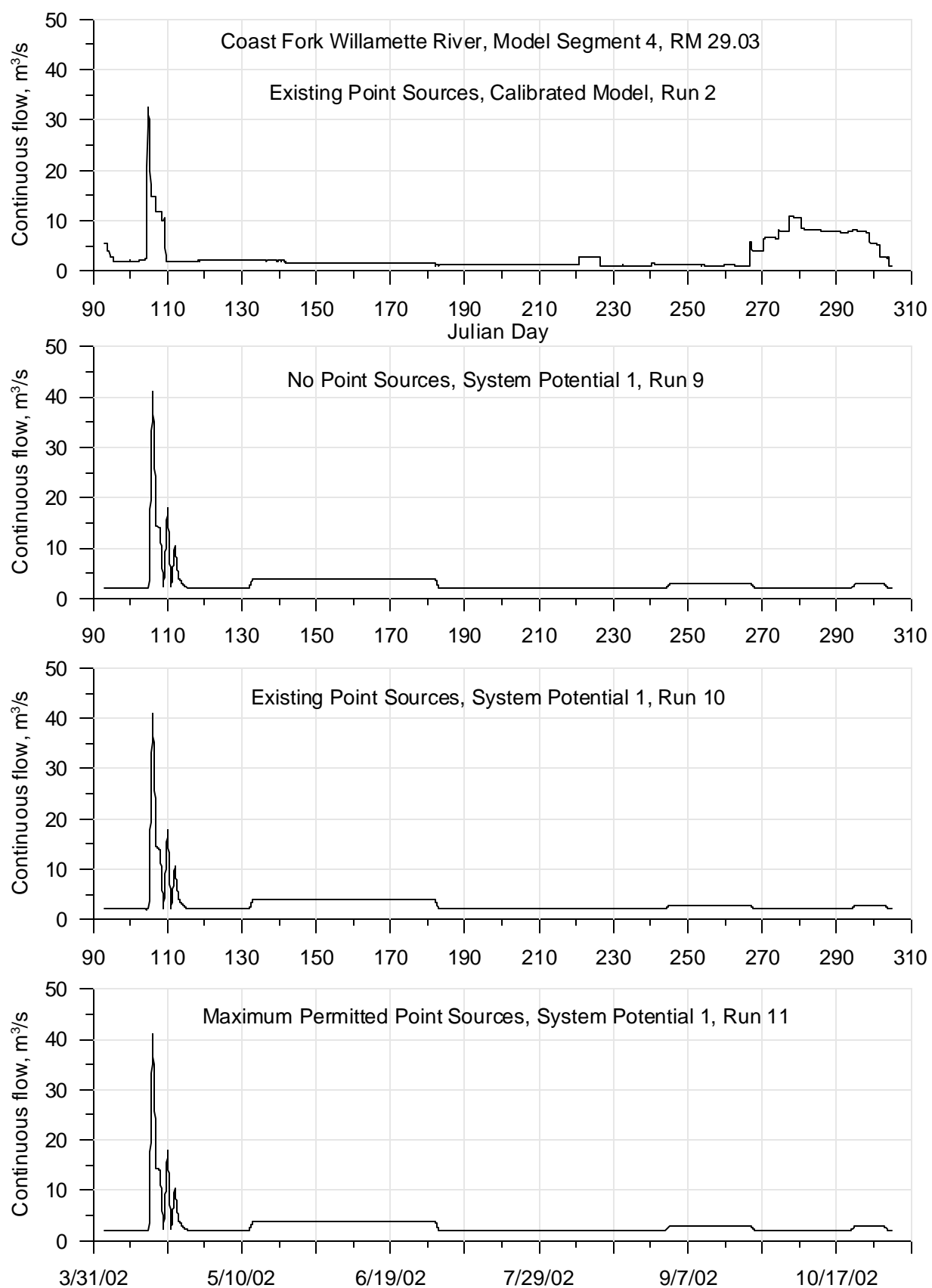
**Figure 235: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 13.05**



**Figure 236: Calibrated model and System Potential 1 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 6.13**

## Continuous Flow





**Figure 237: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Coast Fork Willamette River at RM 29.03**

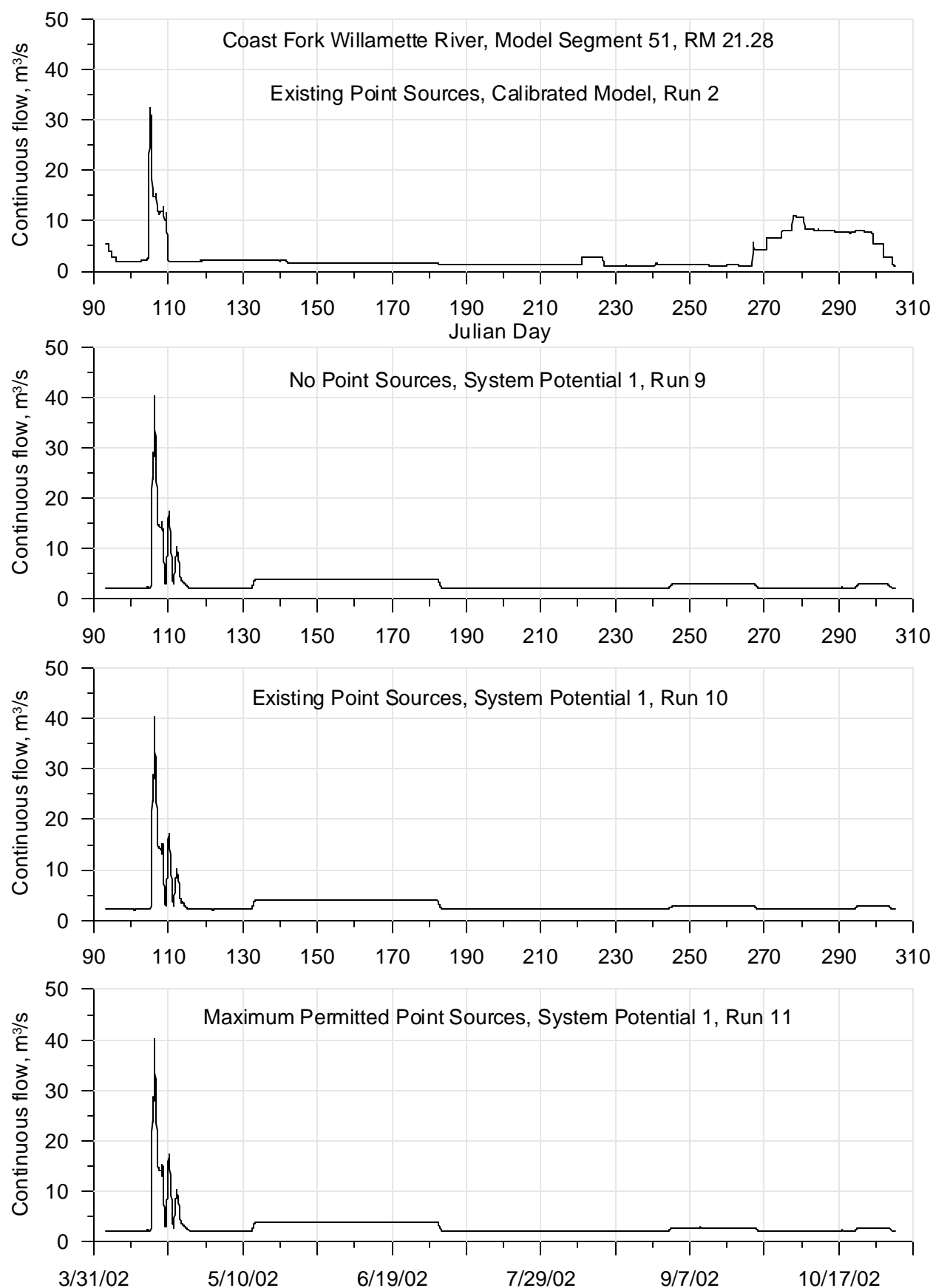
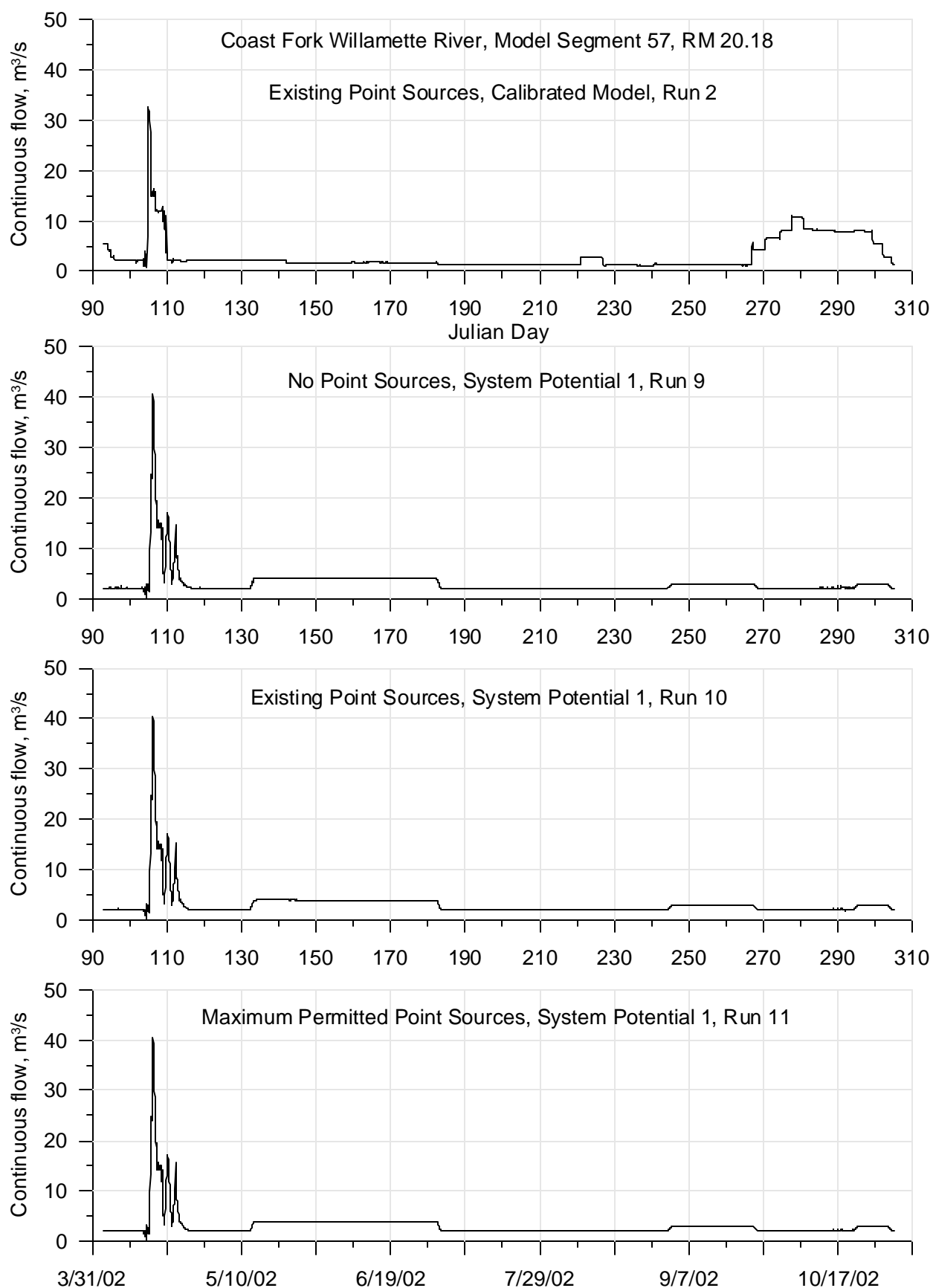
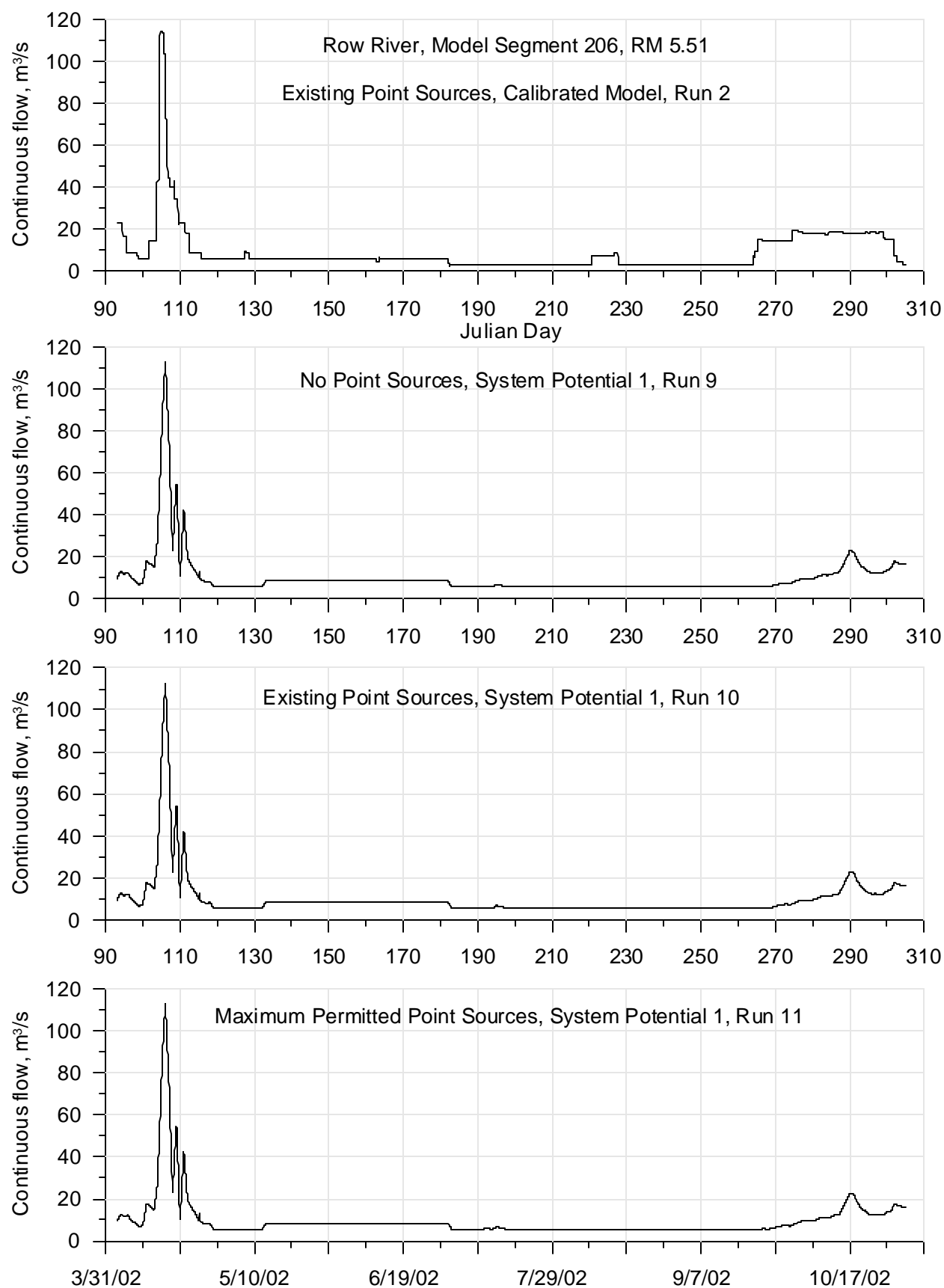


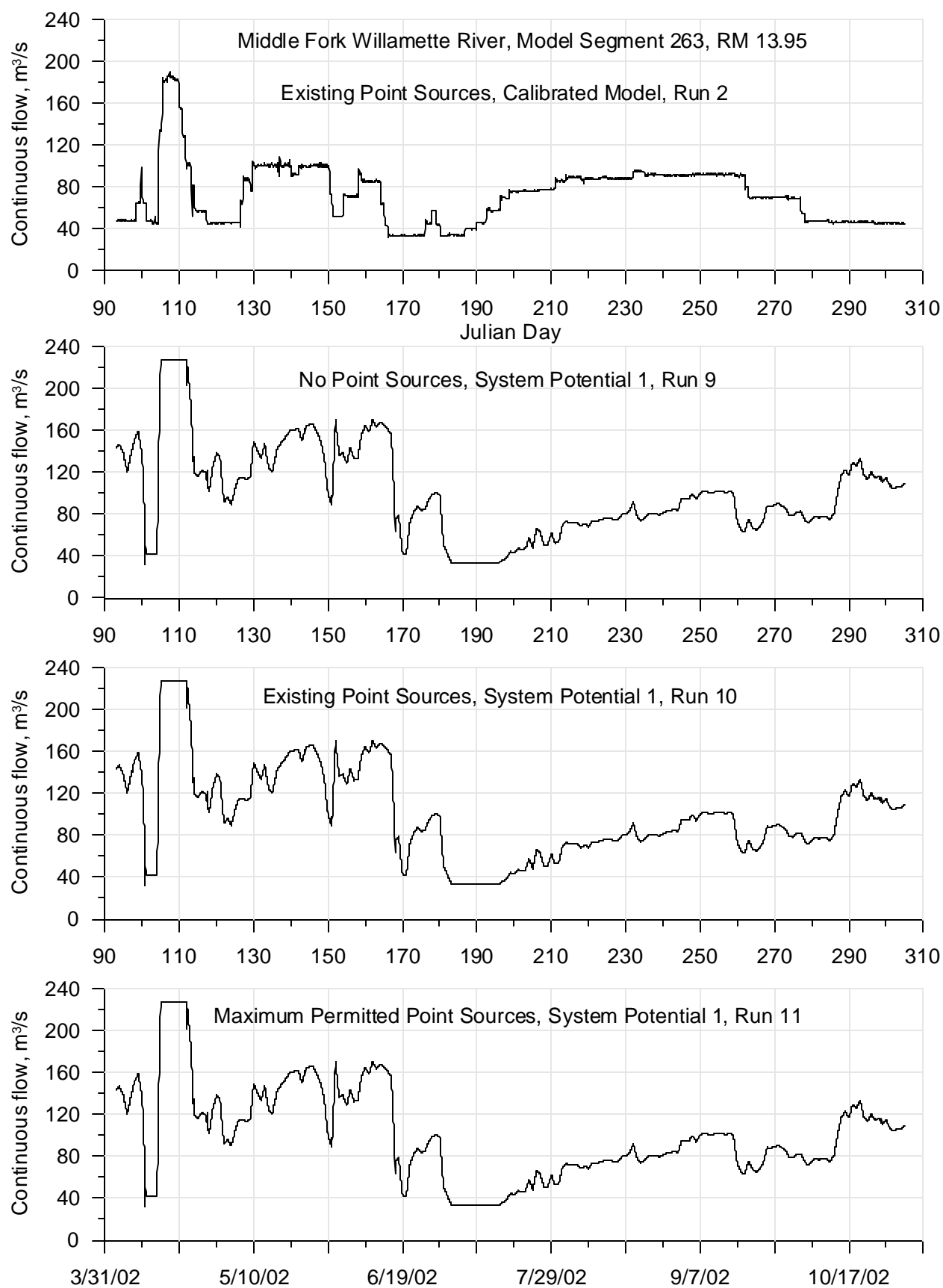
Figure 238: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Coast Fork Willamette River at RM 21.28



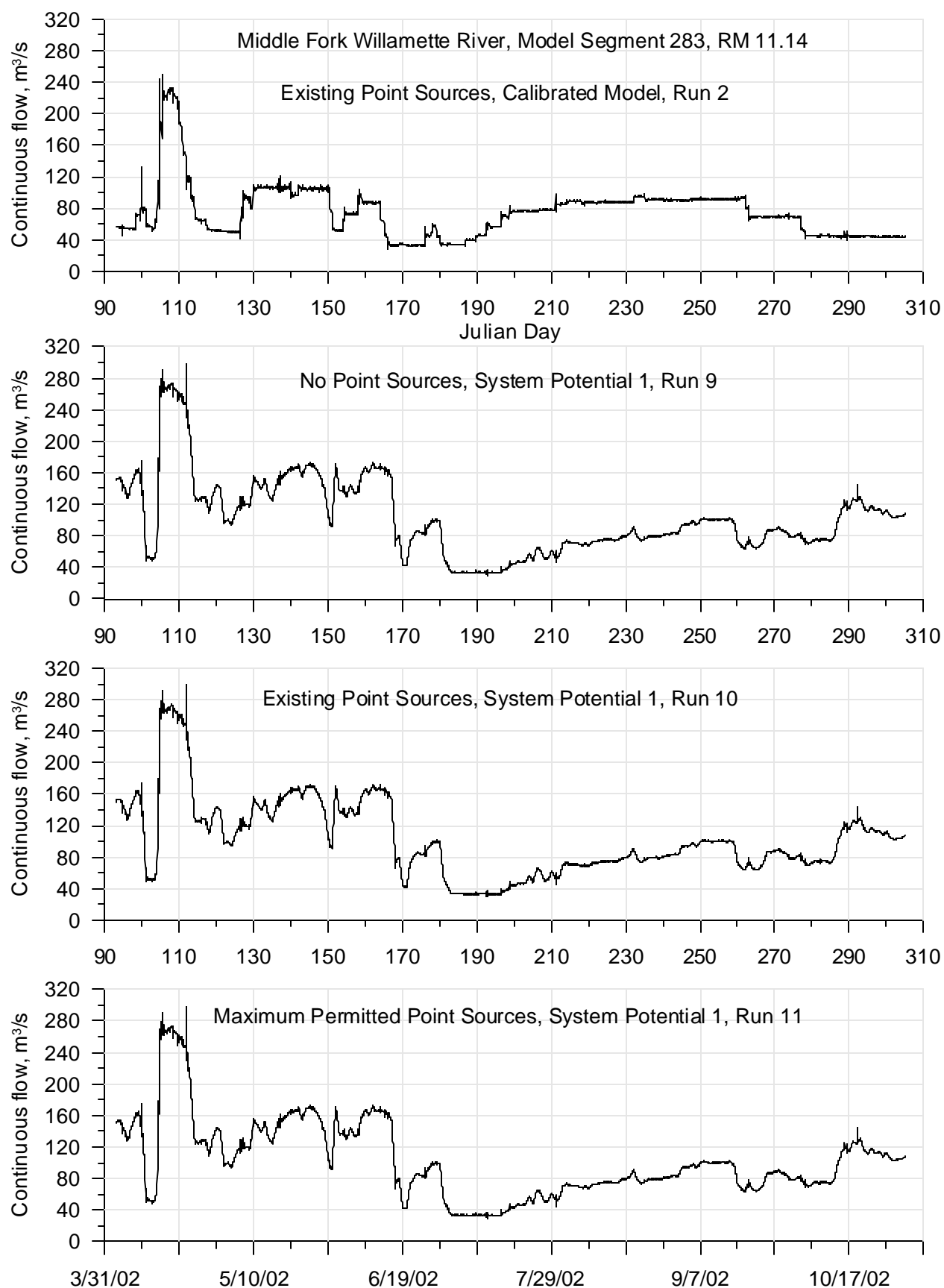
**Figure 239: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Coast Fork Willamette River at RM 20.18**



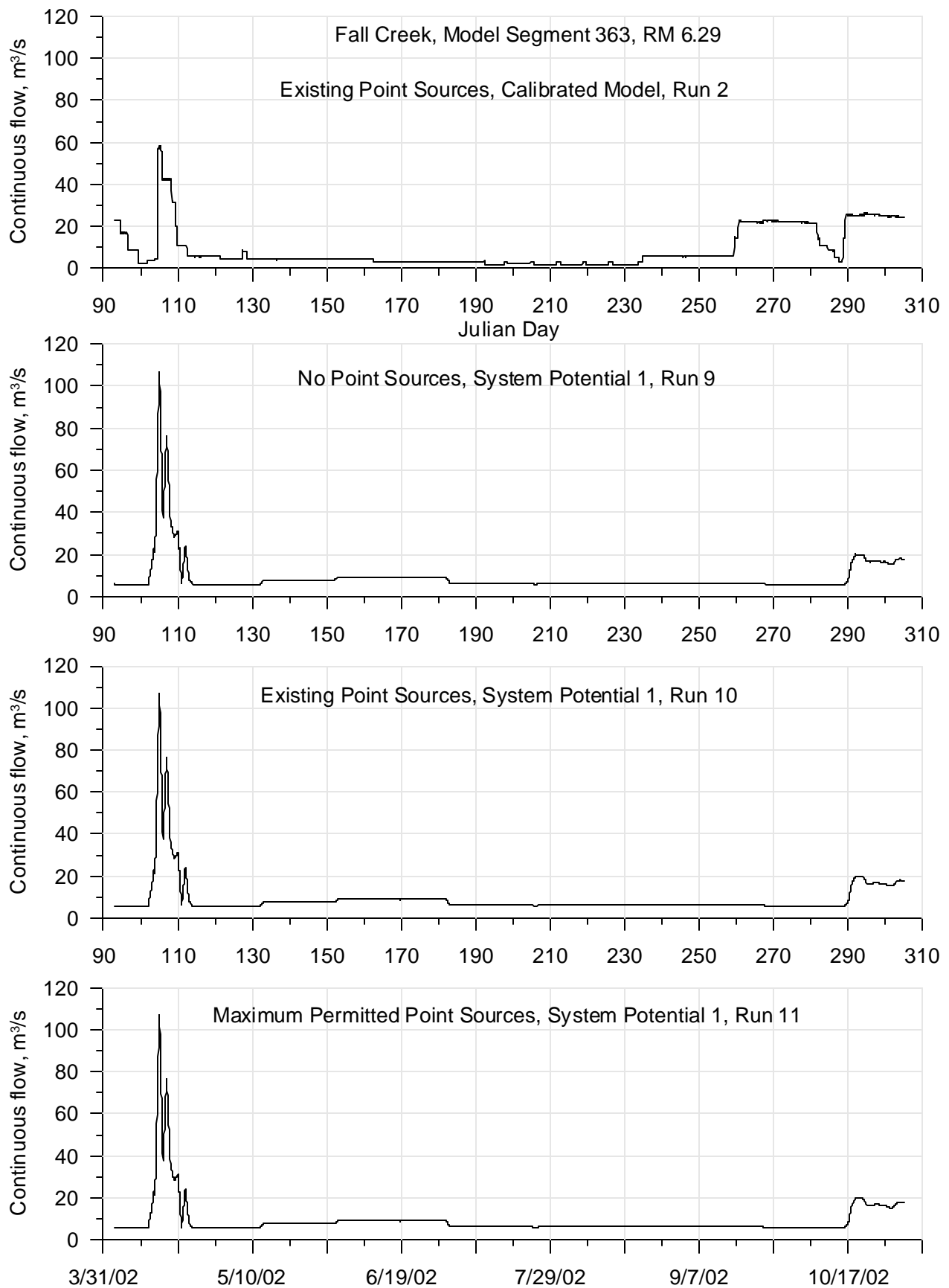
**Figure 240: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Row River at RM 5.51**



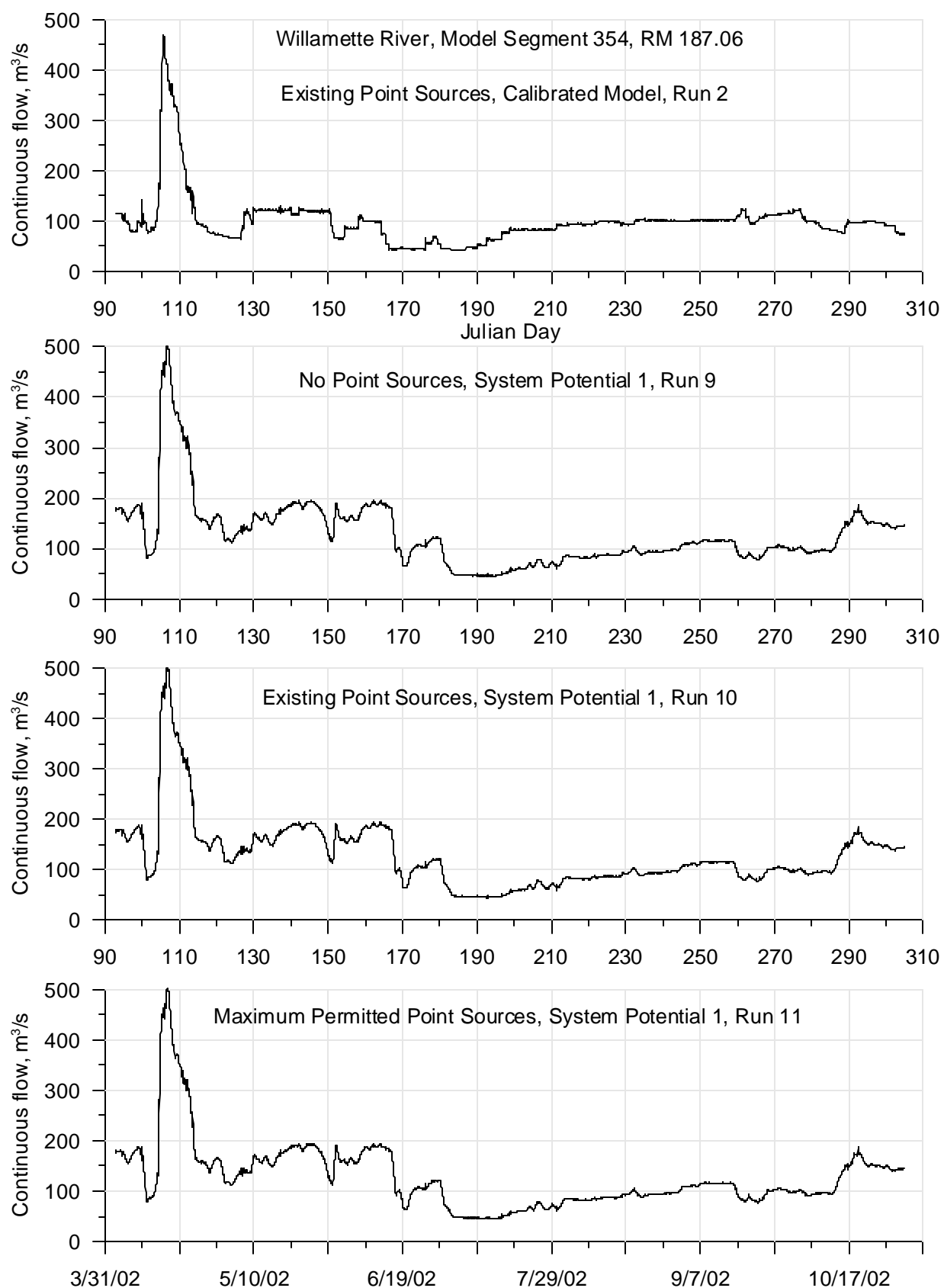
**Figure 241: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Middle Fork Willamette River at RM 13.95**



**Figure 242: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Middle Fork Willamette River at RM 11.14**

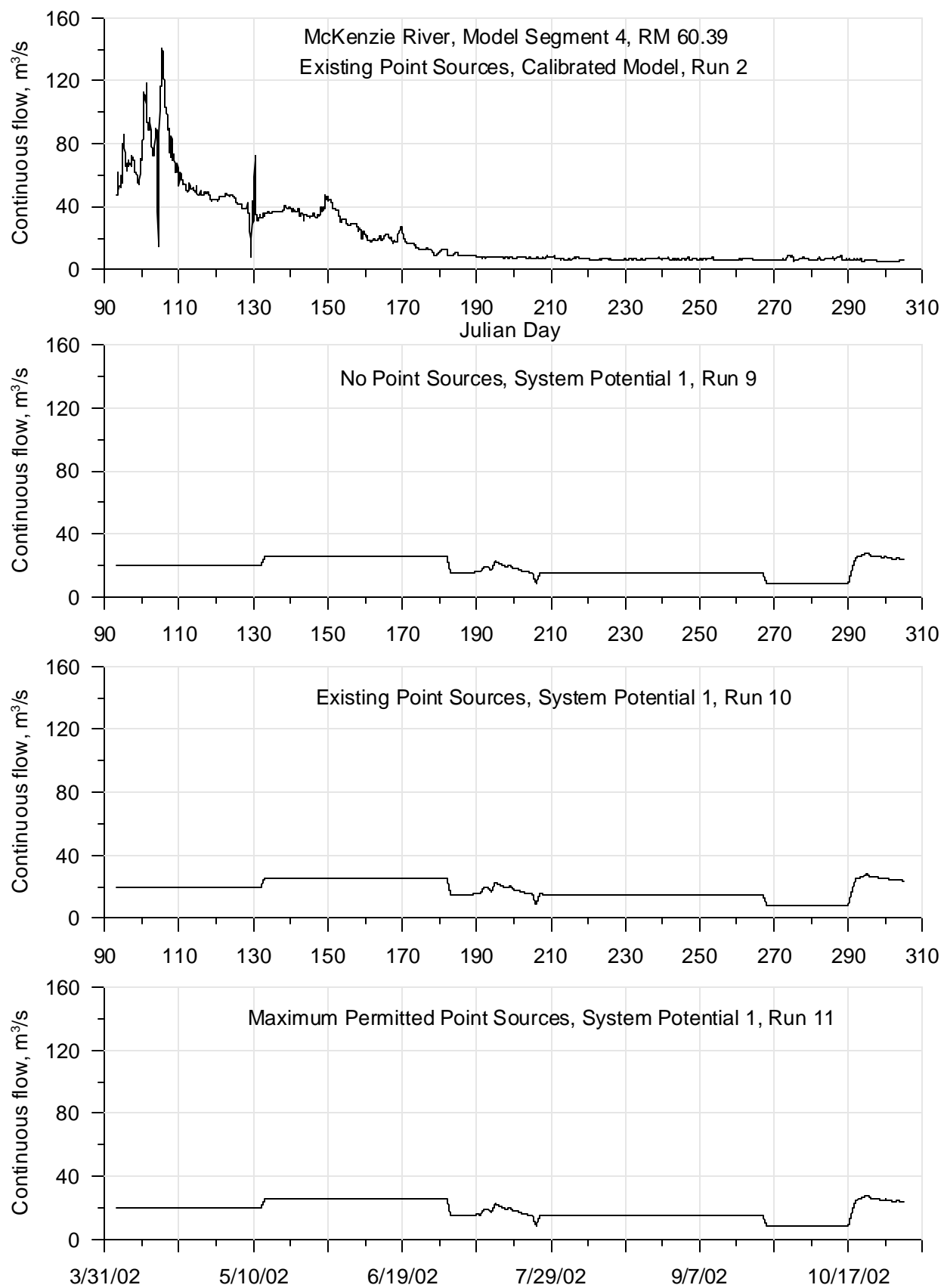


**Figure 243: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Fall Creek at RM 6.29**

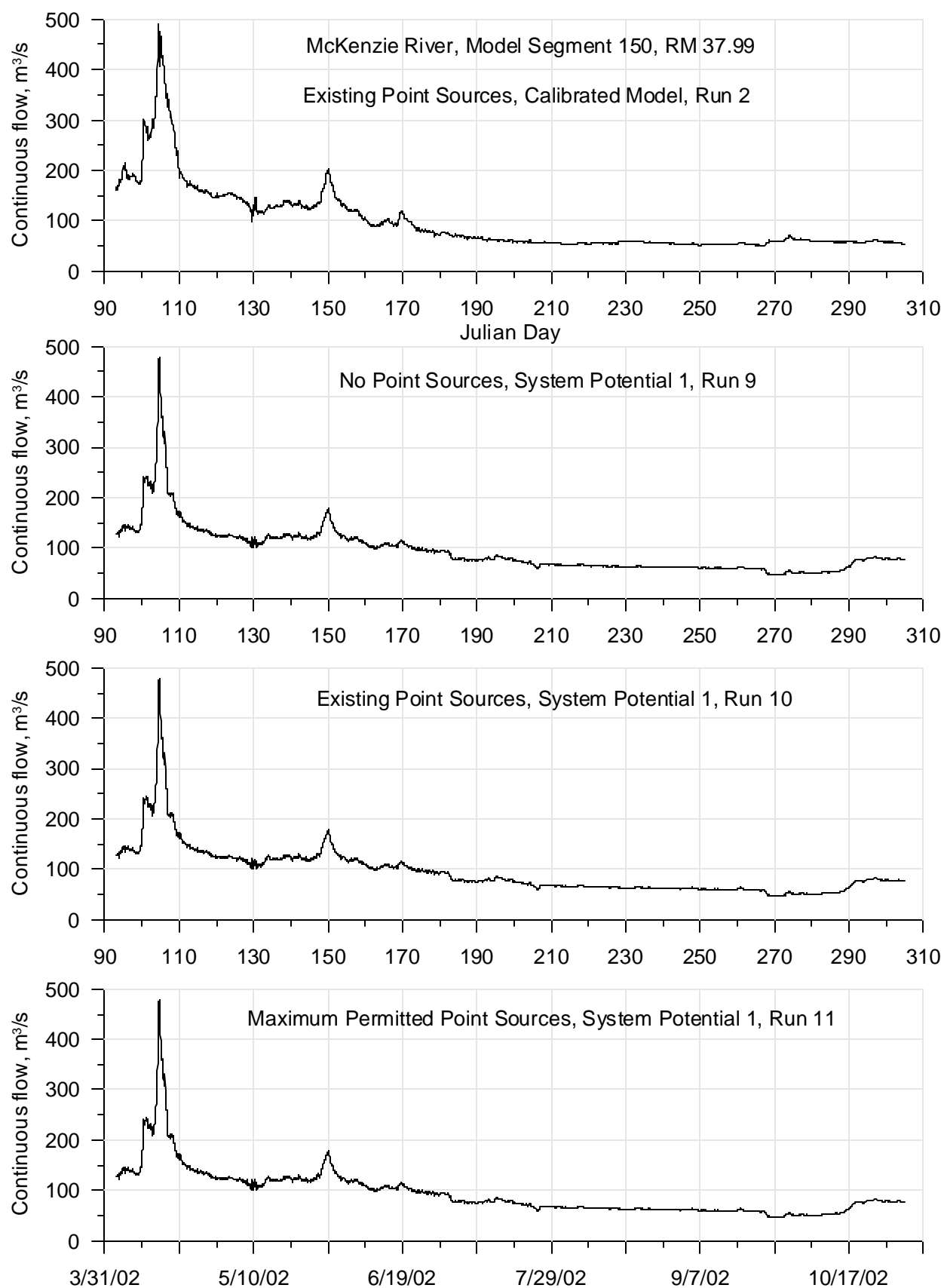


**Figure 244: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 187.06**

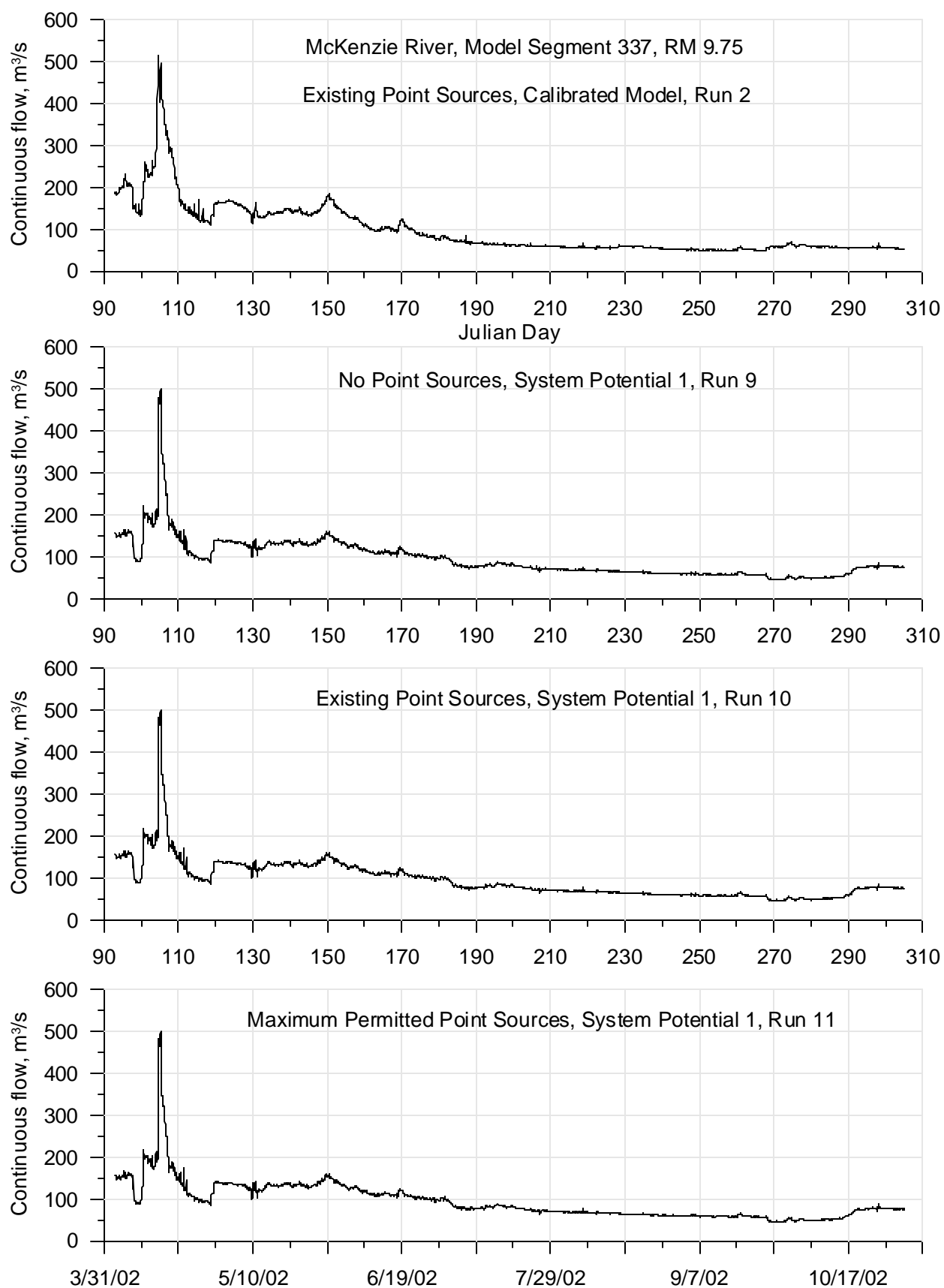




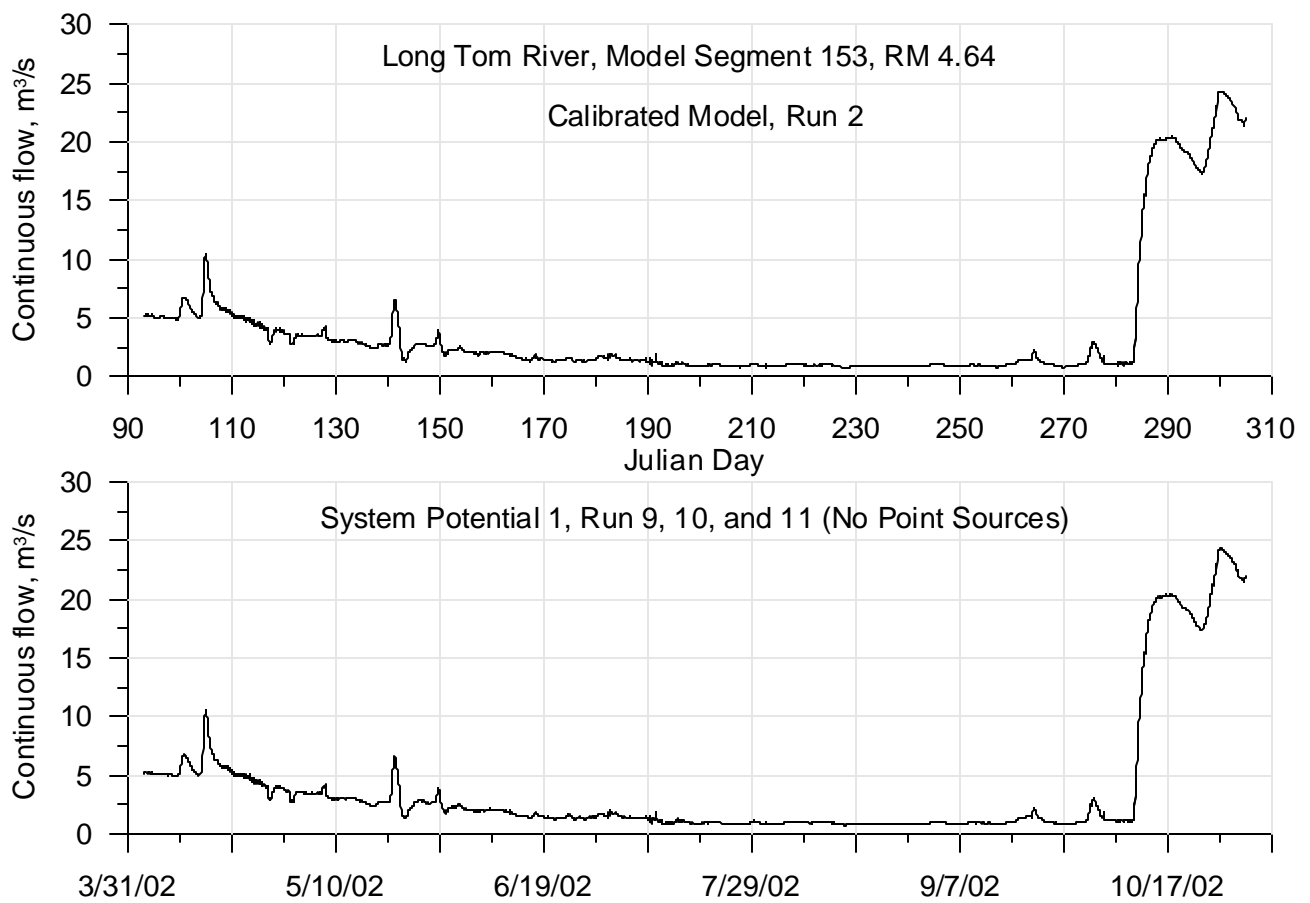
**Figure 245: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the McKenzie River at RM 60.39**



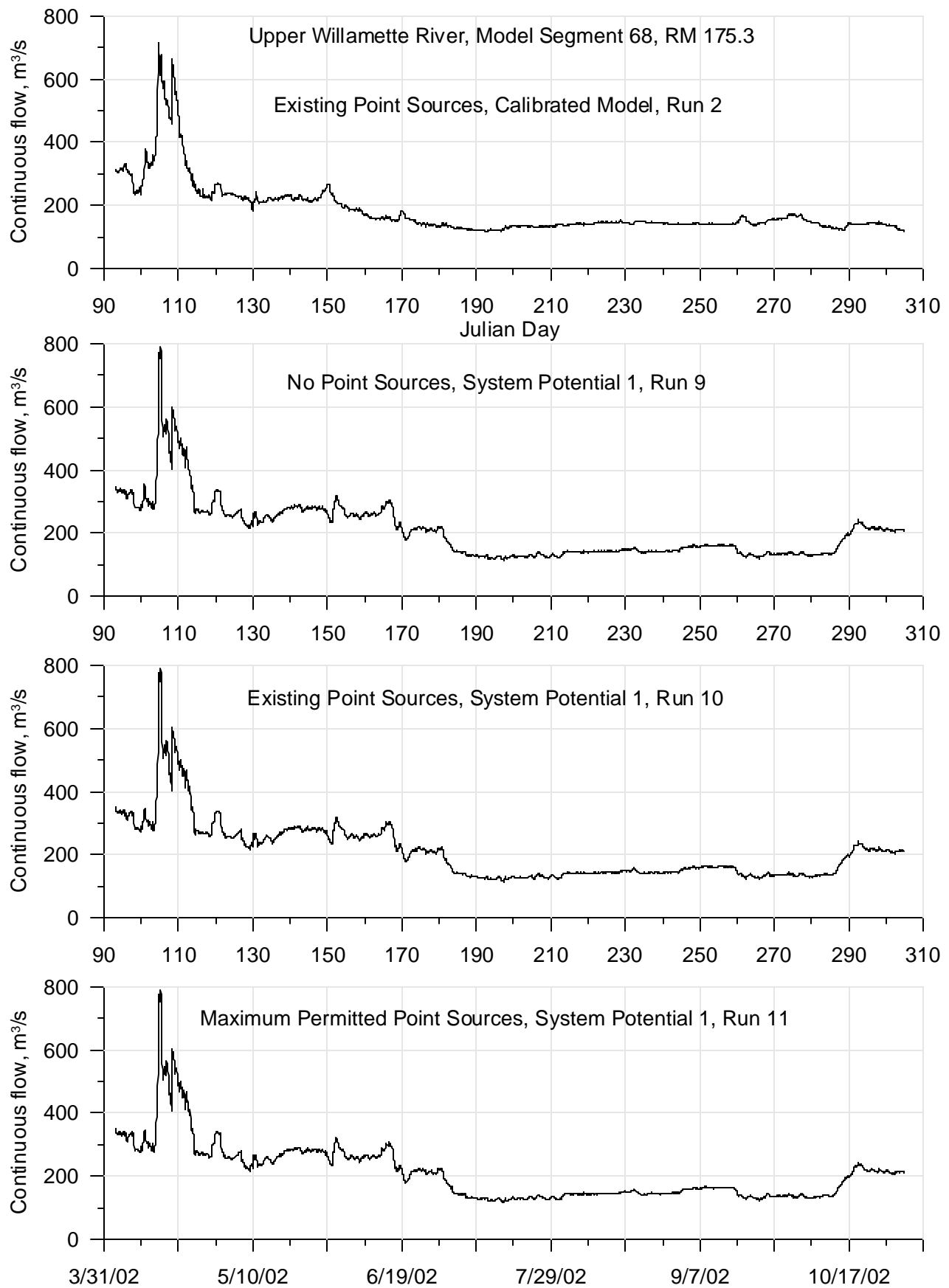
**Figure 246: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the McKenzie River at RM 37.99**



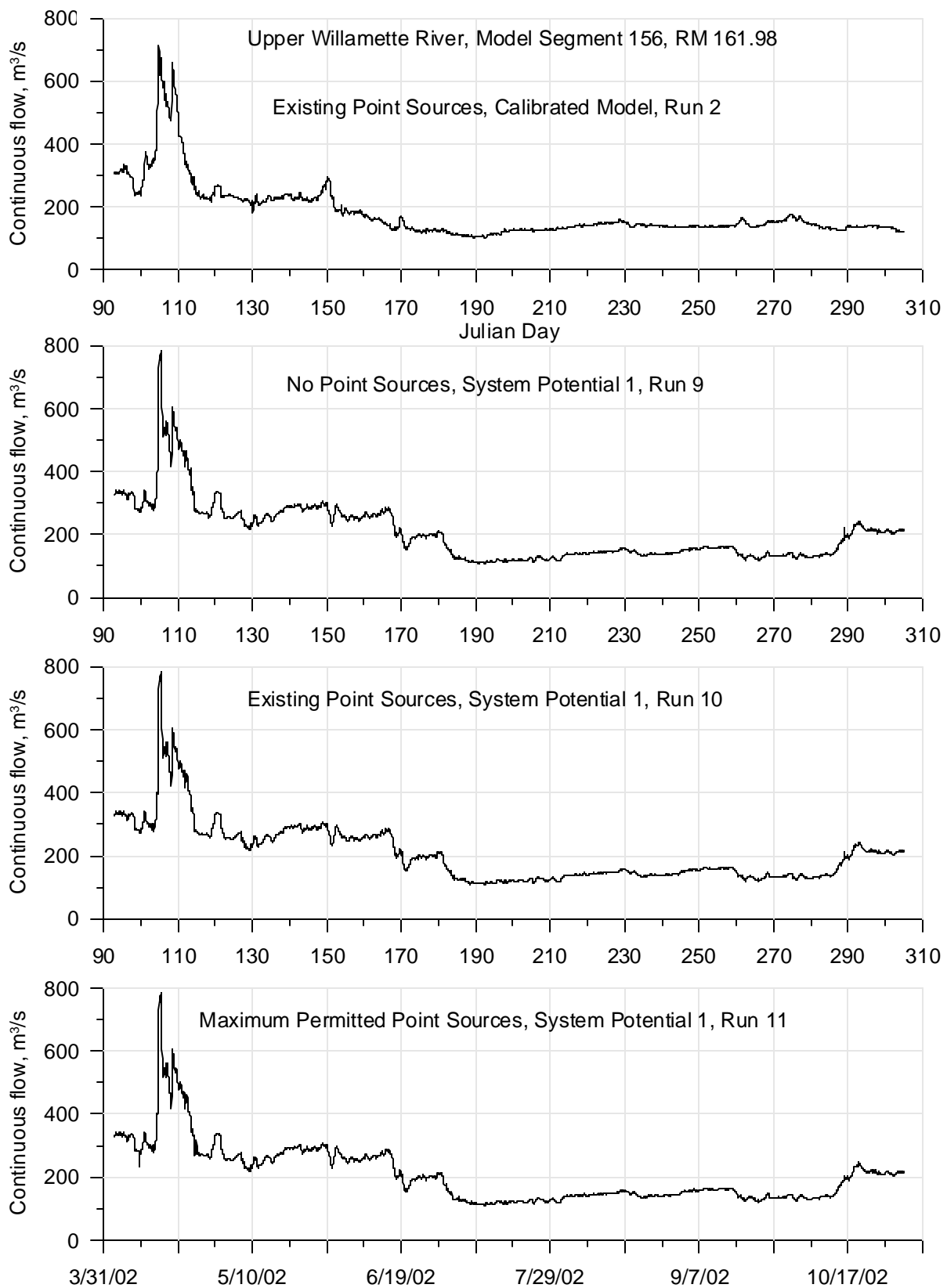
**Figure 247: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the McKenzie River at RM 9.75**



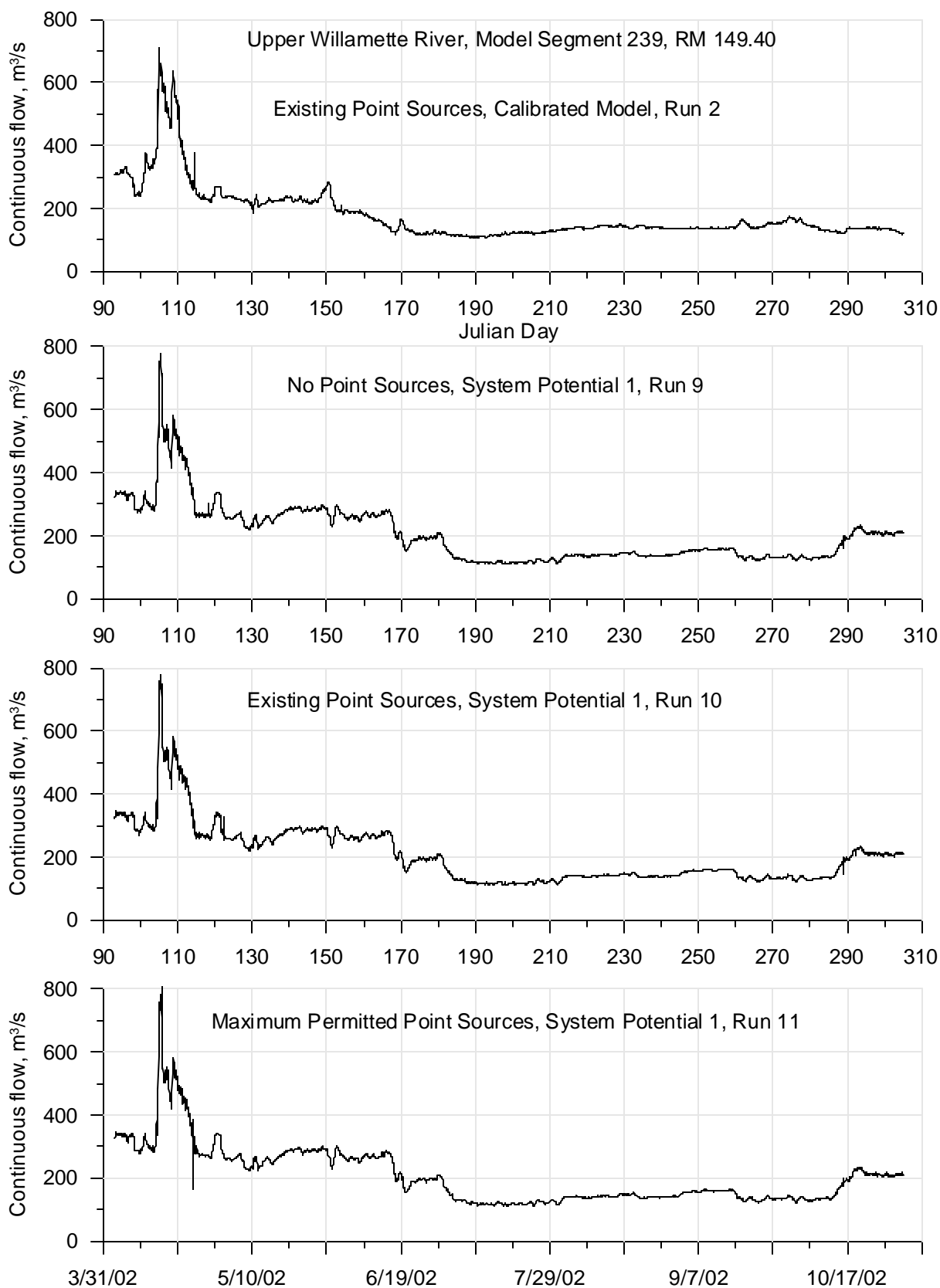
**Figure 248: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Long Tom River at RM 4.64**



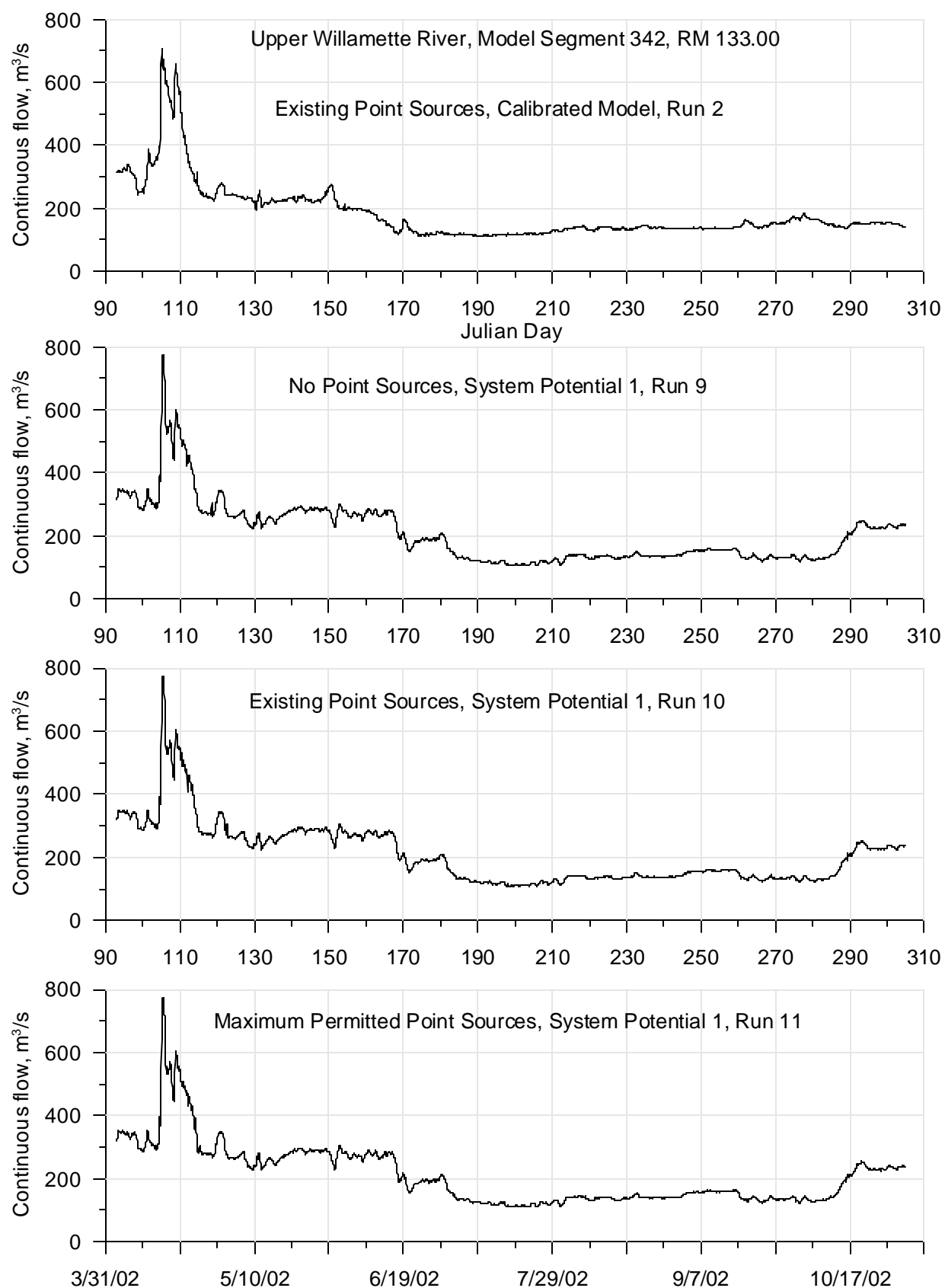
**Figure 249: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 175.3**



**Figure 250: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 161.98**

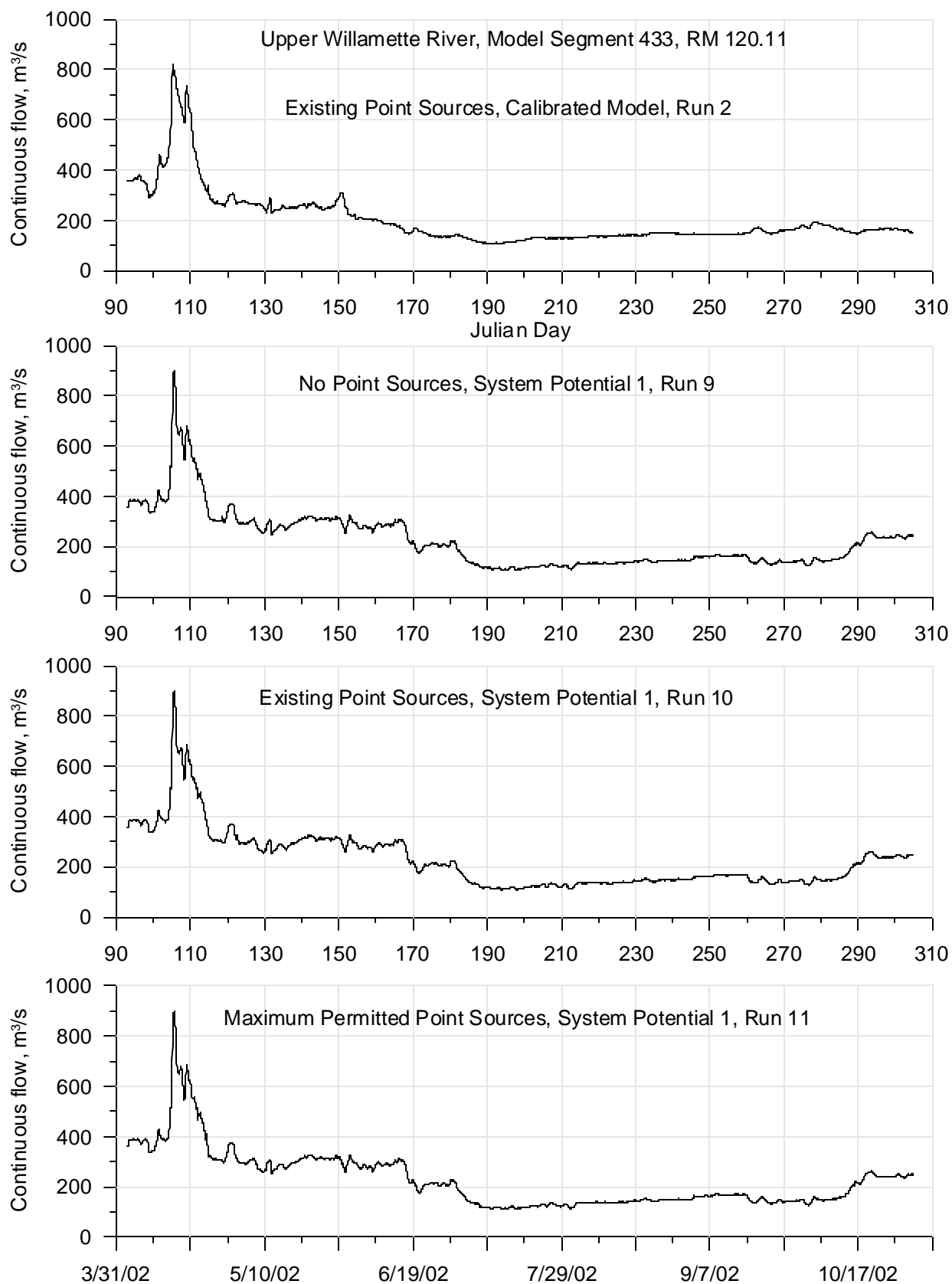


**Figure 251: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 149.4**

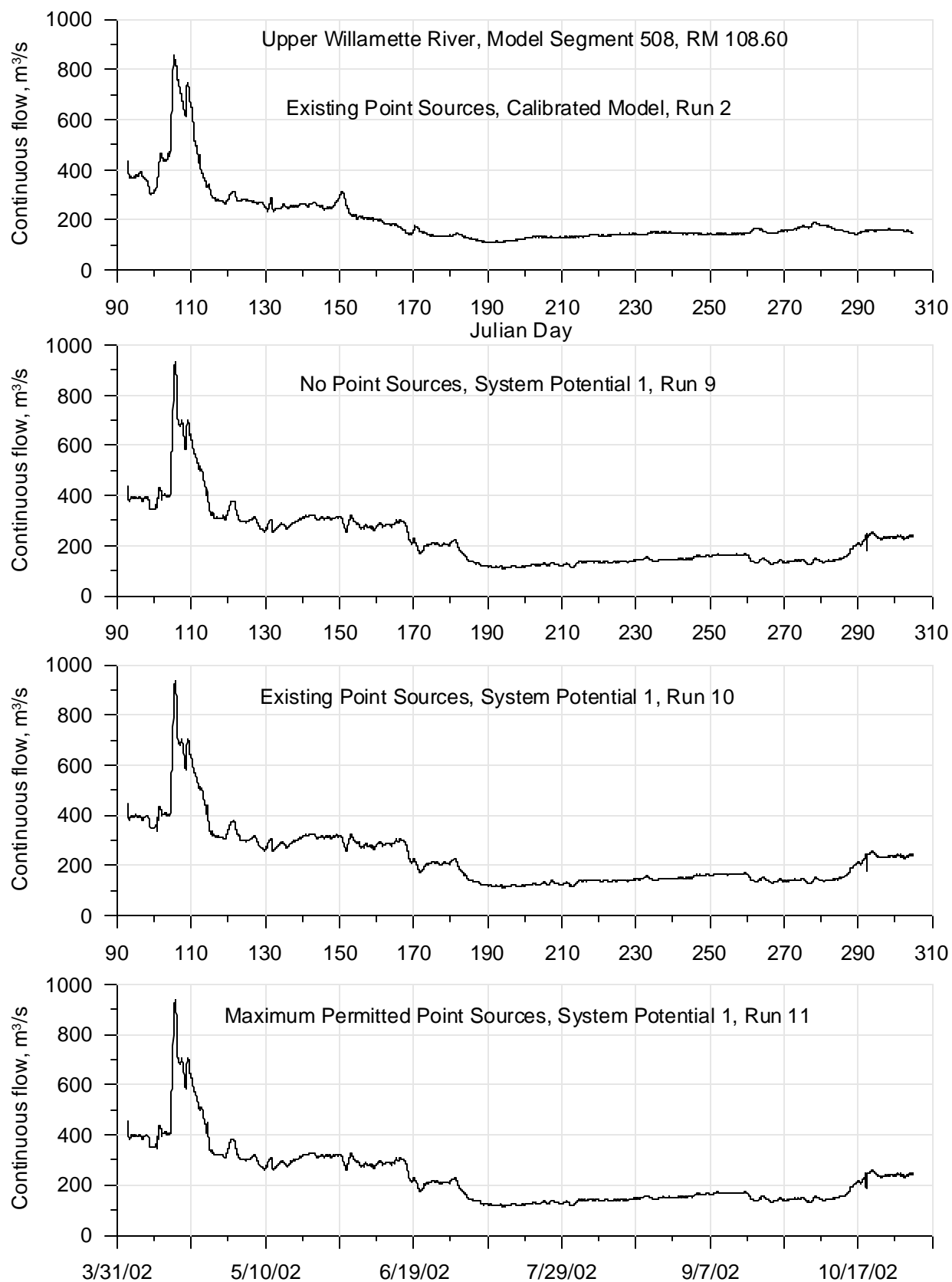


**Figure 252: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 133**

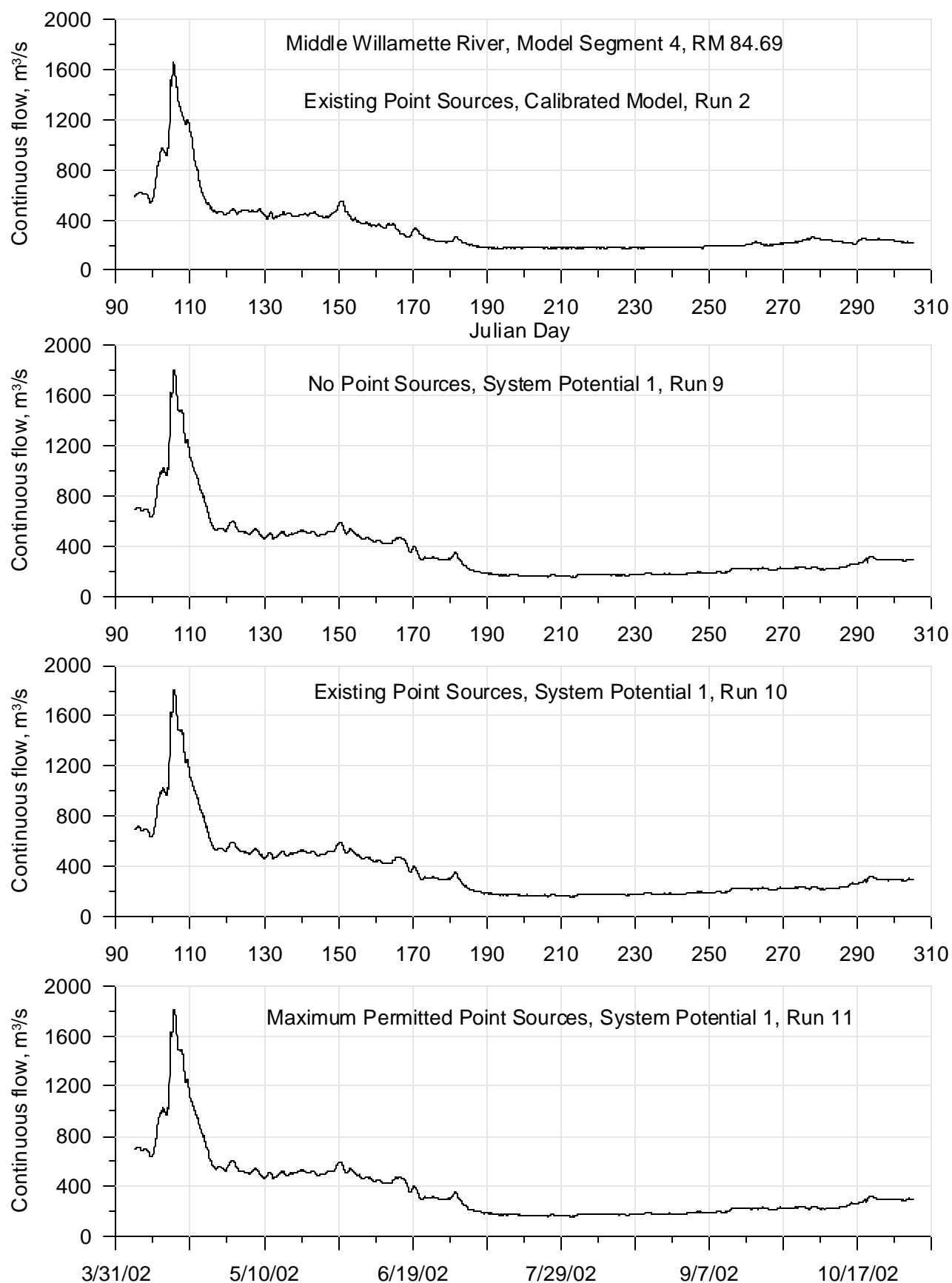




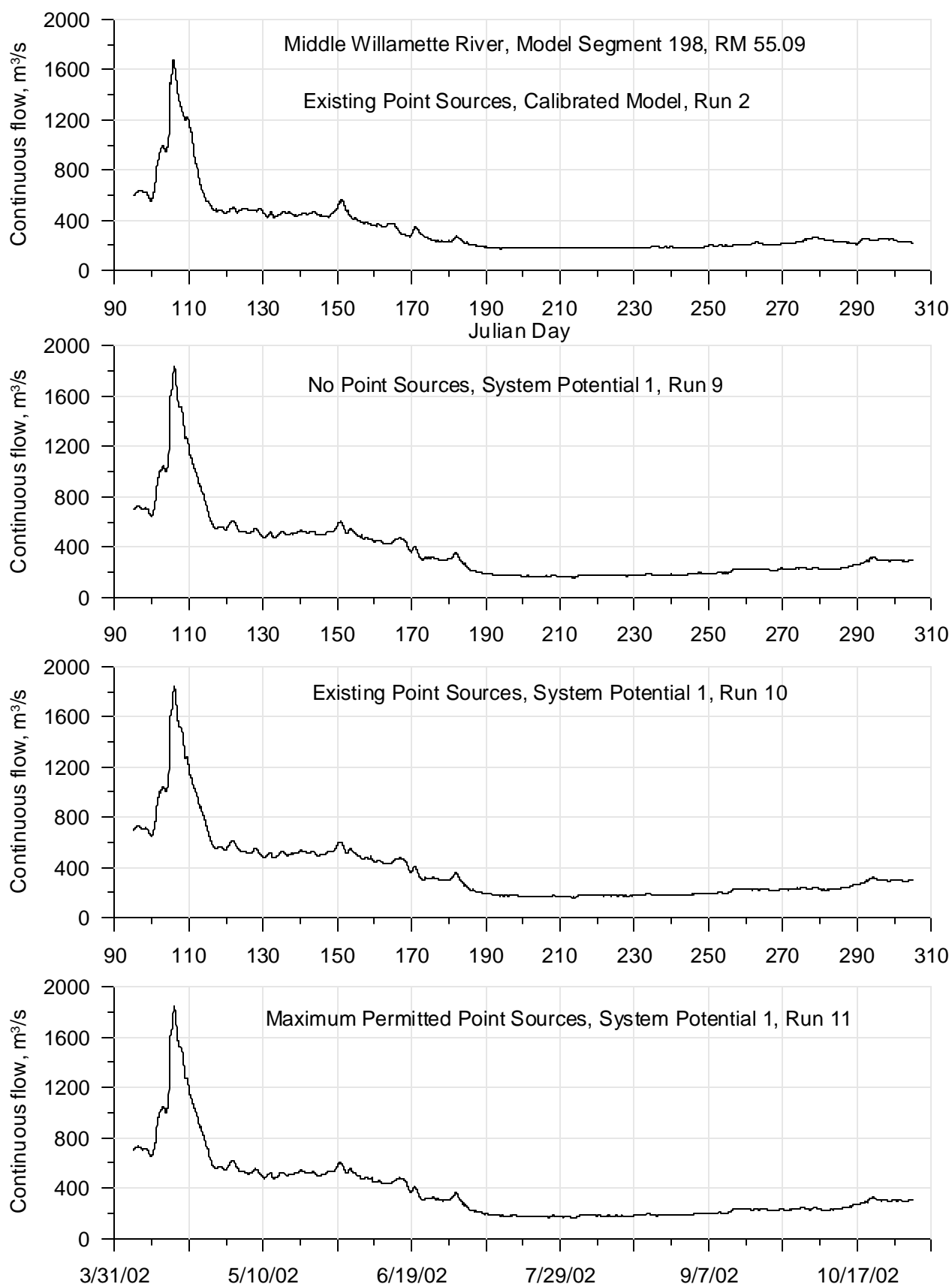
**Figure 253: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 120.11**



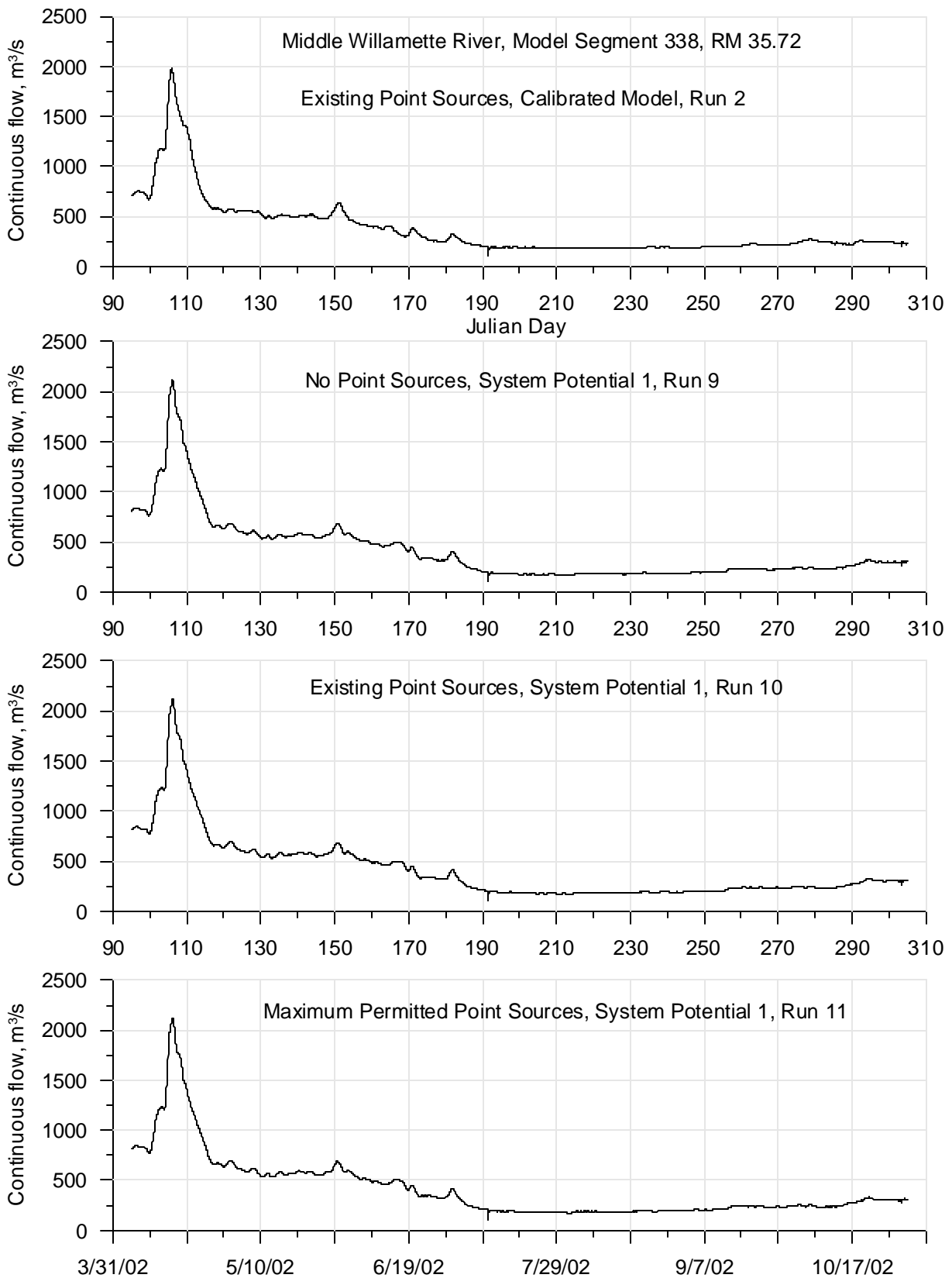
**Figure 254: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 108.6**



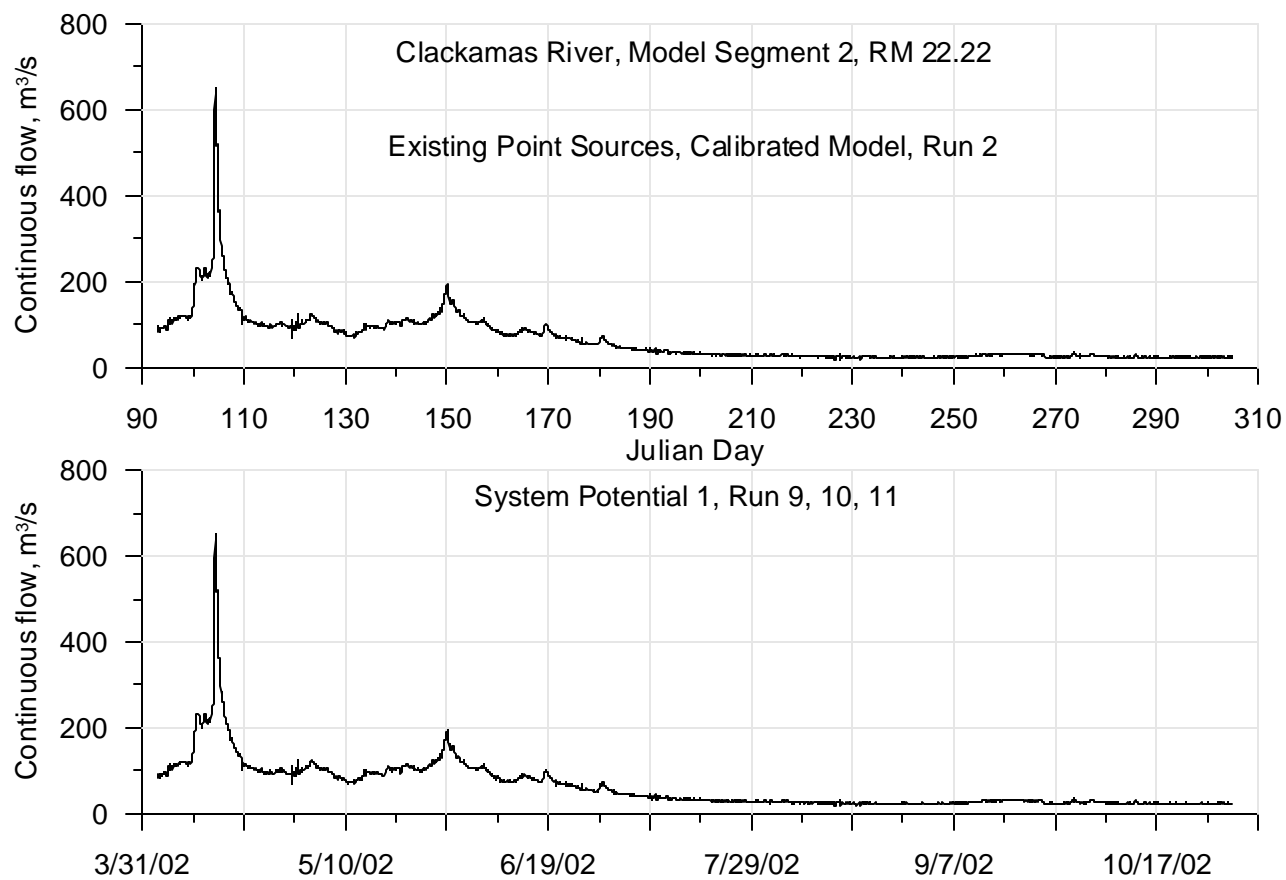
**Figure 255: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 84.69**



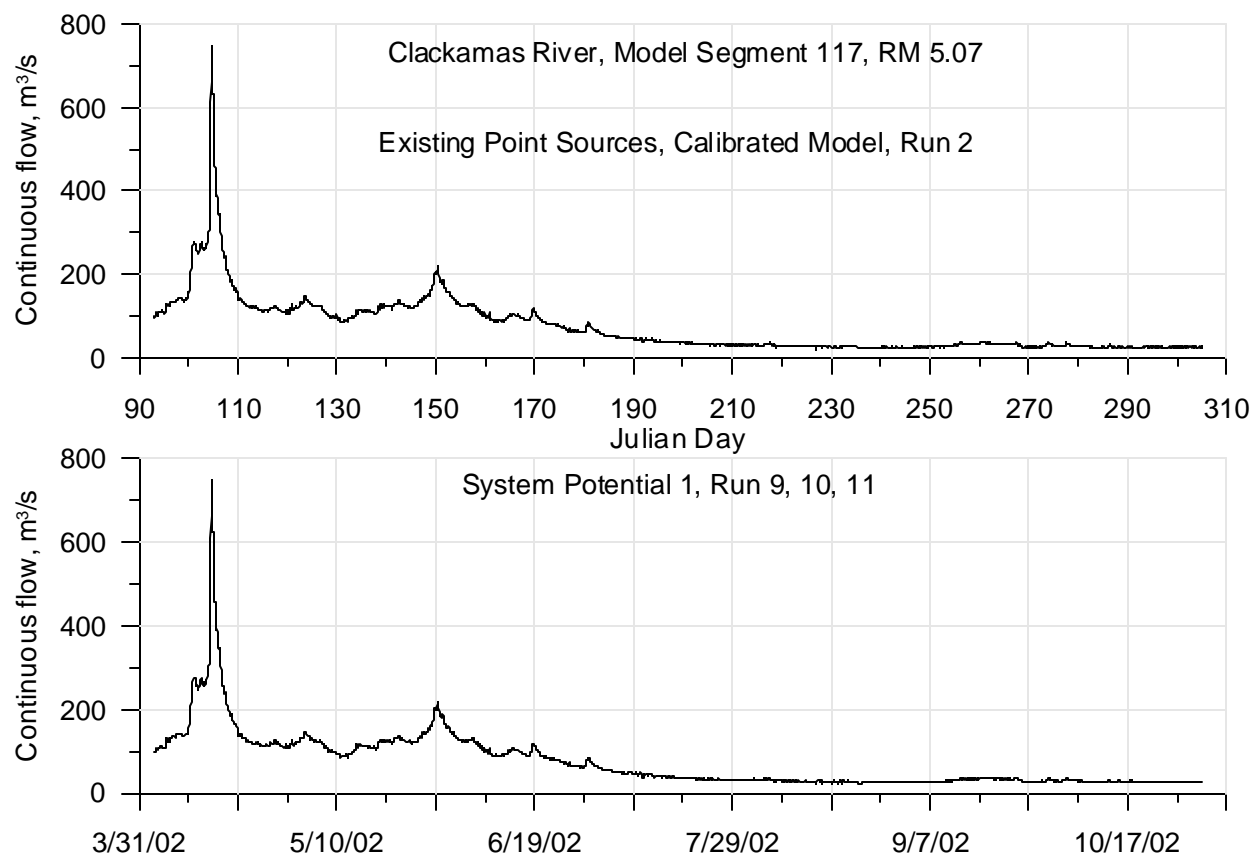
**Figure 256: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 55.09**



**Figure 257: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 35.72**



**Figure 258: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Clackamas River at RM 22.22**



**Figure 259: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Clackamas River at RM 5.07**

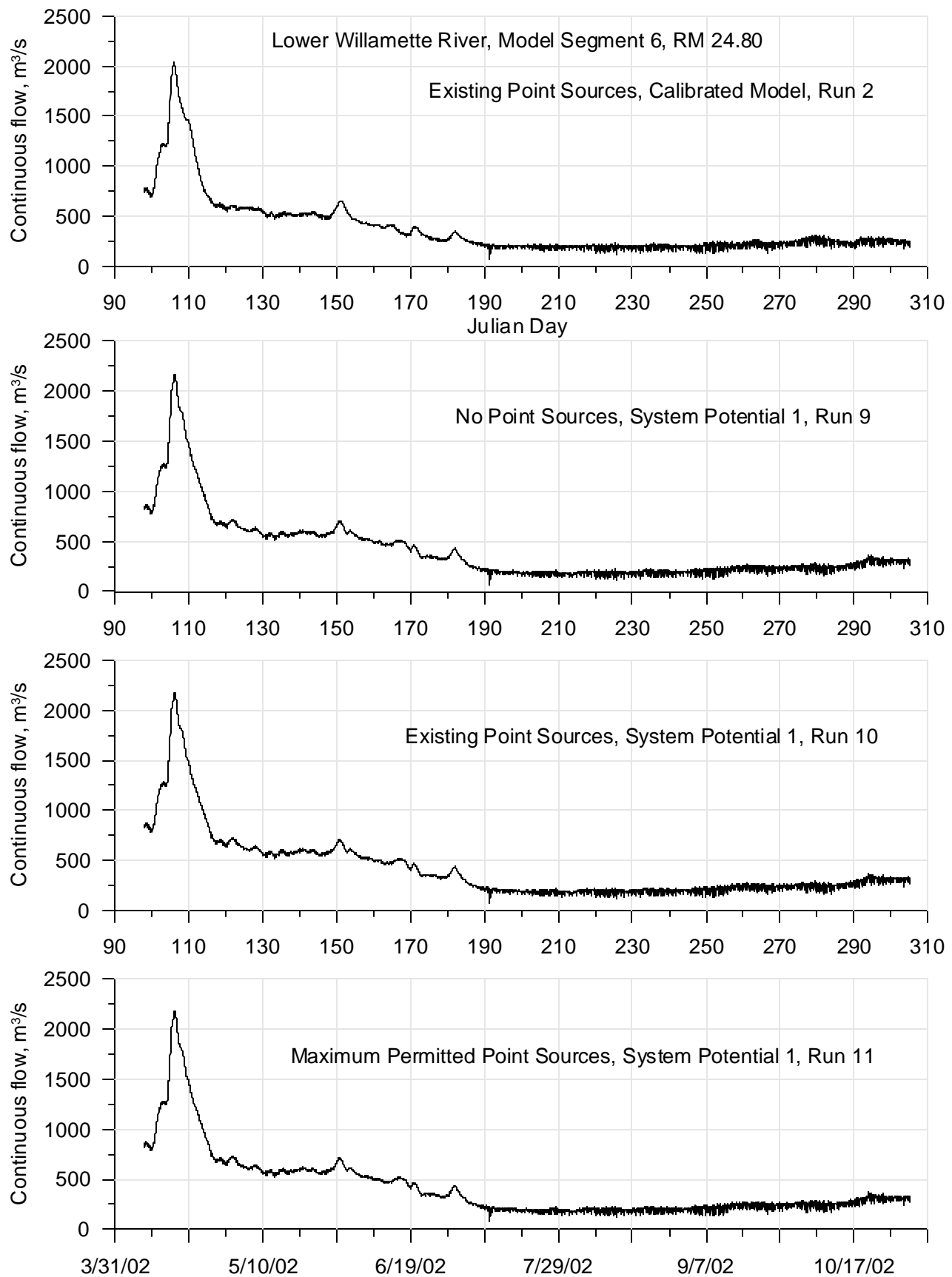


Figure 260: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 24.8



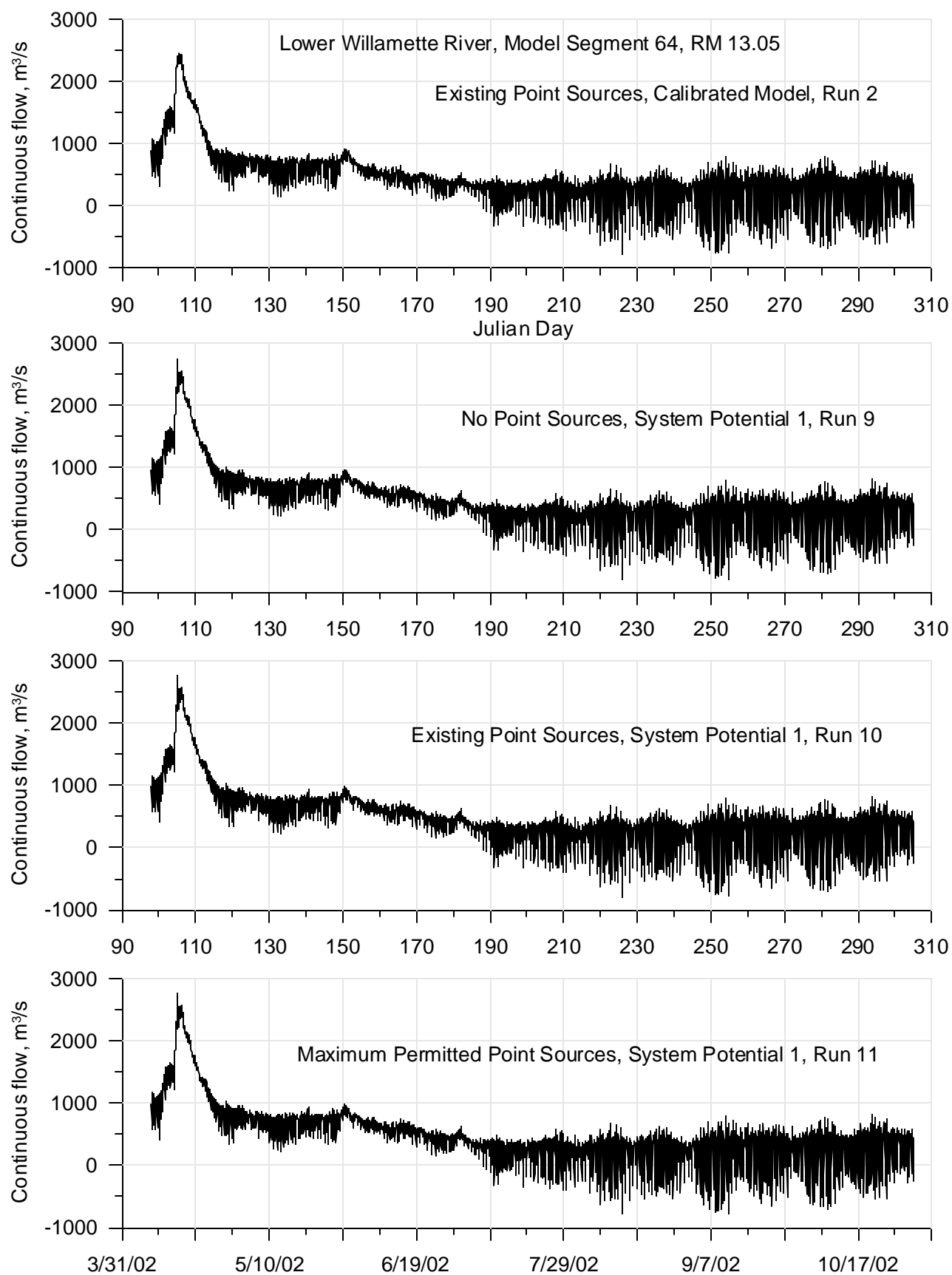
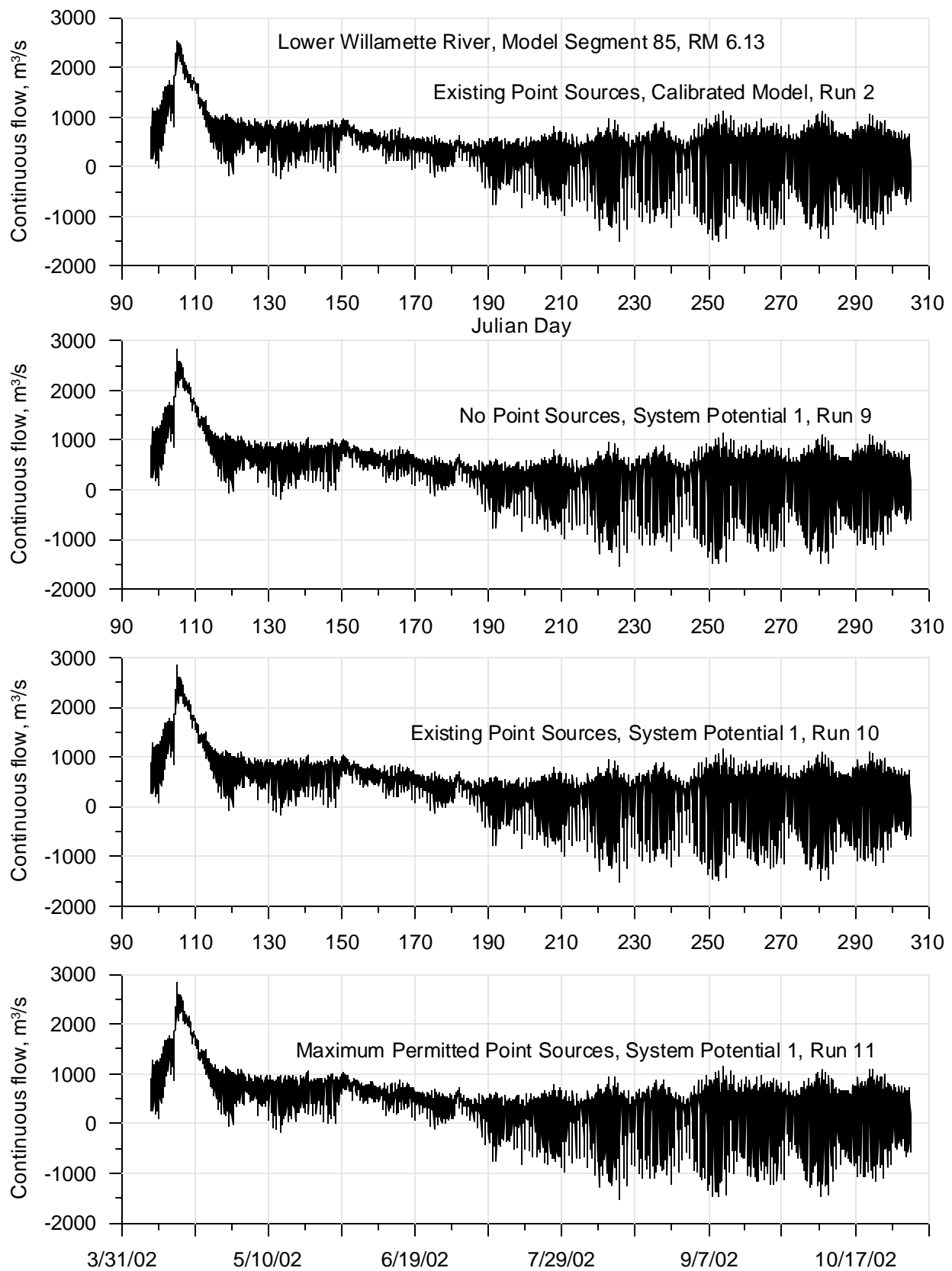
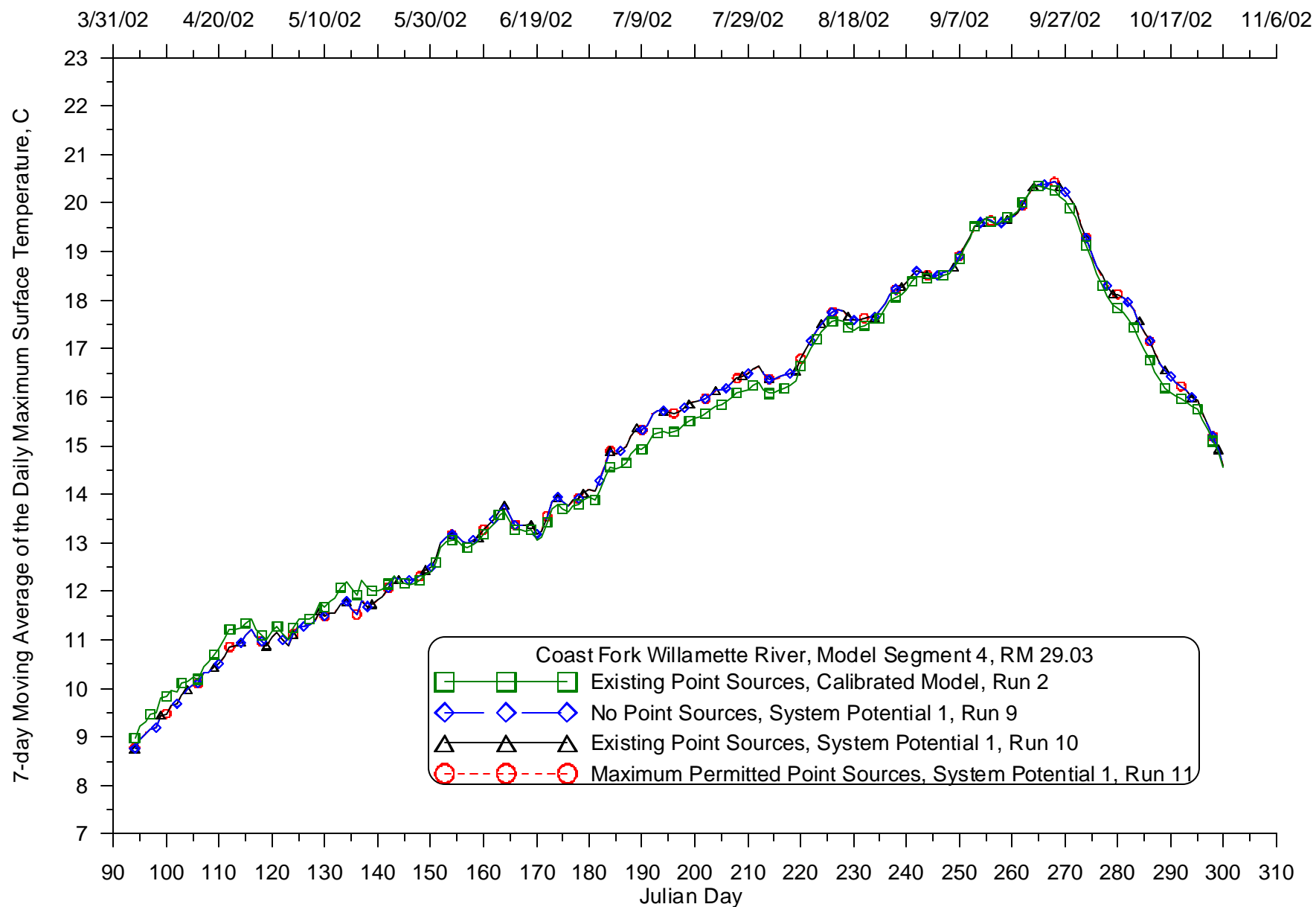


Figure 261: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 13.05

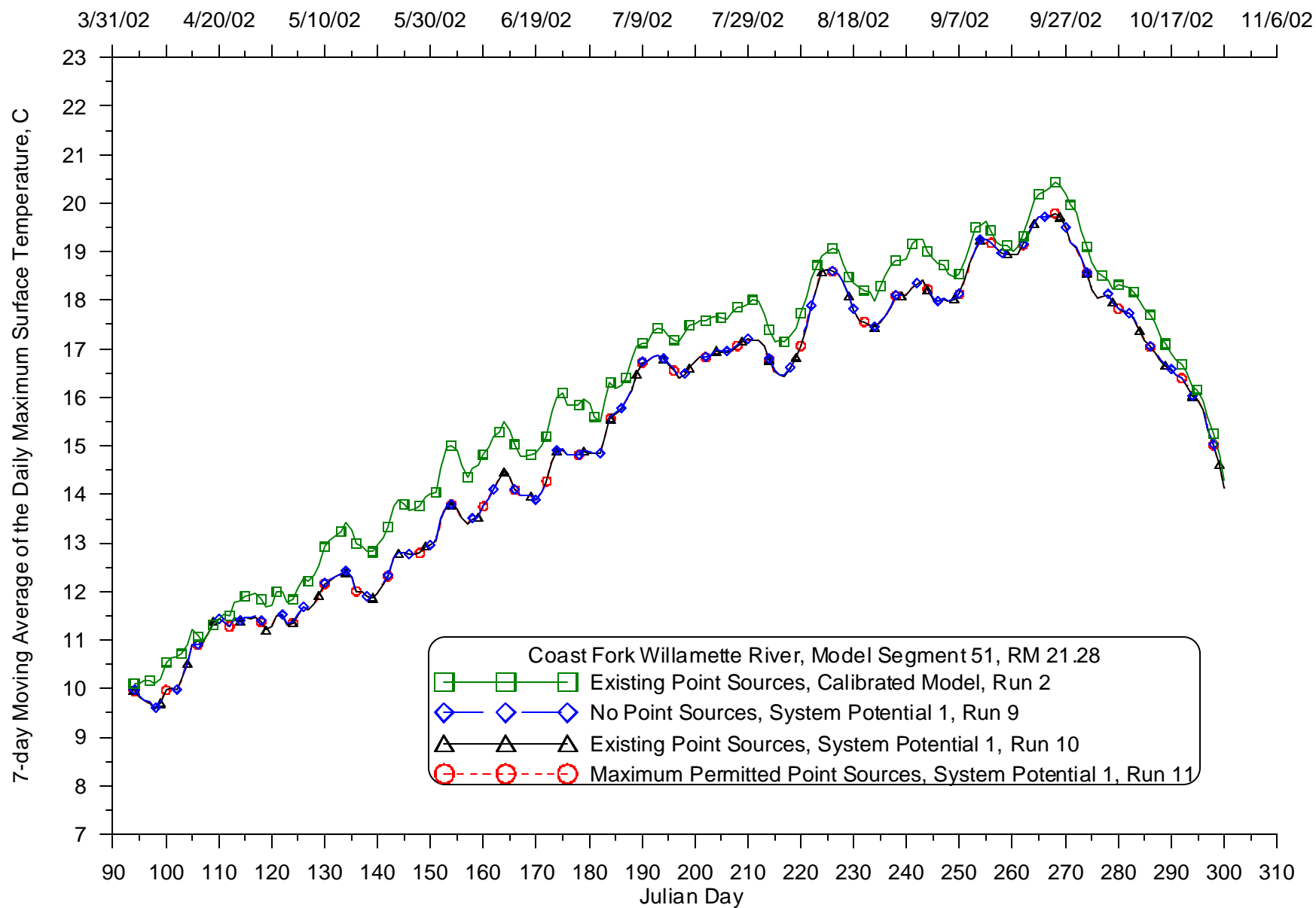


**Figure 262: Calibrated model and System Potential 1 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 6.13**

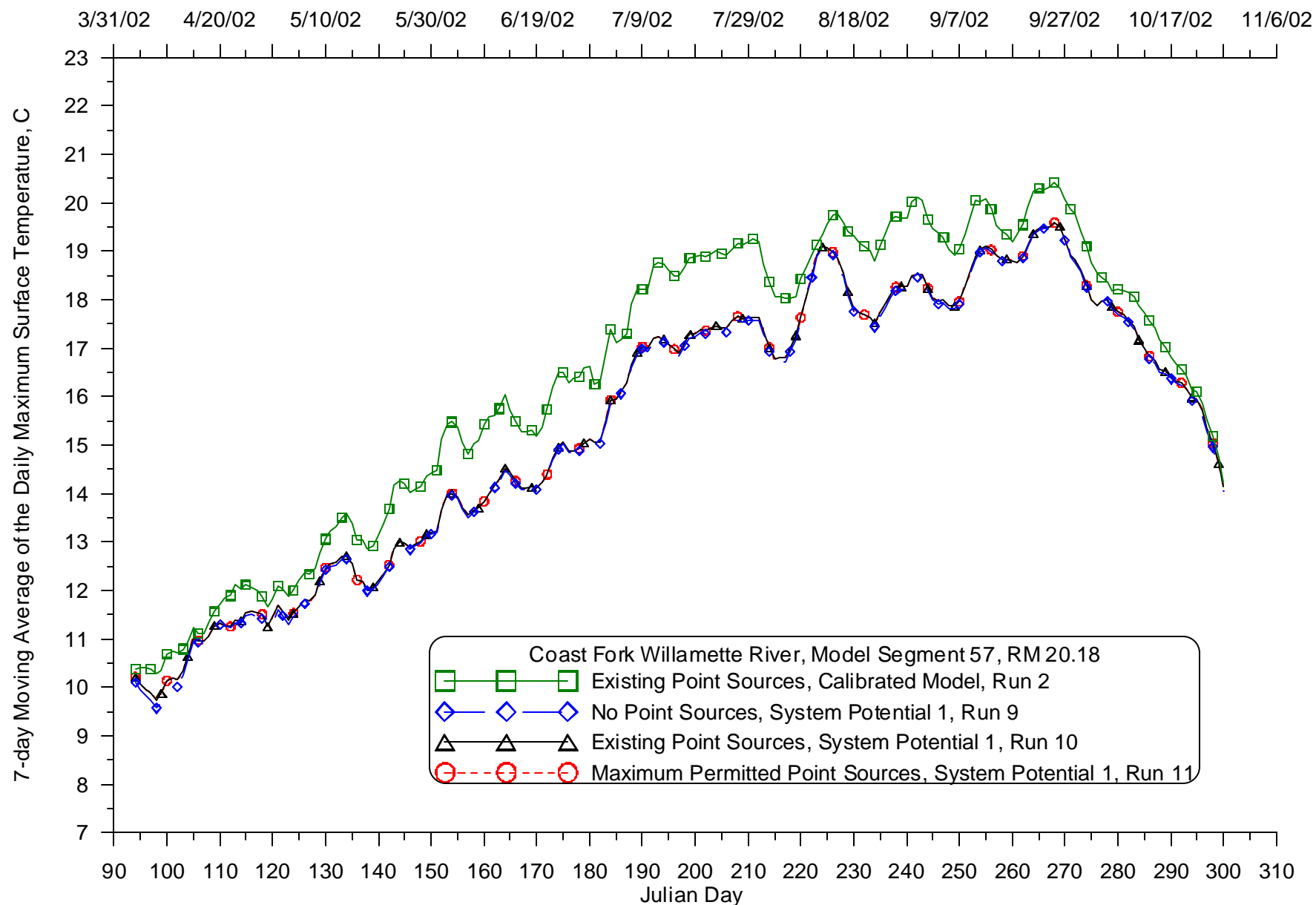
**Daily seven day moving average of daily maximum temperature**



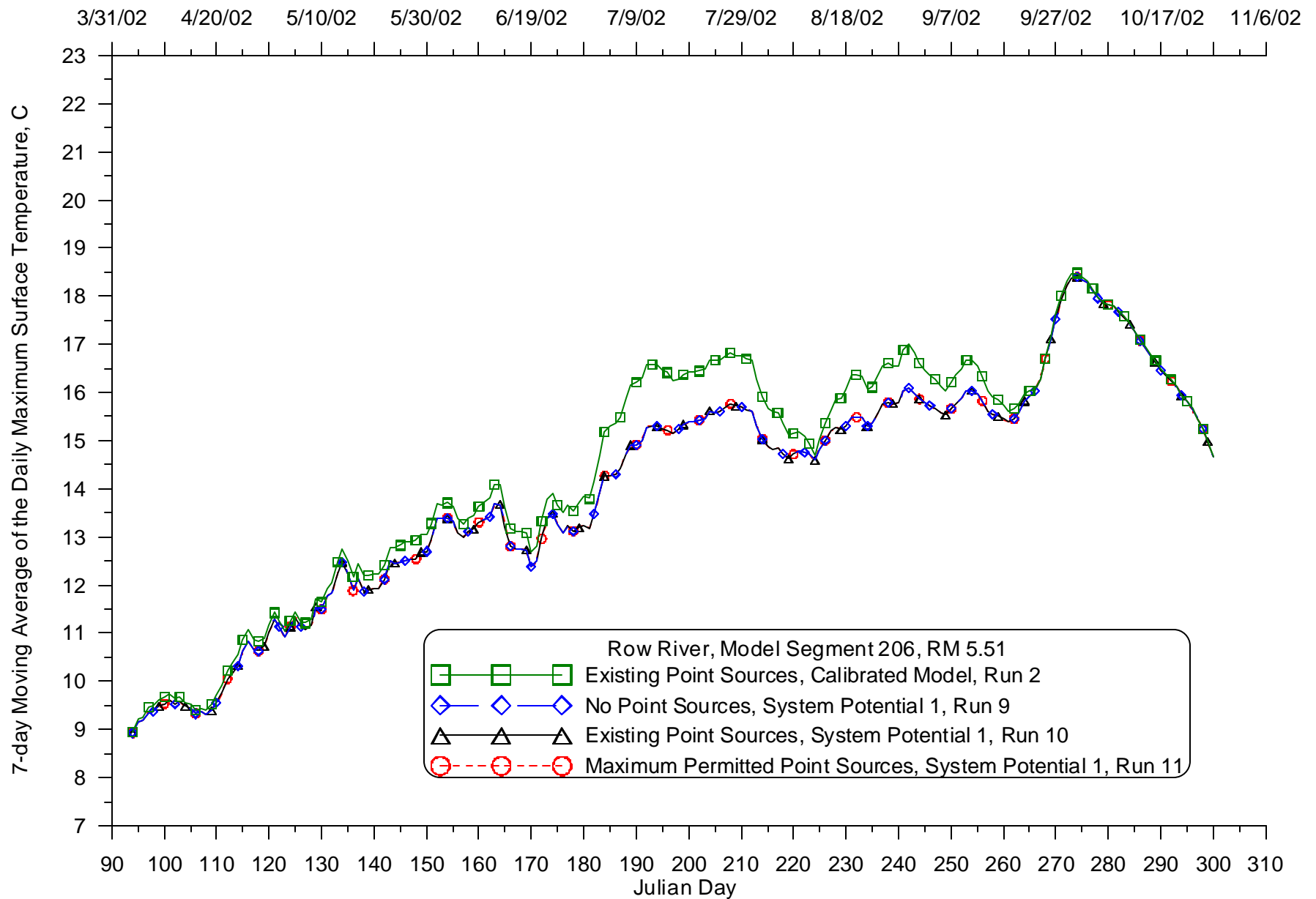
**Figure 263: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Coast Fork Willamette River at RM 29.03**



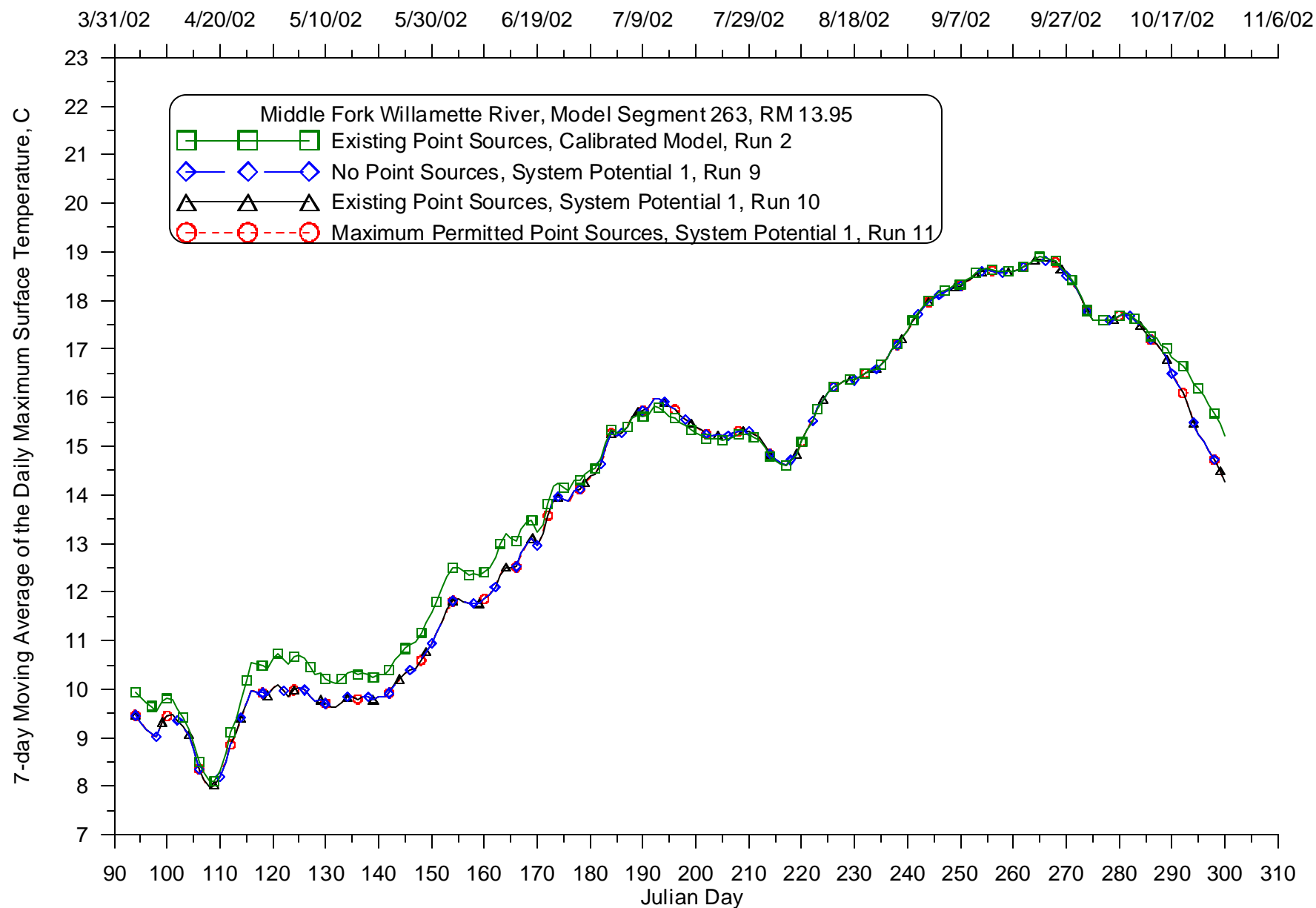
**Figure 264: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Coast Fork Willamette River at RM 21.28**



**Figure 265: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Coast Fork Willamette River at RM 20.18**

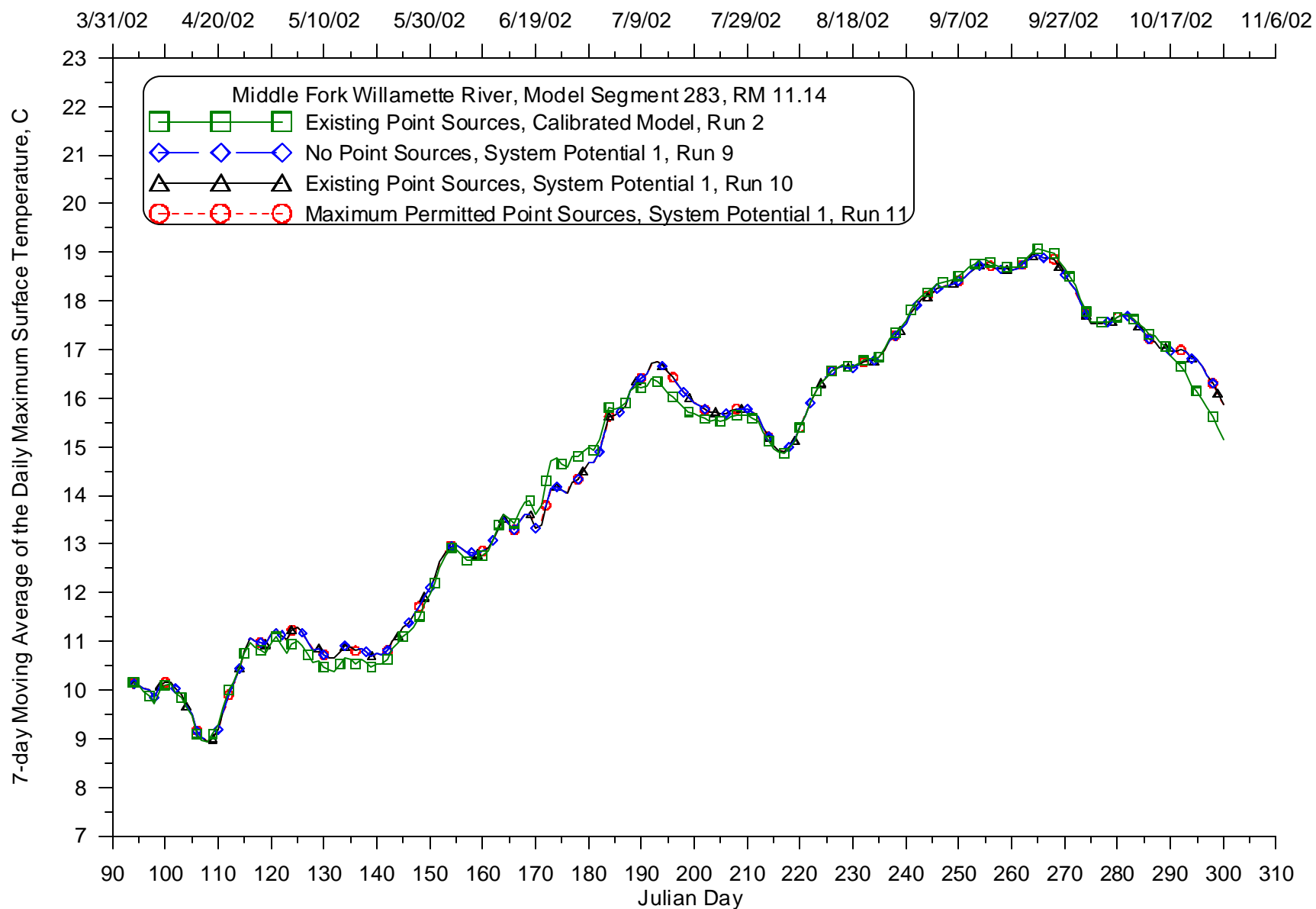


**Figure 266: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Row River at RM 5.51**



**Figure 267: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Middle Fork Willamette River at RM 13.95**





**Figure 268: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Middle Fork Willamette River at RM 11.14**

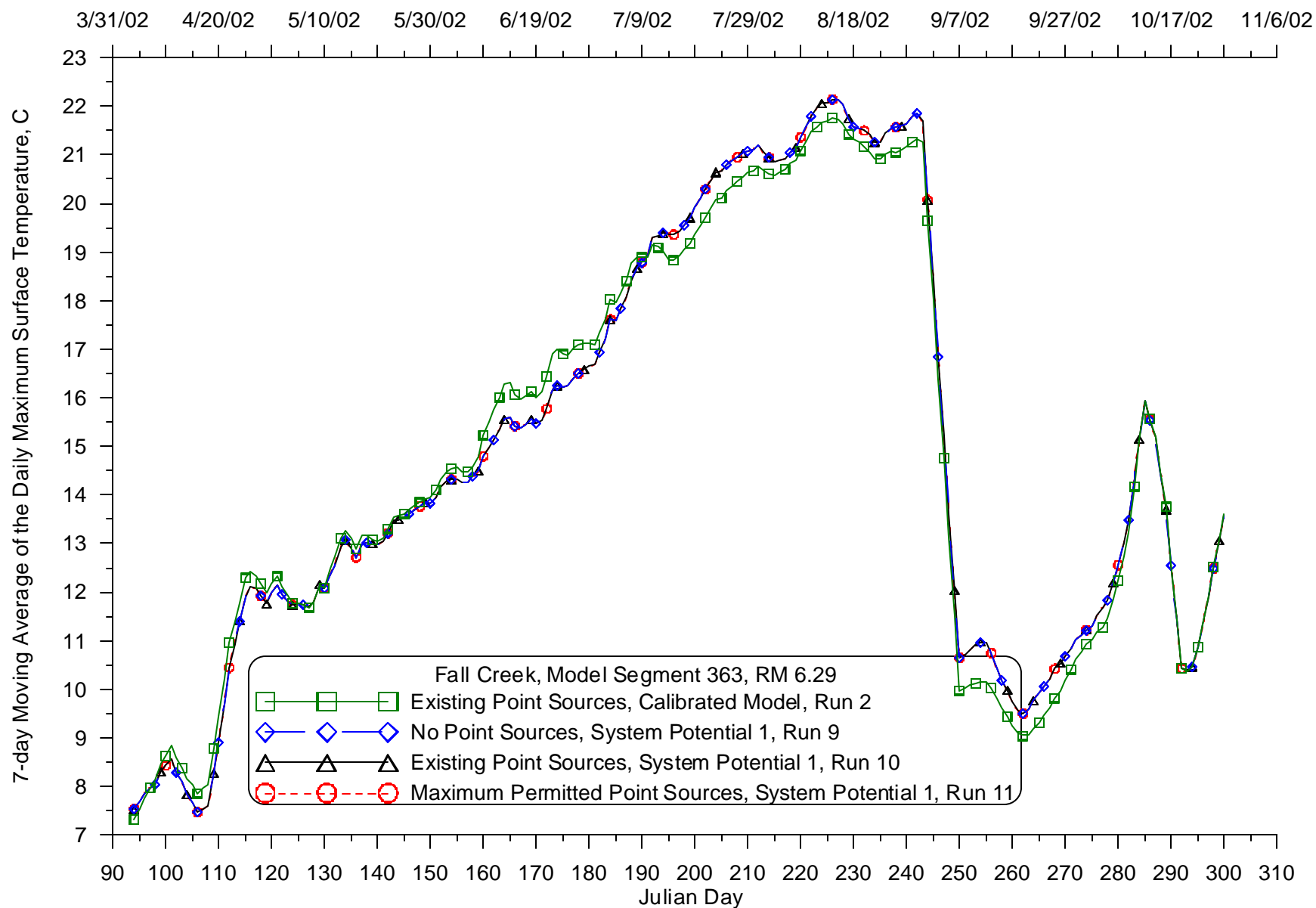
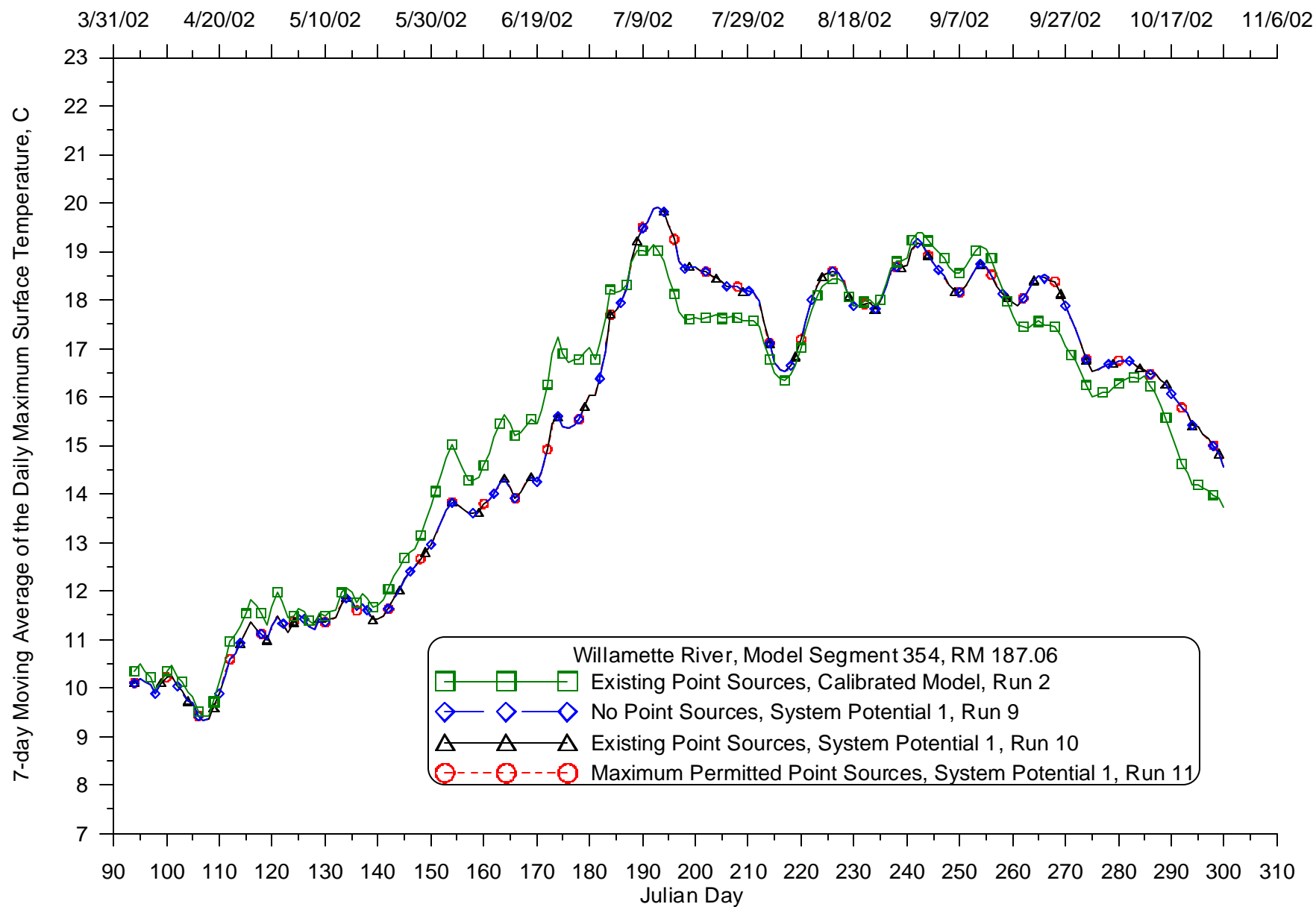
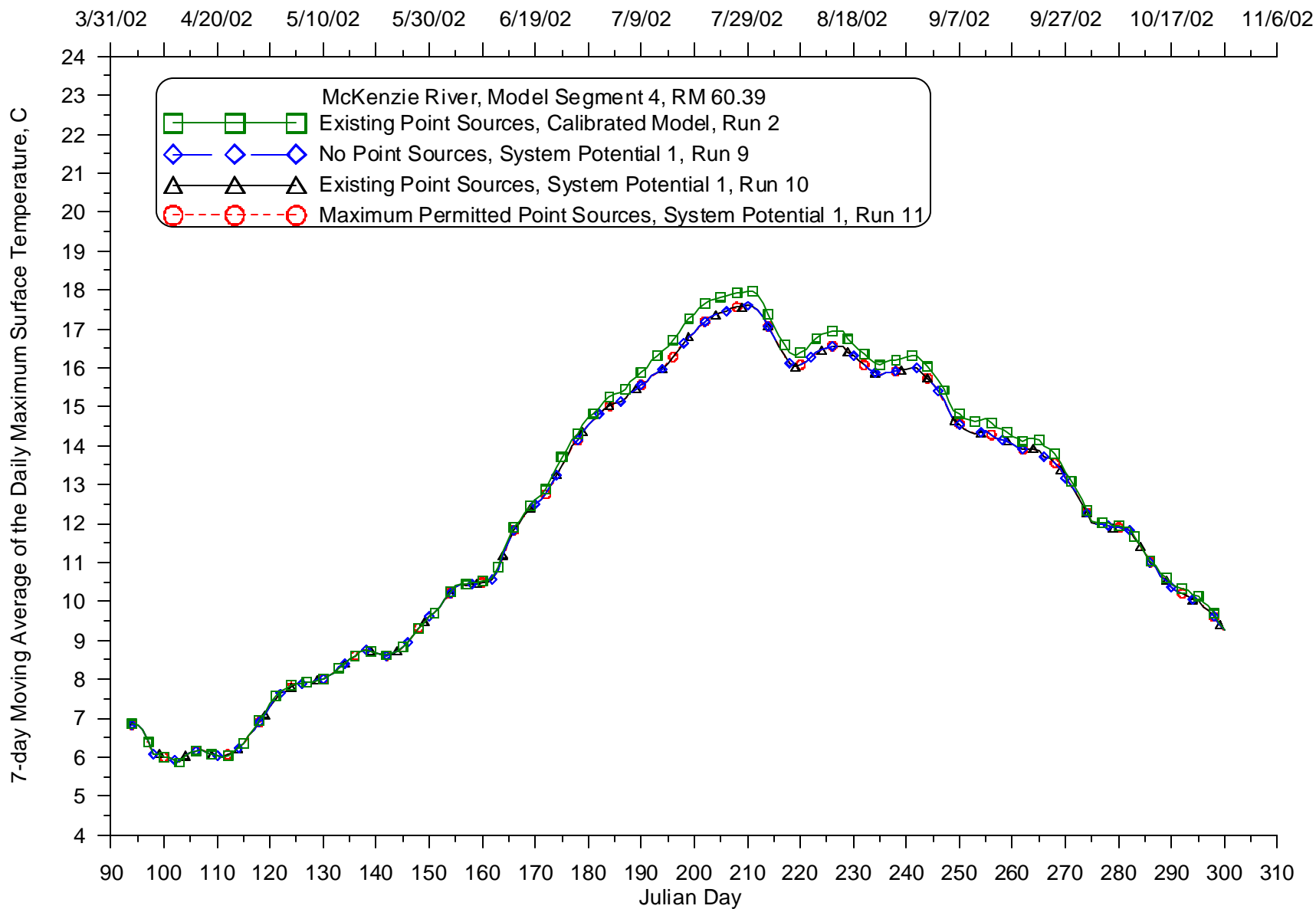


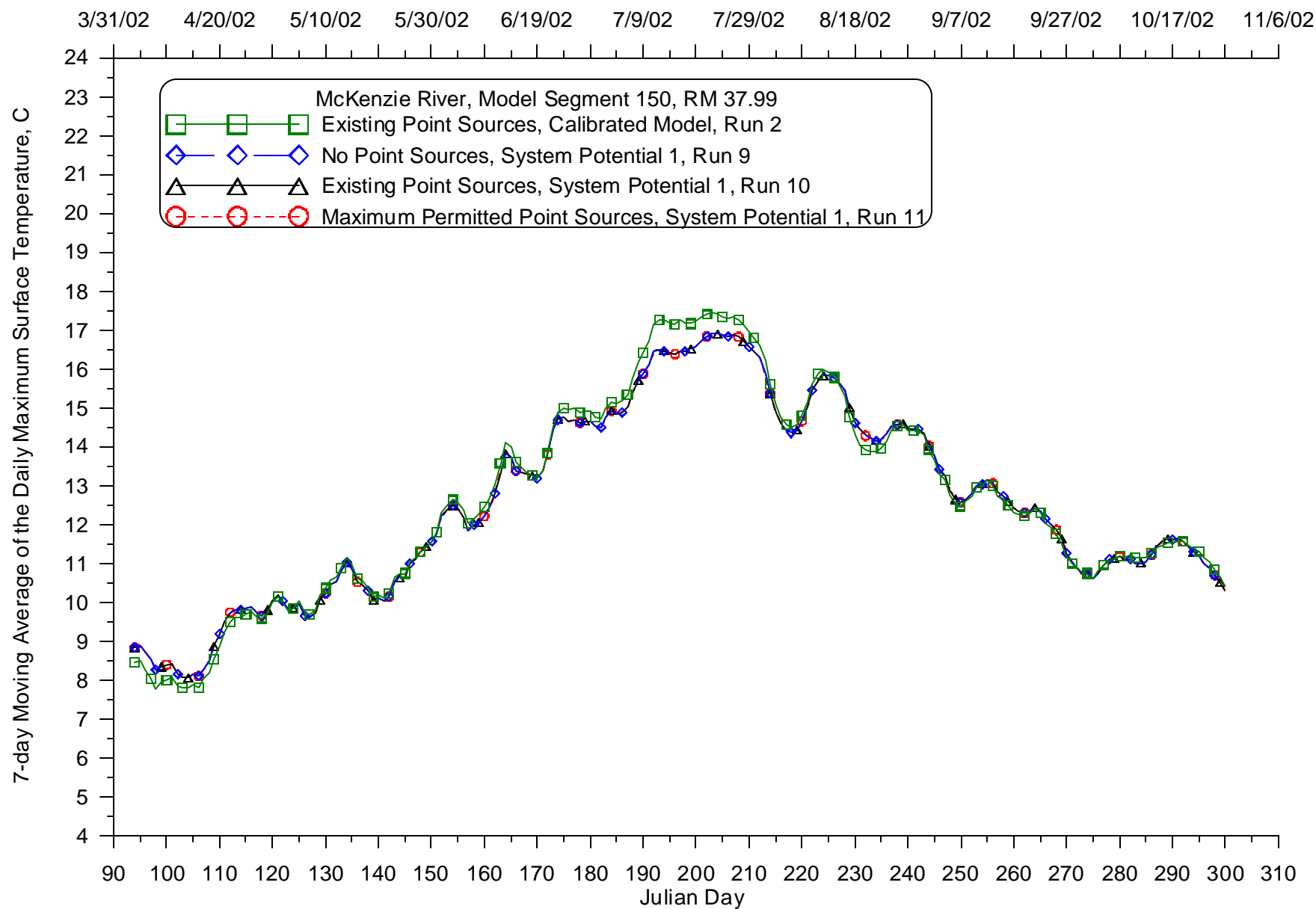
Figure 269: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for Fall Creek at RM 6.29



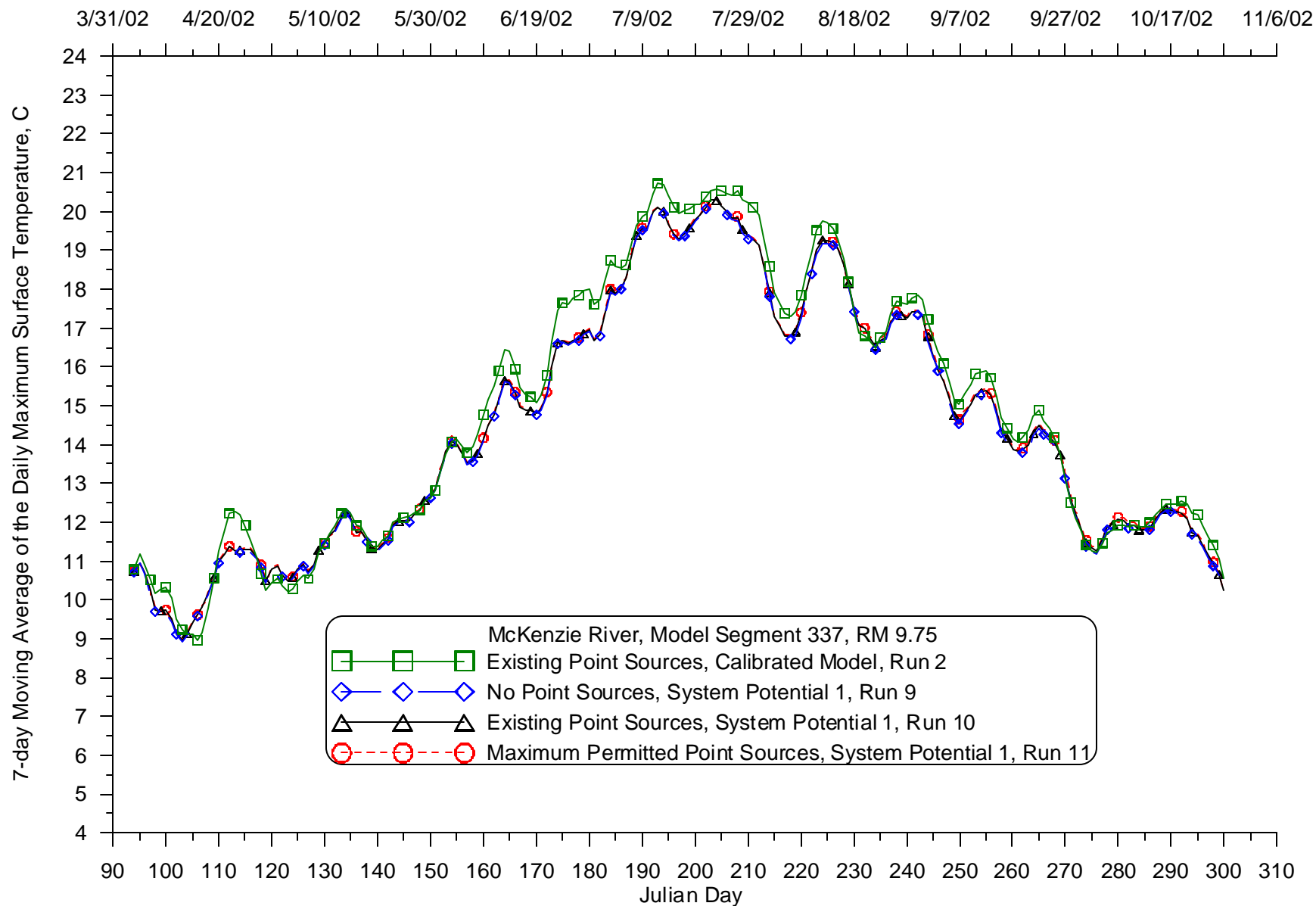
**Figure 270: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 187.06**



**Figure 271: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the McKenzie River at RM 60.39**



**Figure 272: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the McKenzie River at RM 37.99**



**Figure 273: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the McKenzie River at RM 9.75**

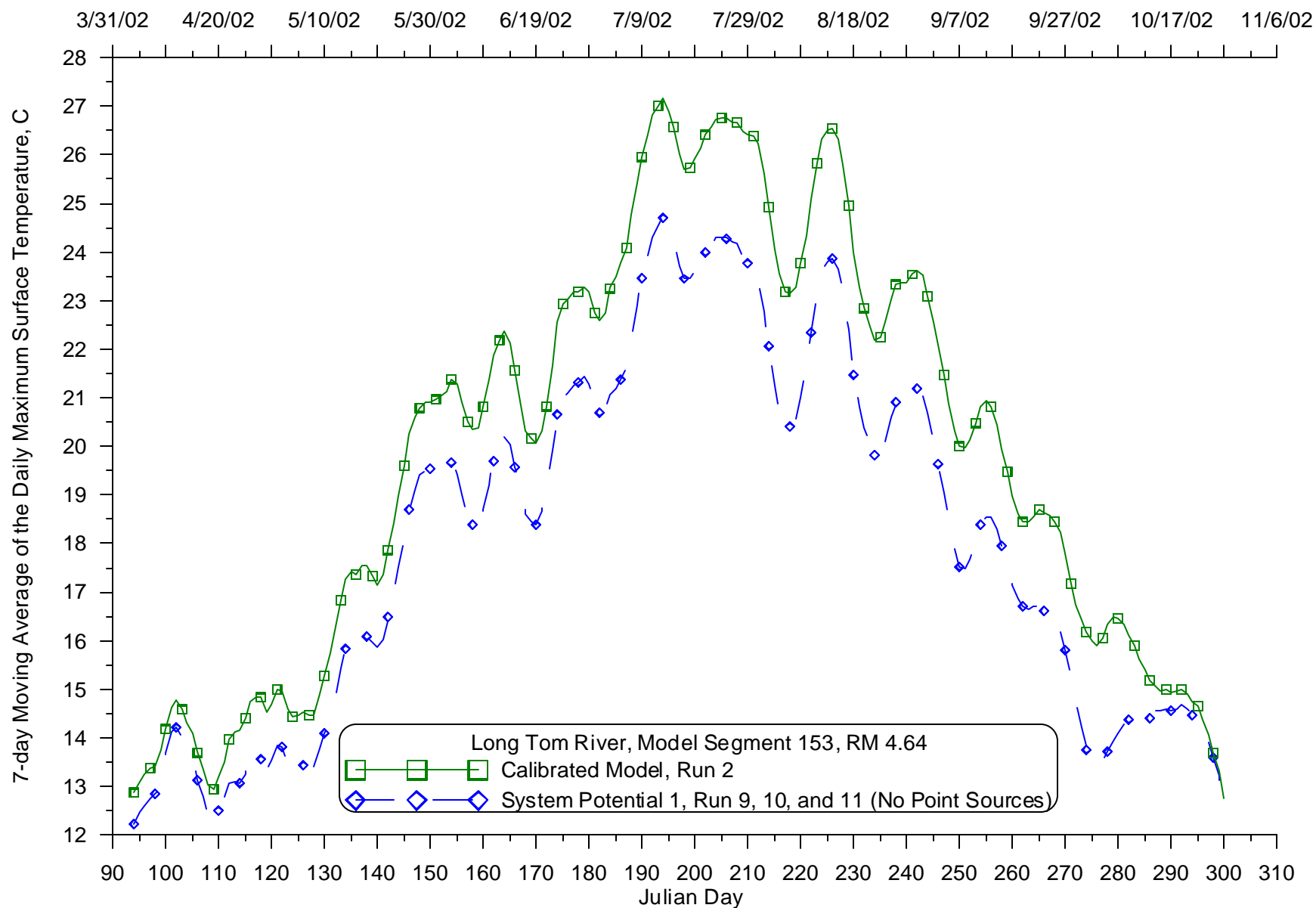
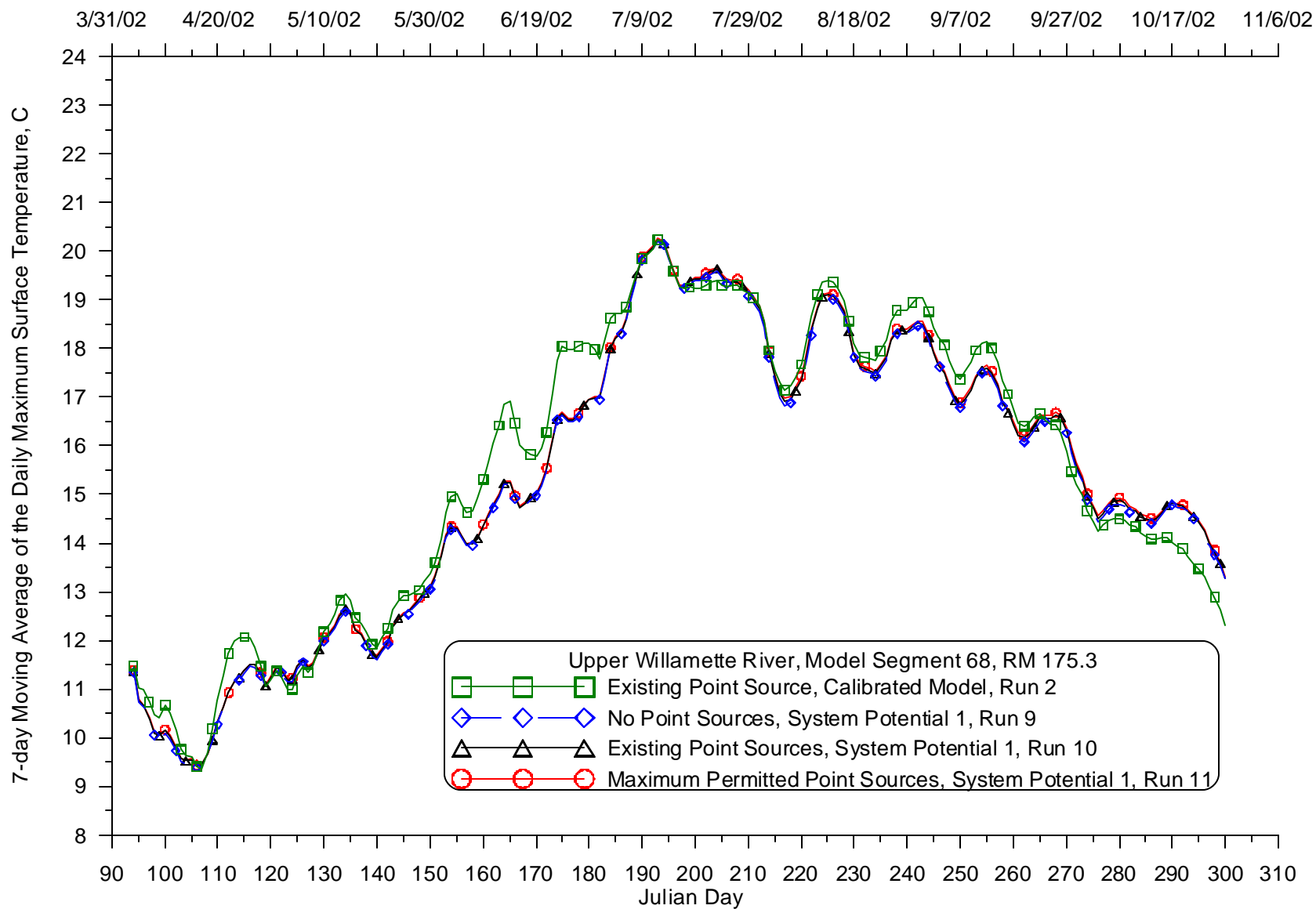
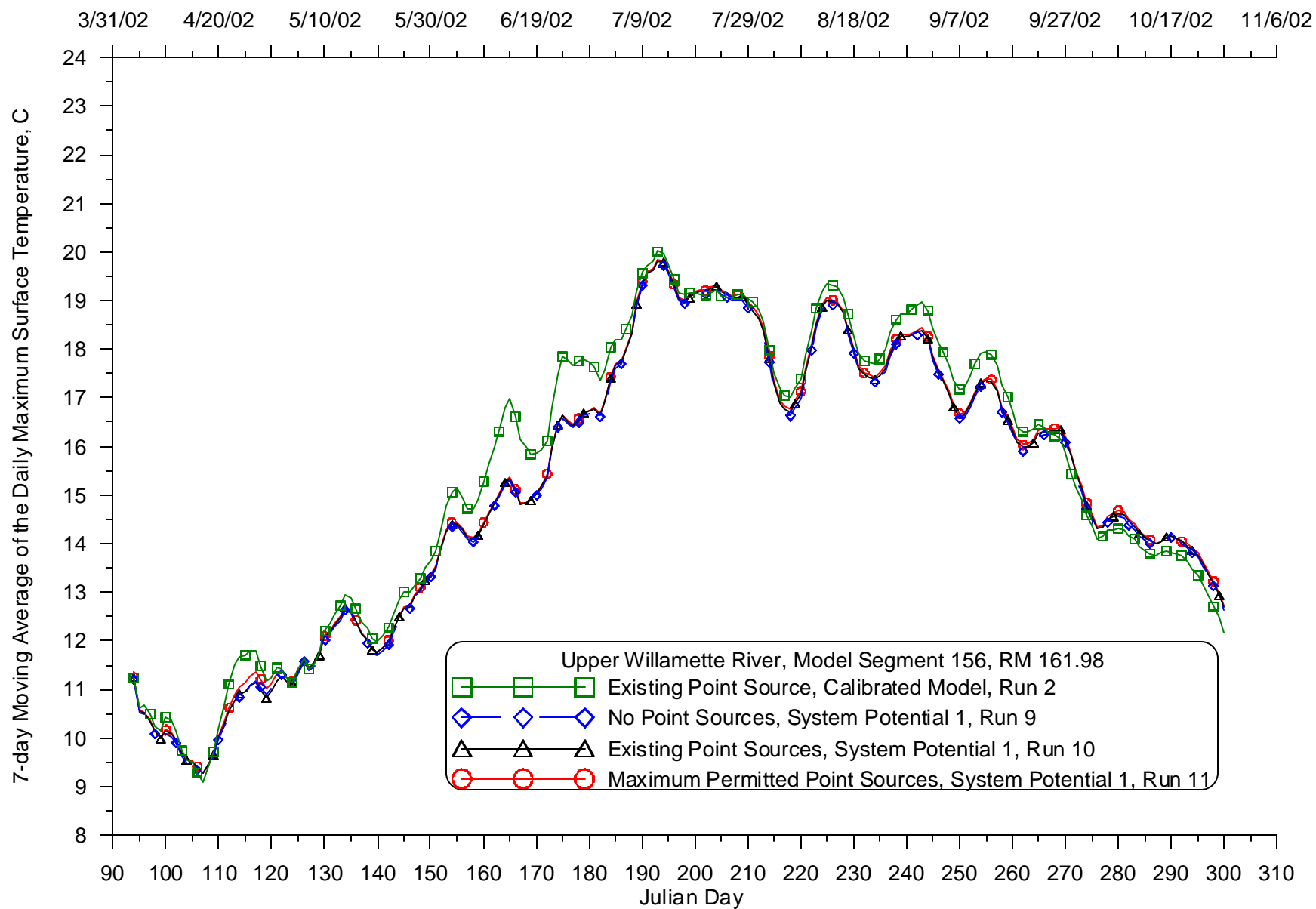


Figure 274: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Long Tom River at RM 4.64

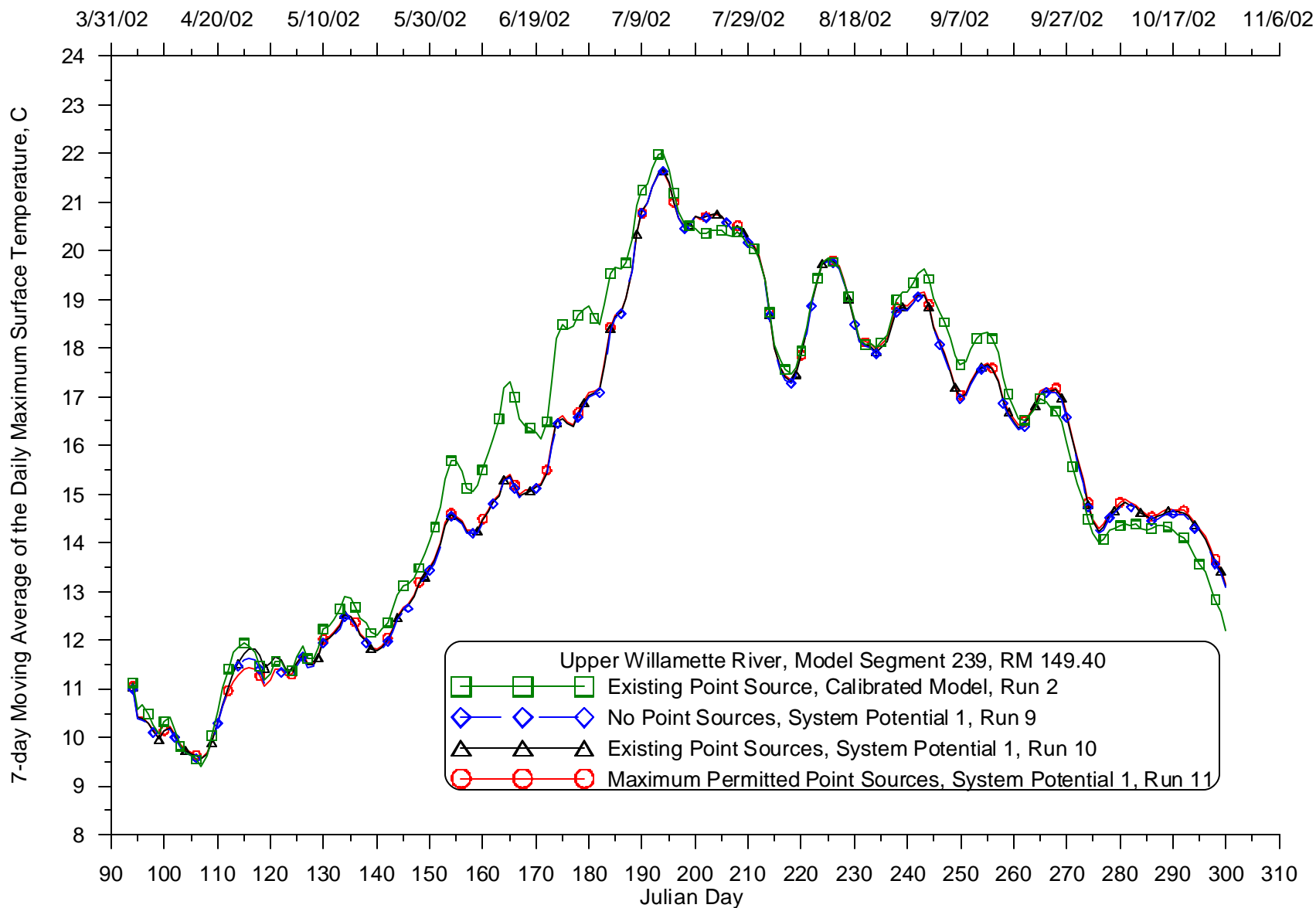


**Figure 275: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 175.3**

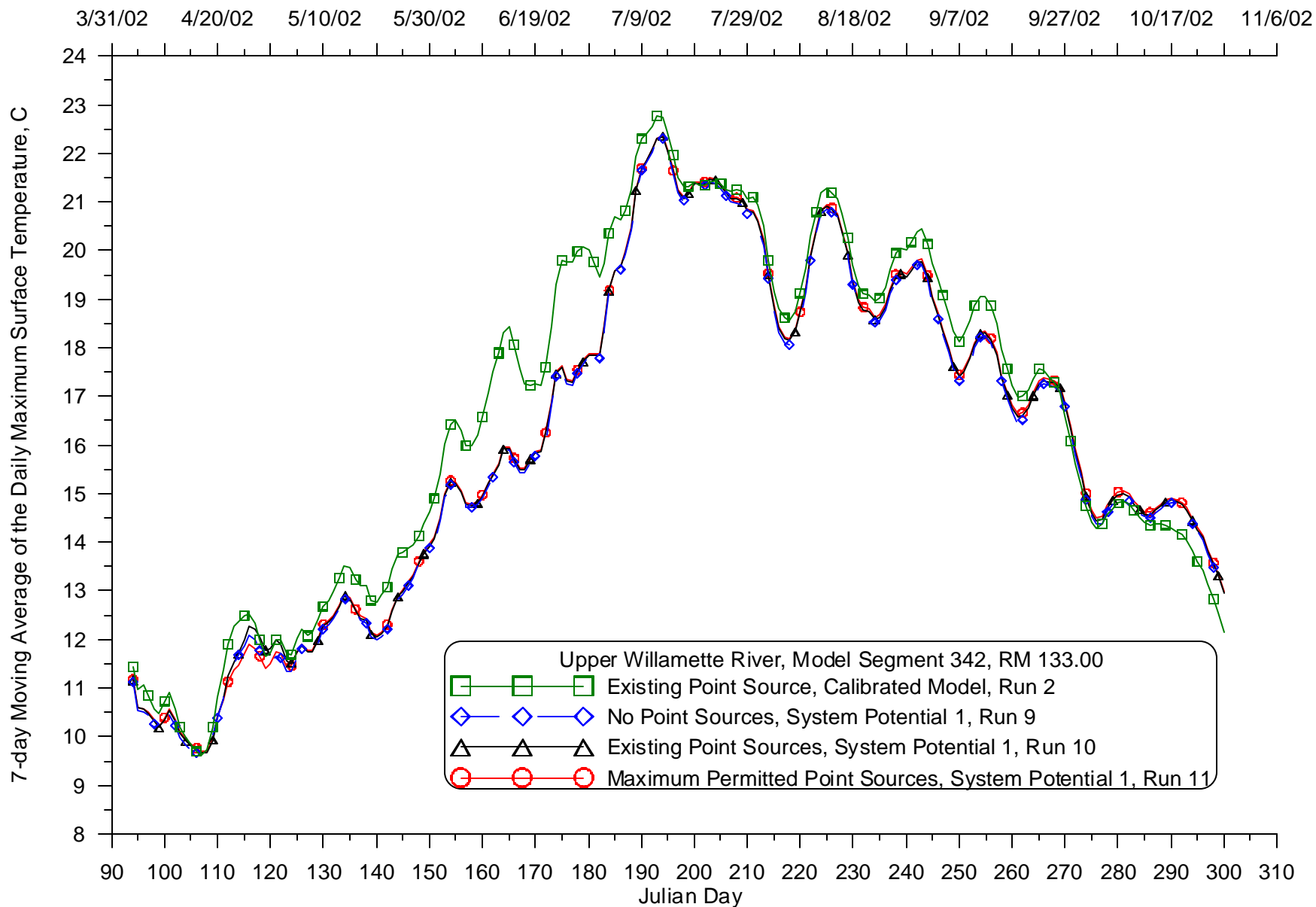




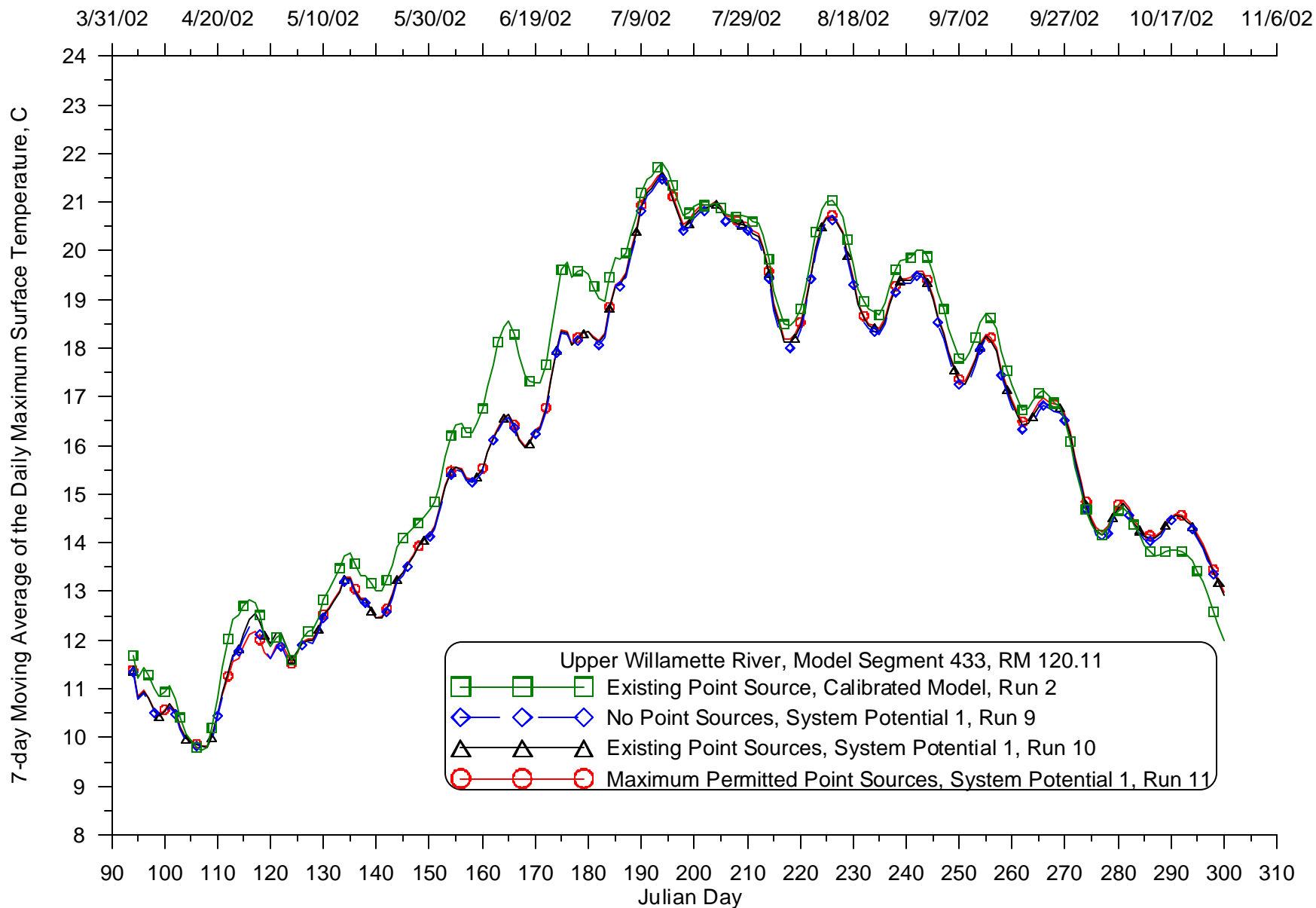
**Figure 276: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 161.98**



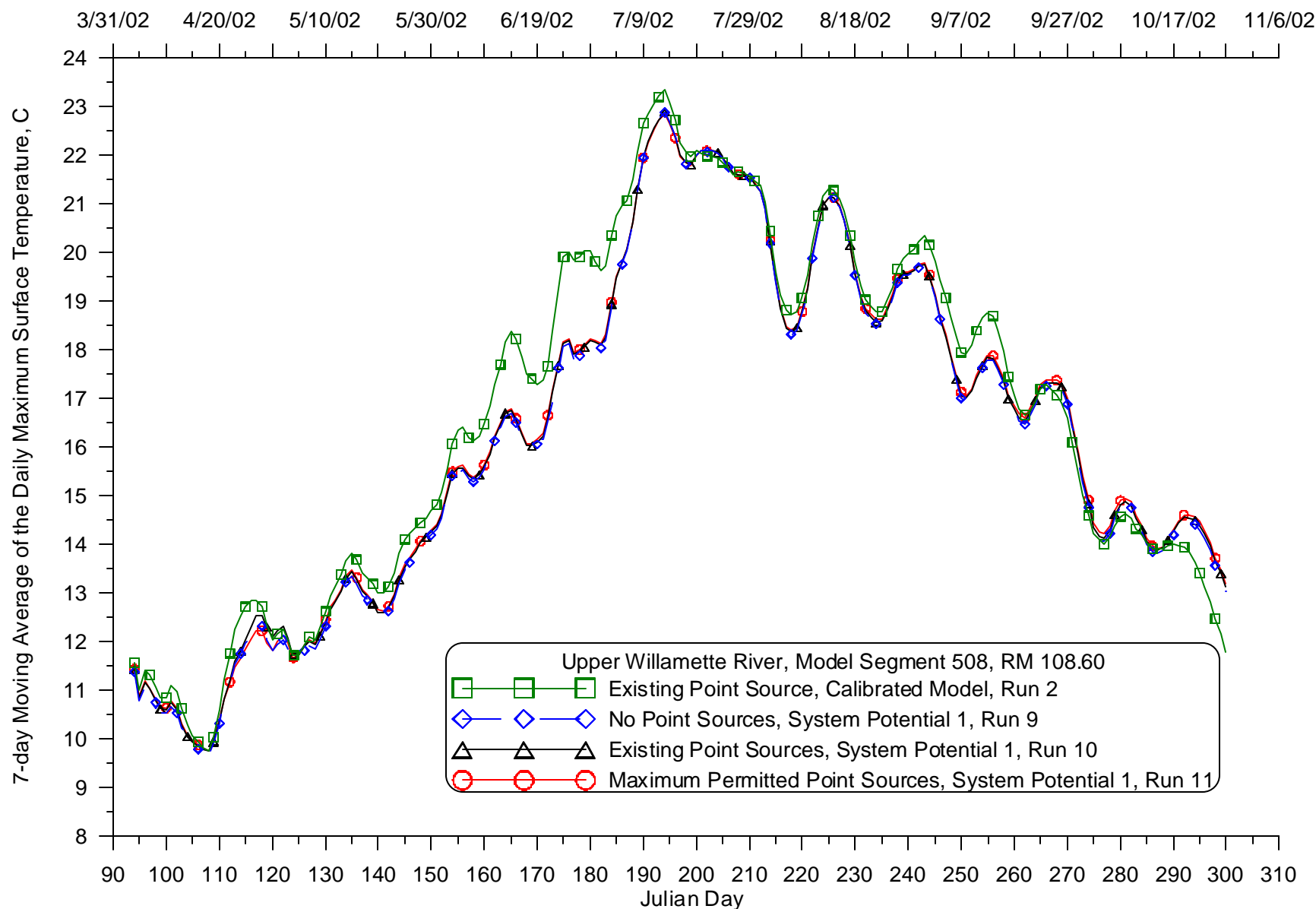
**Figure 277: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 149.40**



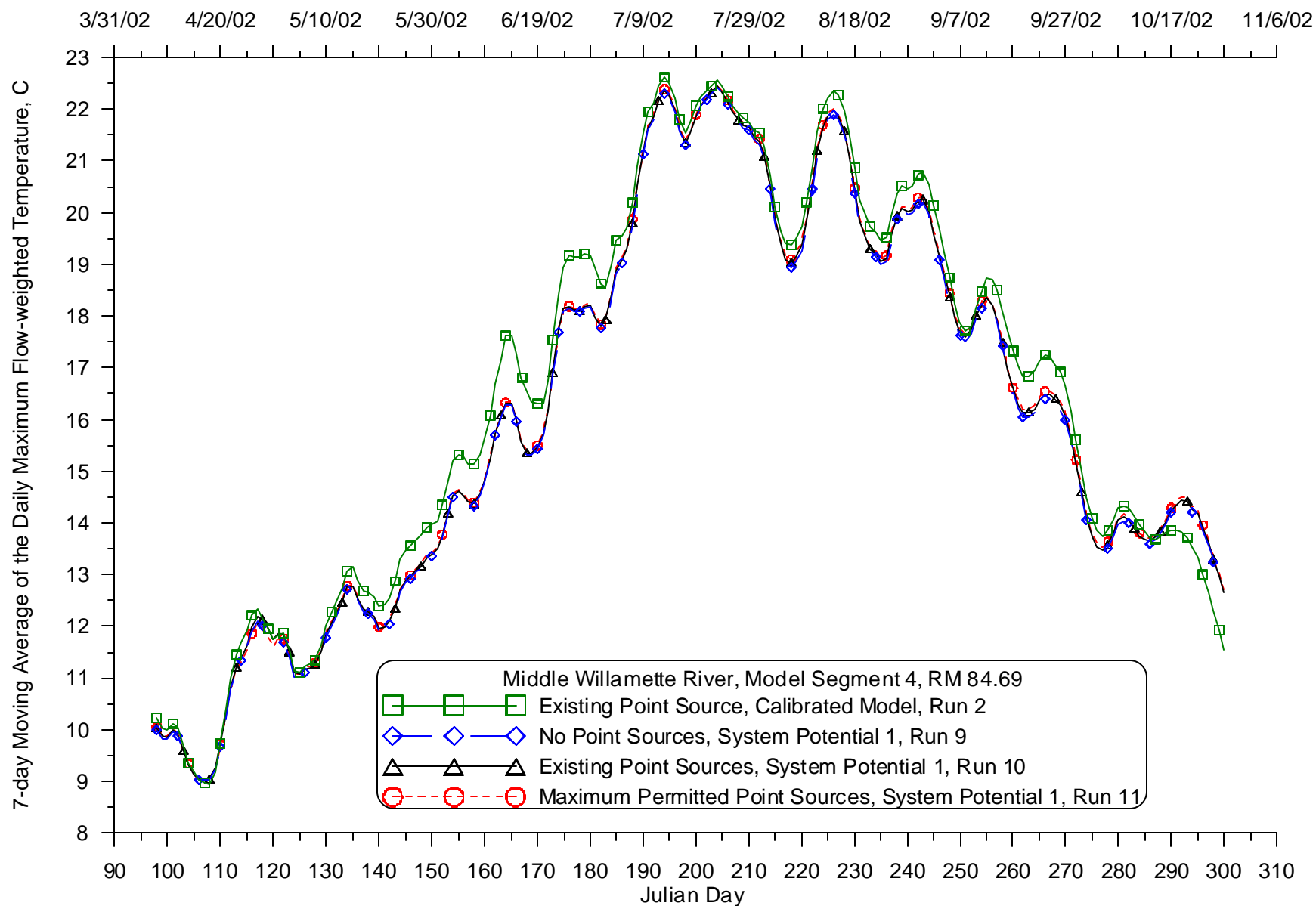
**Figure 278: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 133**



**Figure 279: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 120.11**



**Figure 280: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 108.6**



**Figure 281: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 84.69**

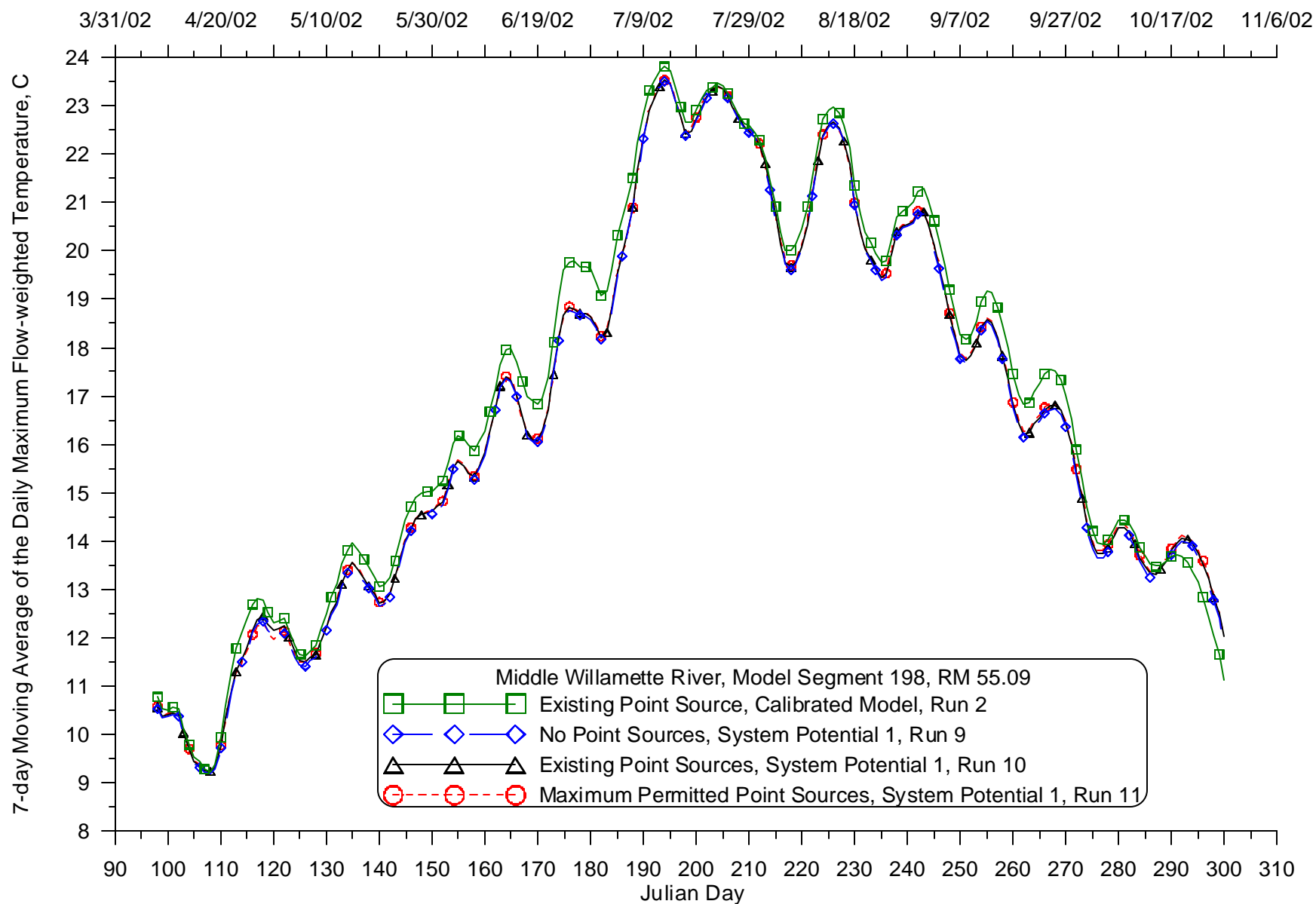
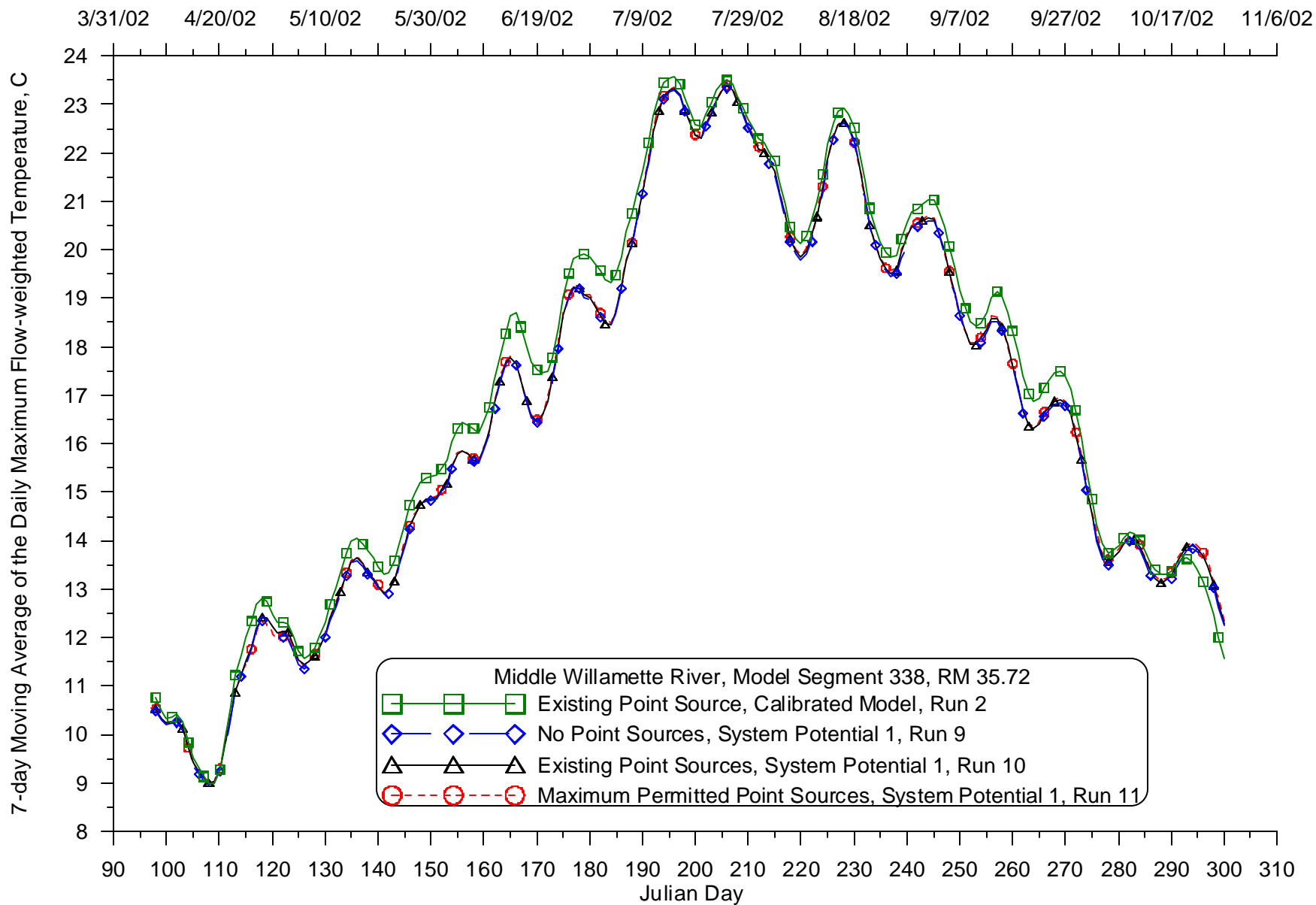
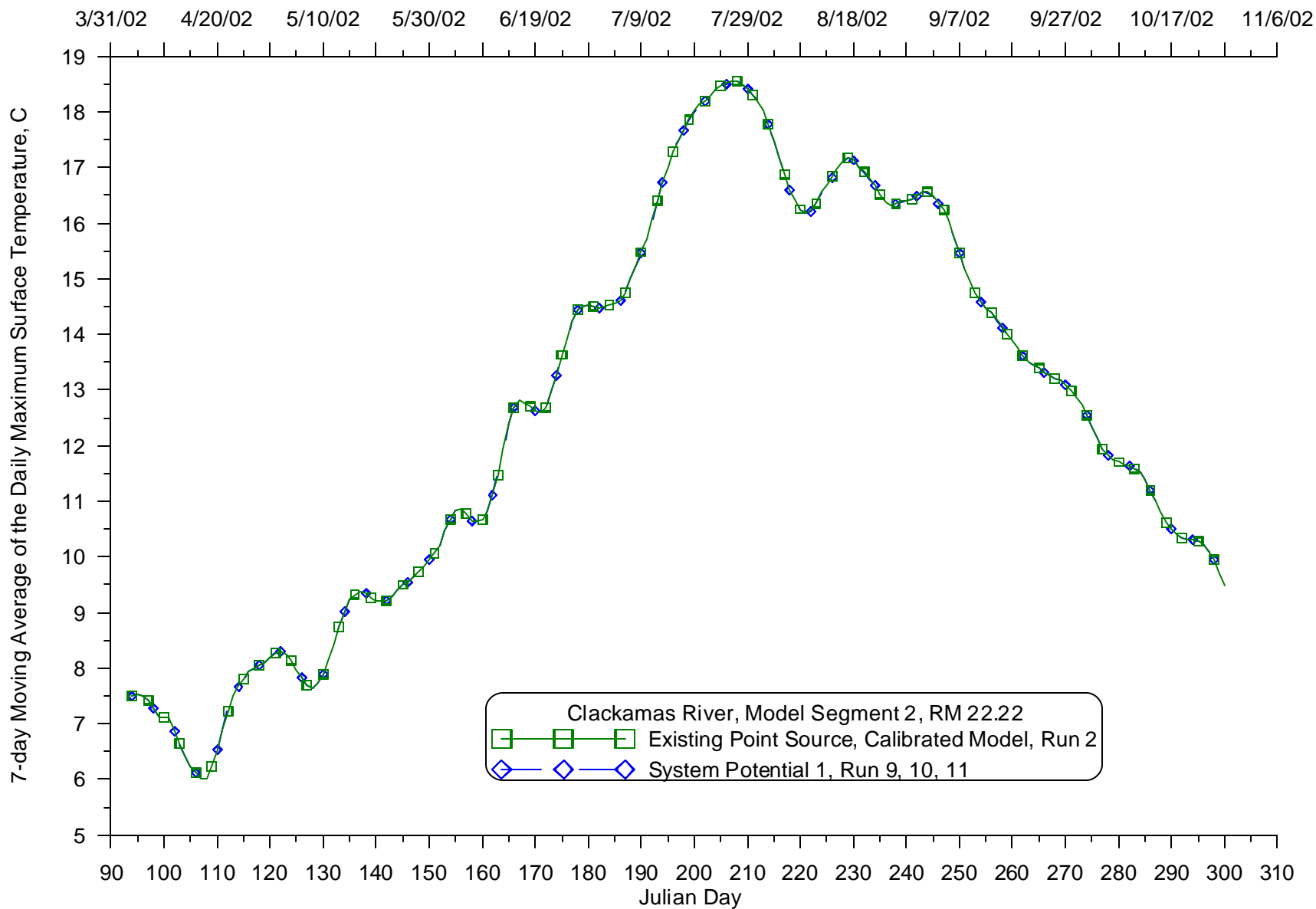


Figure 282: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 55.09

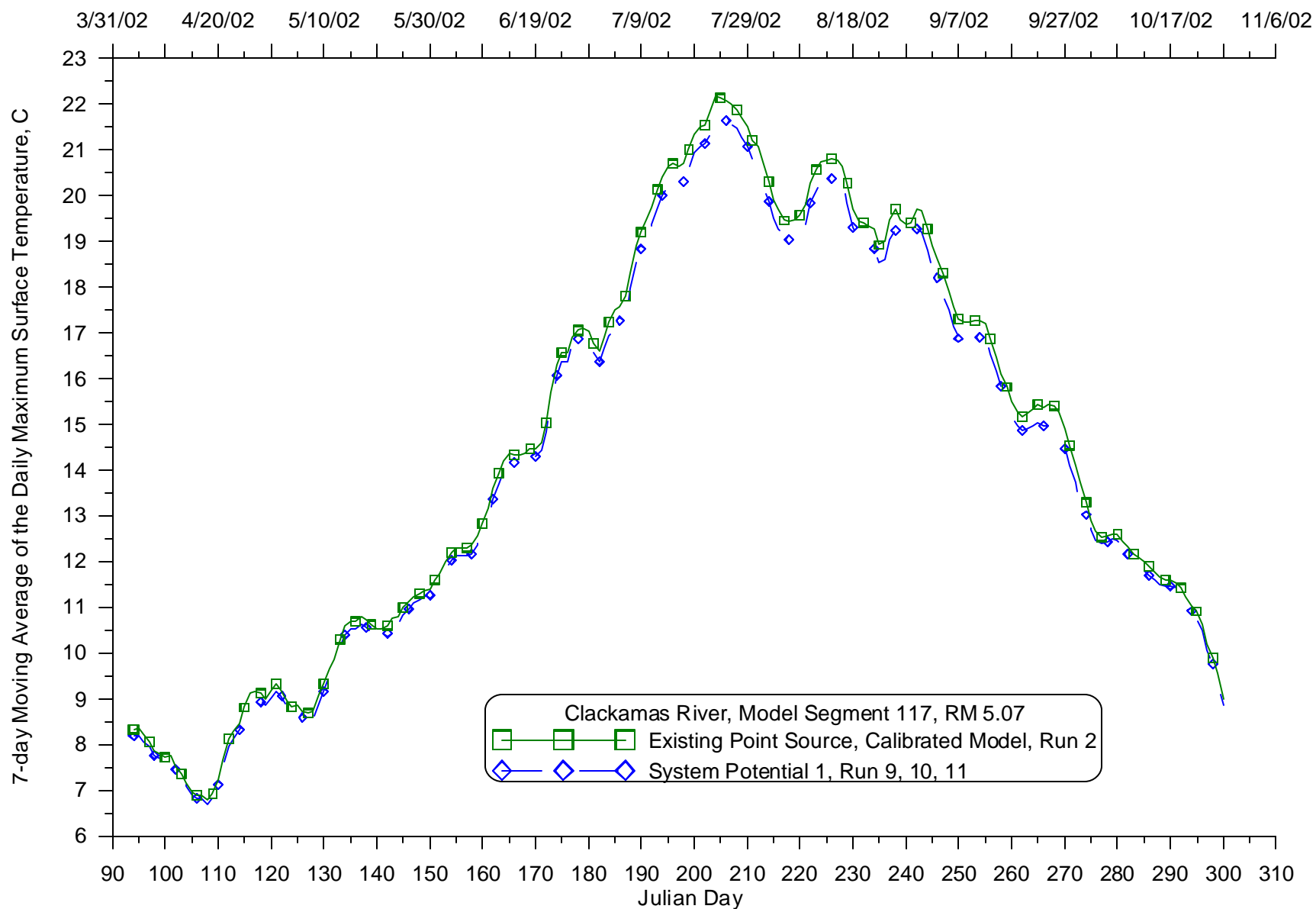


**Figure 283: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 35.72**





**Figure 284: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Clackamas River at RM 22.22**



**Figure 285: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Clackamas River at RM 5.07**

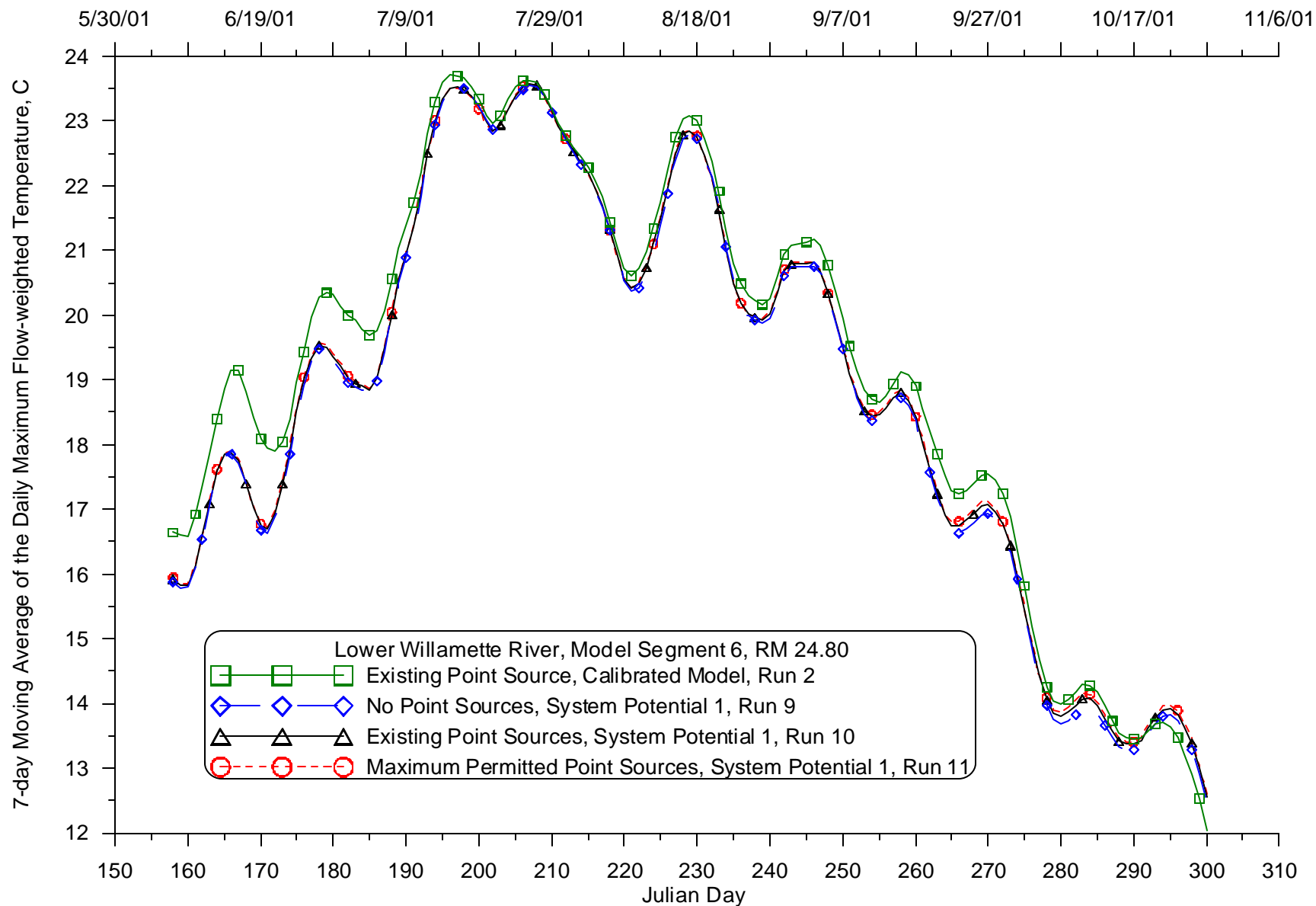


Figure 286: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 24.8`

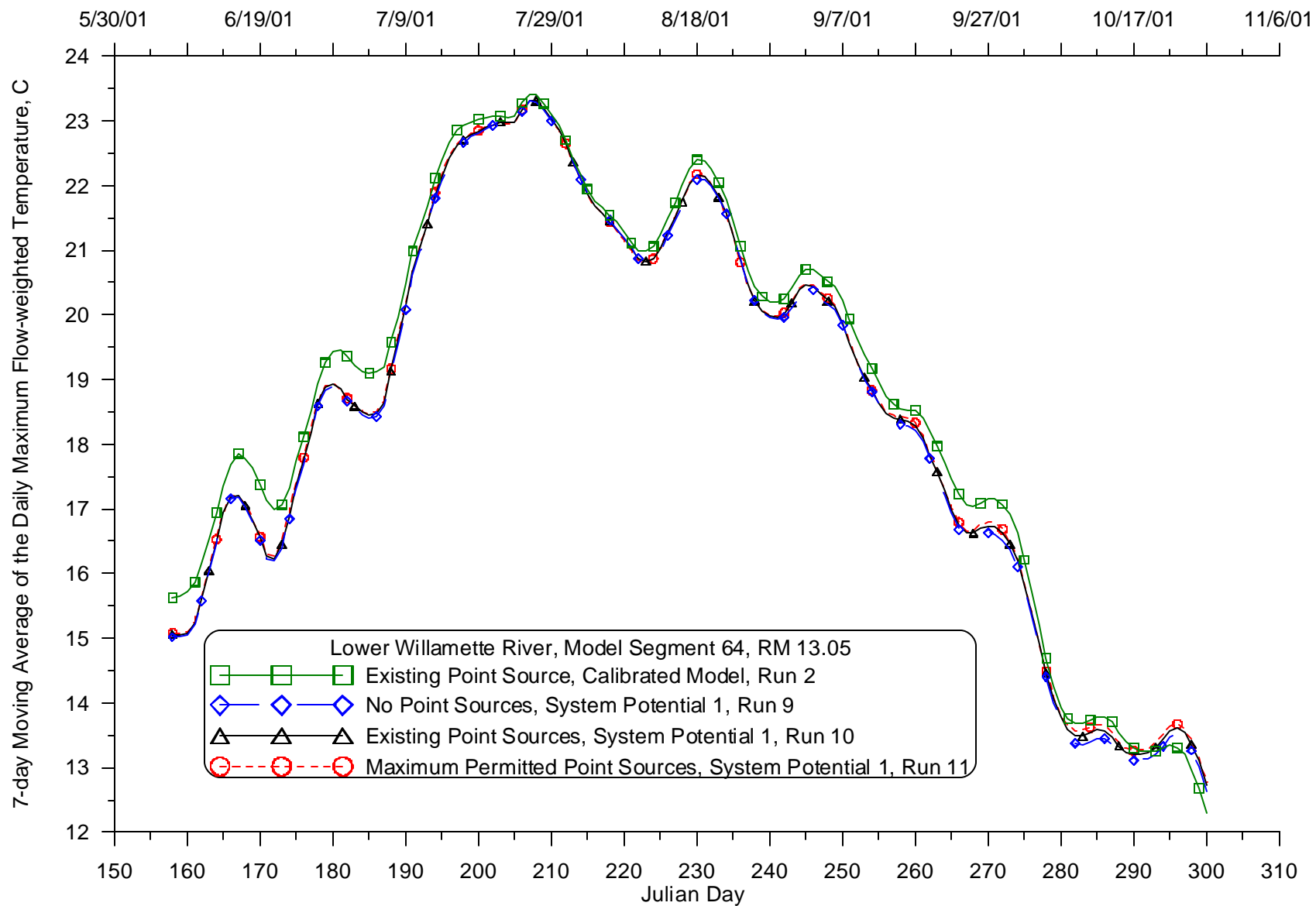


Figure 287: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 13.05

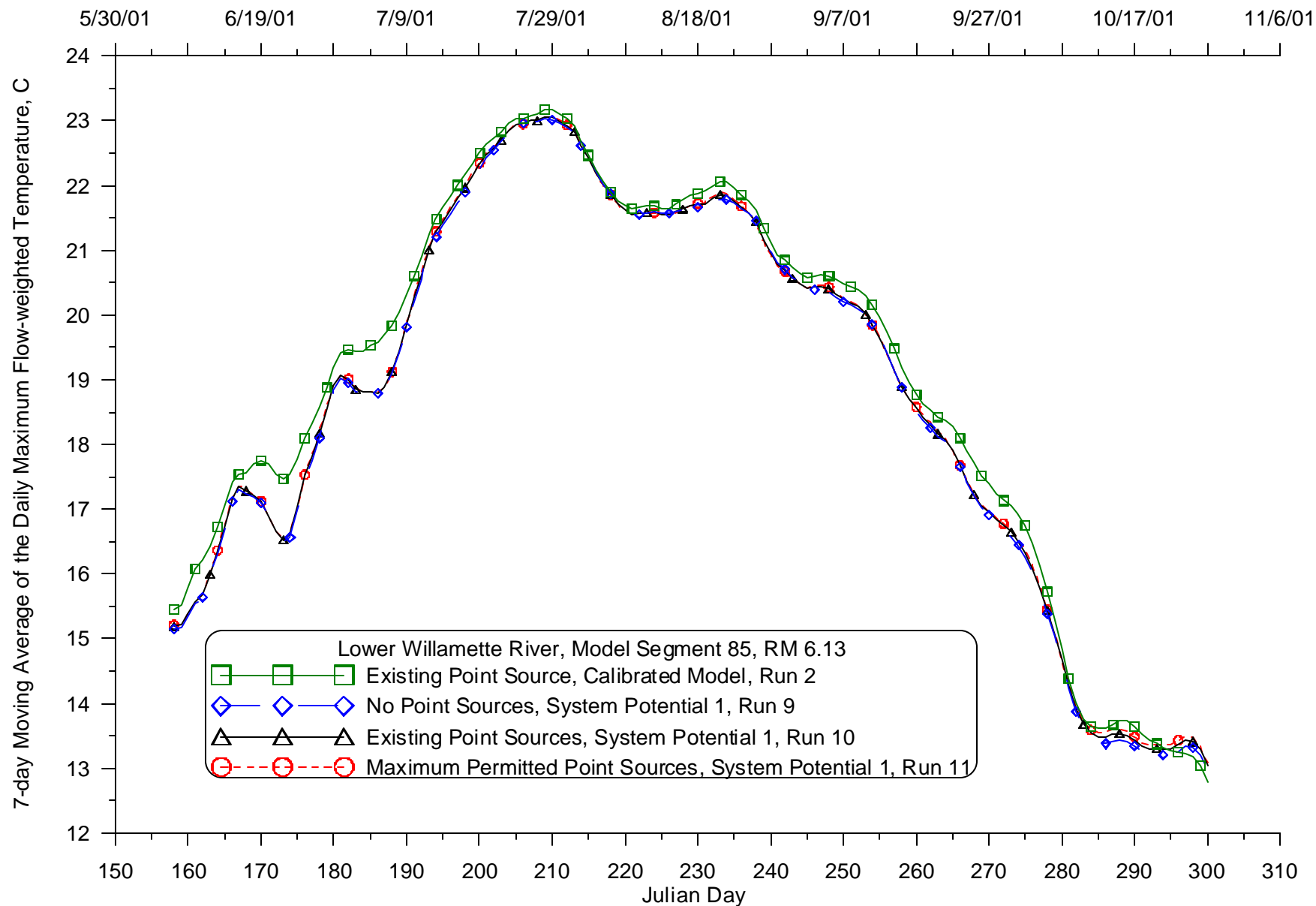


Figure 288: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 6.13

**Daily seven day average flow**

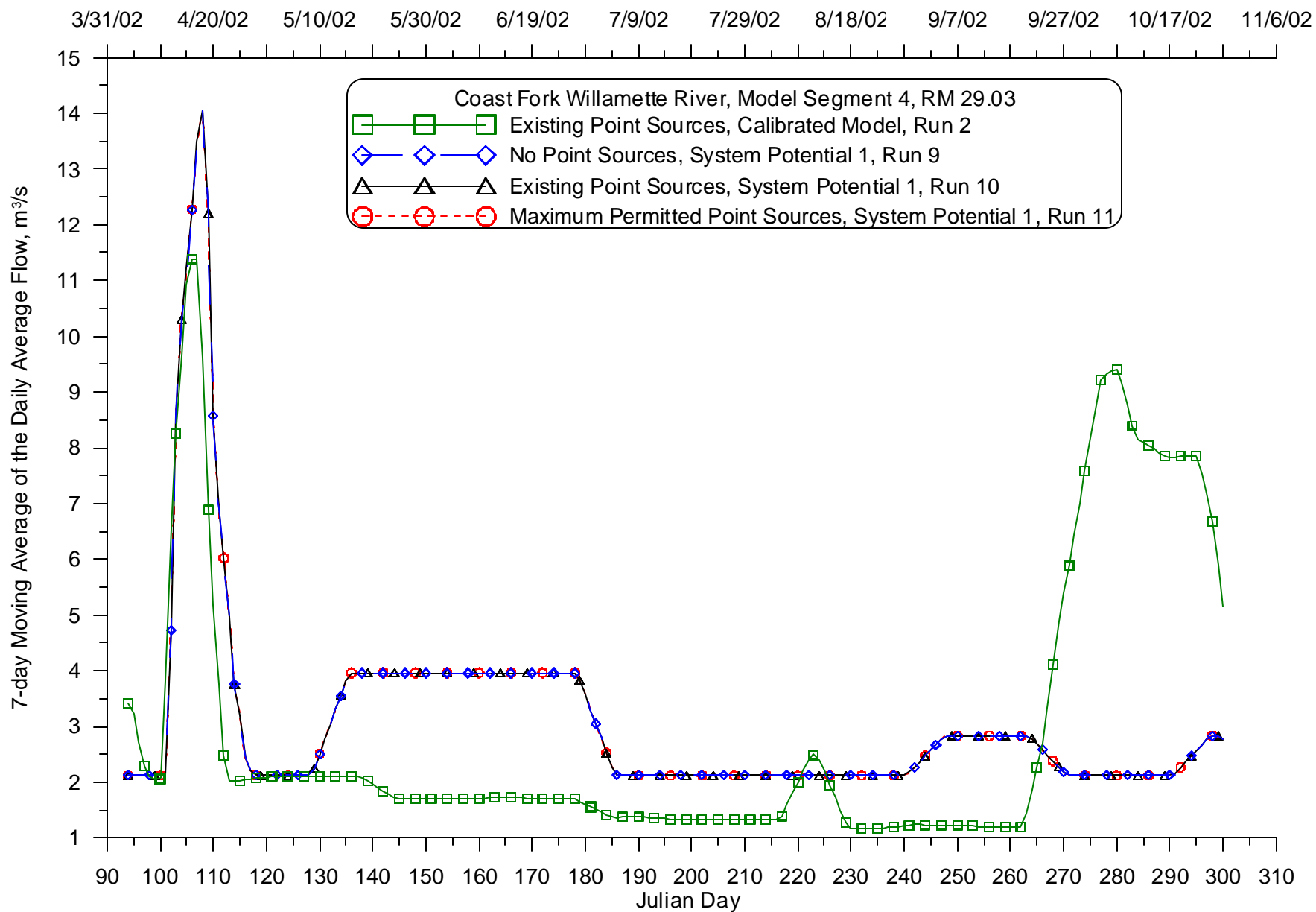


Figure 289: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Coast Fork Willamette River at RM 29.03

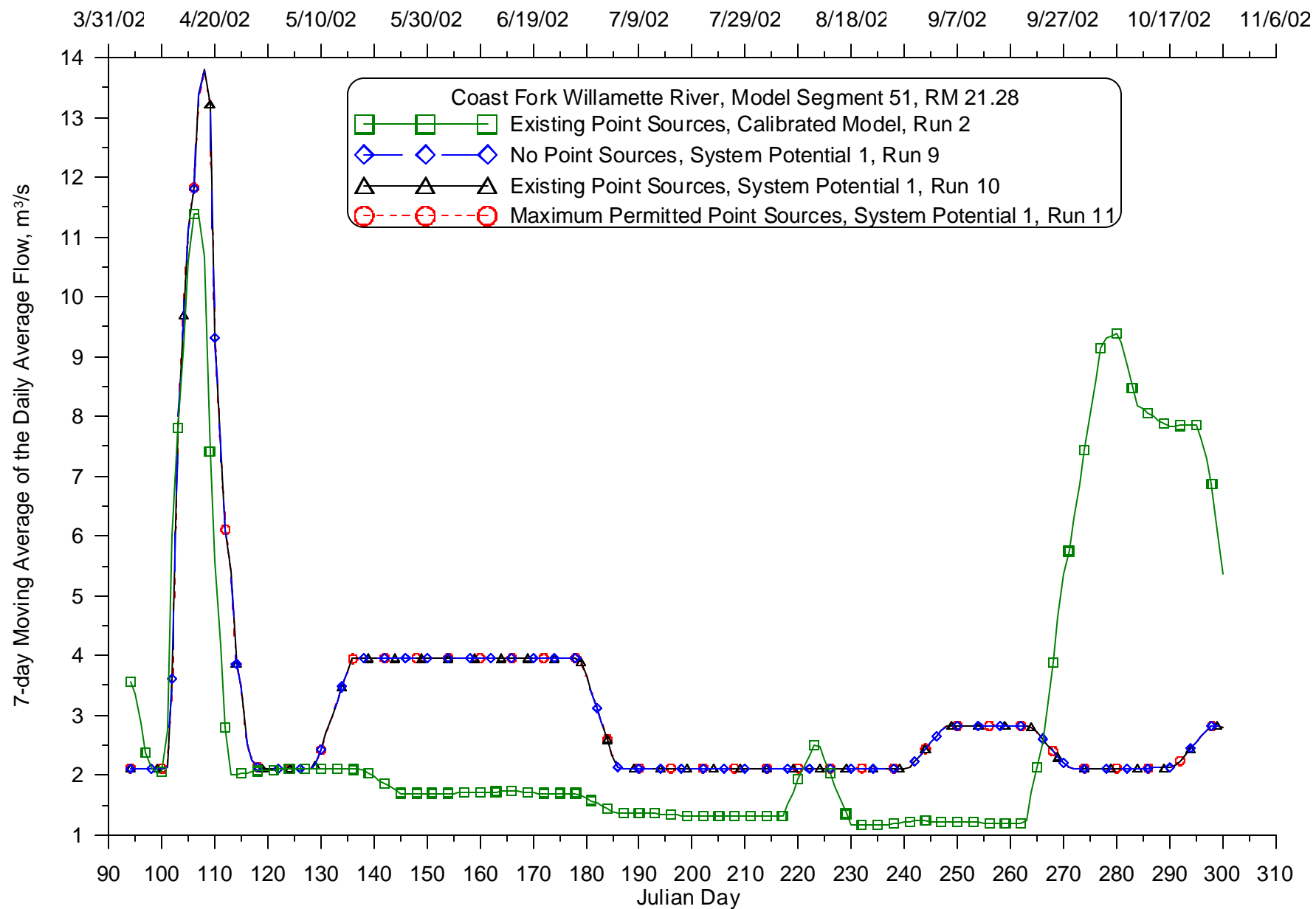
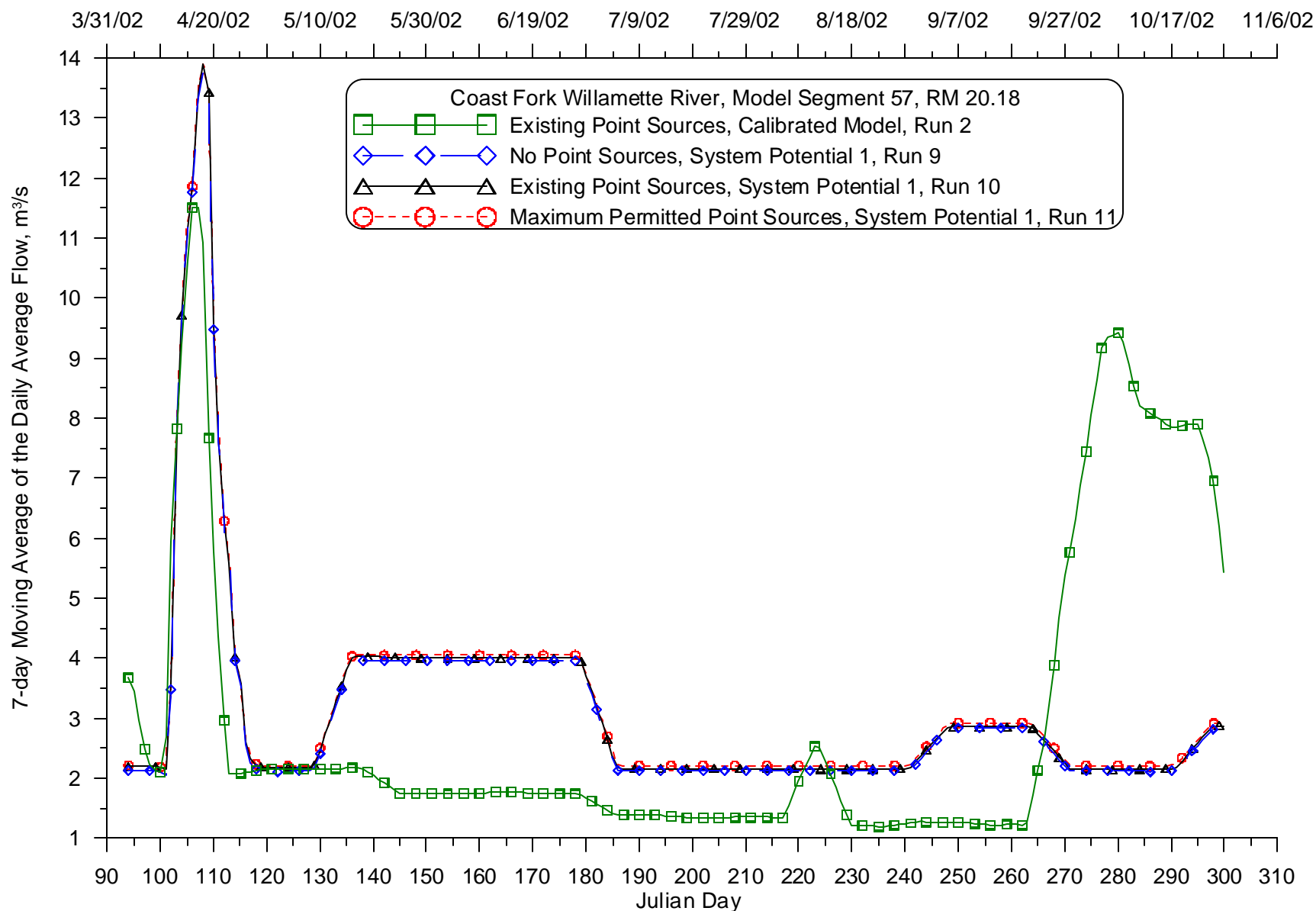
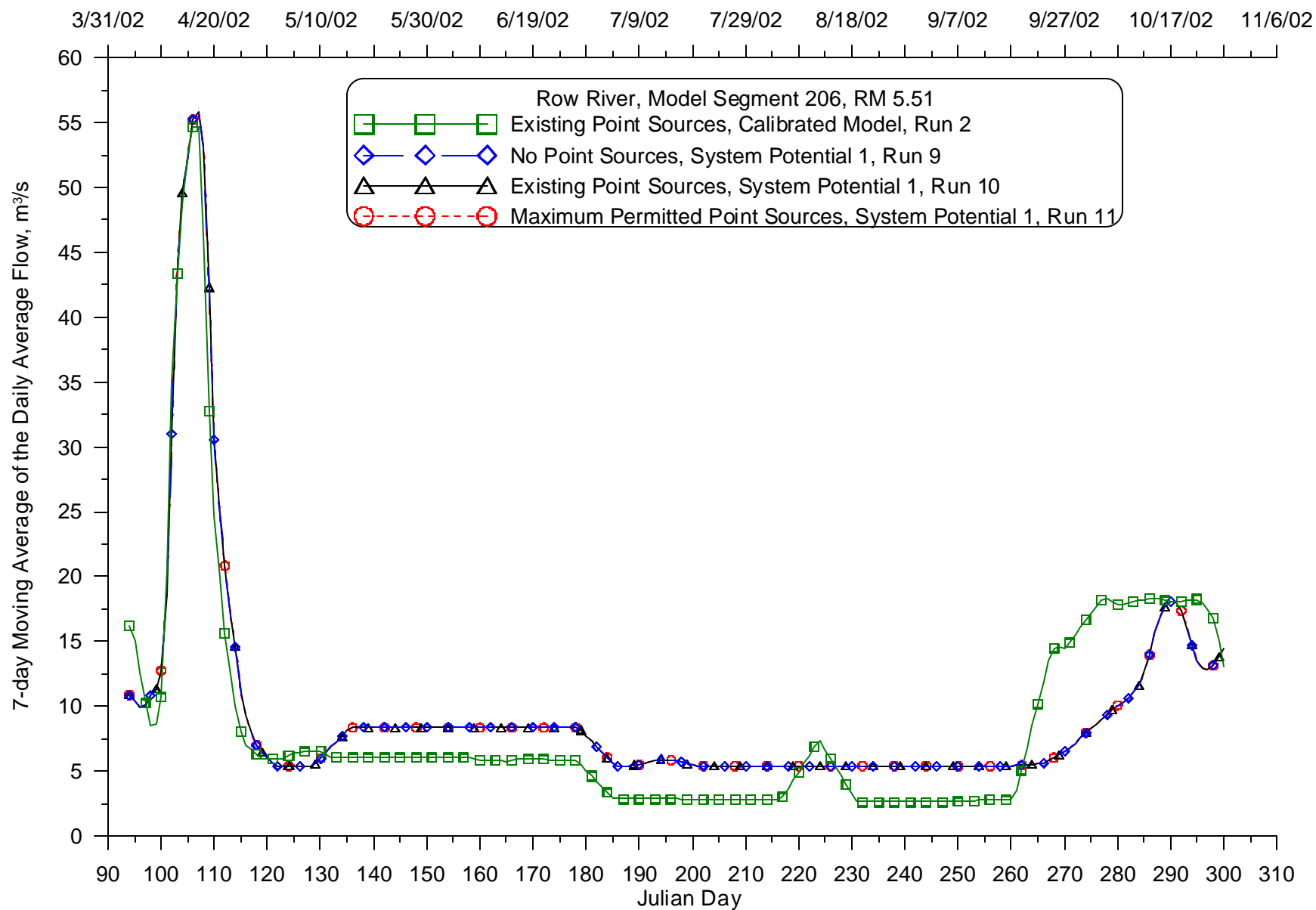


Figure 290: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Coast Fork Willamette River at RM 21.28

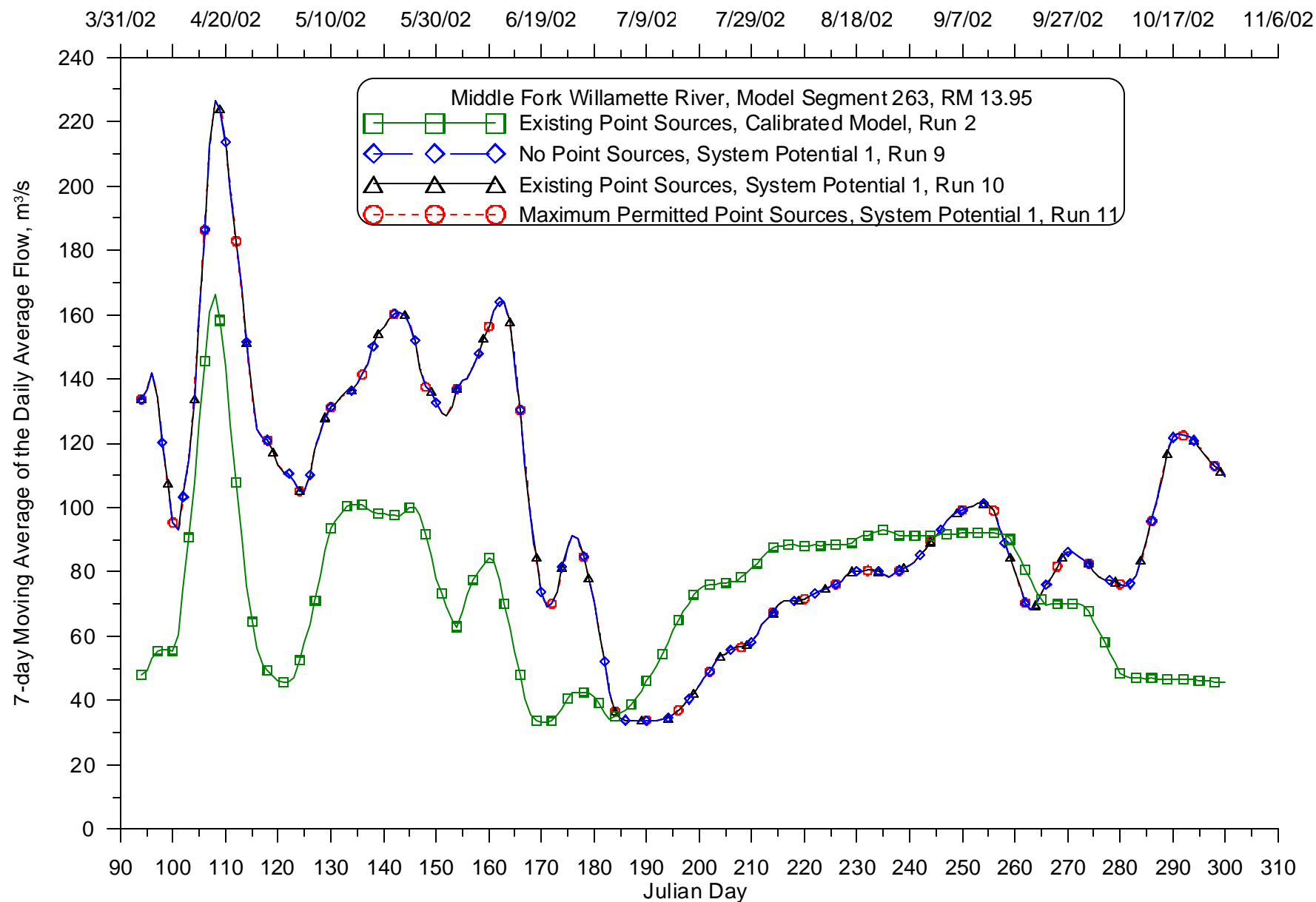




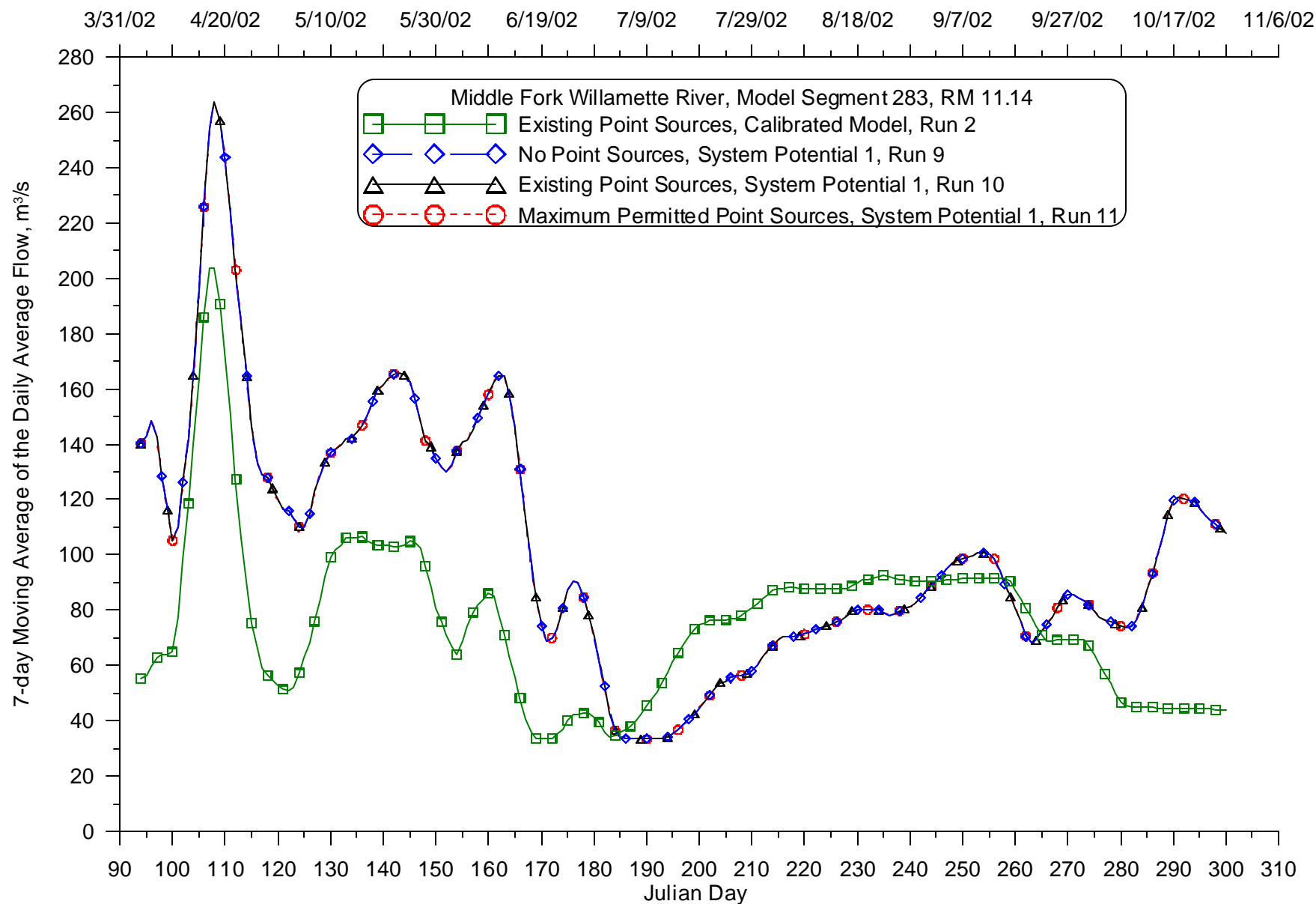
**Figure 291: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Coast Fork Willamette River at RM 20.18**



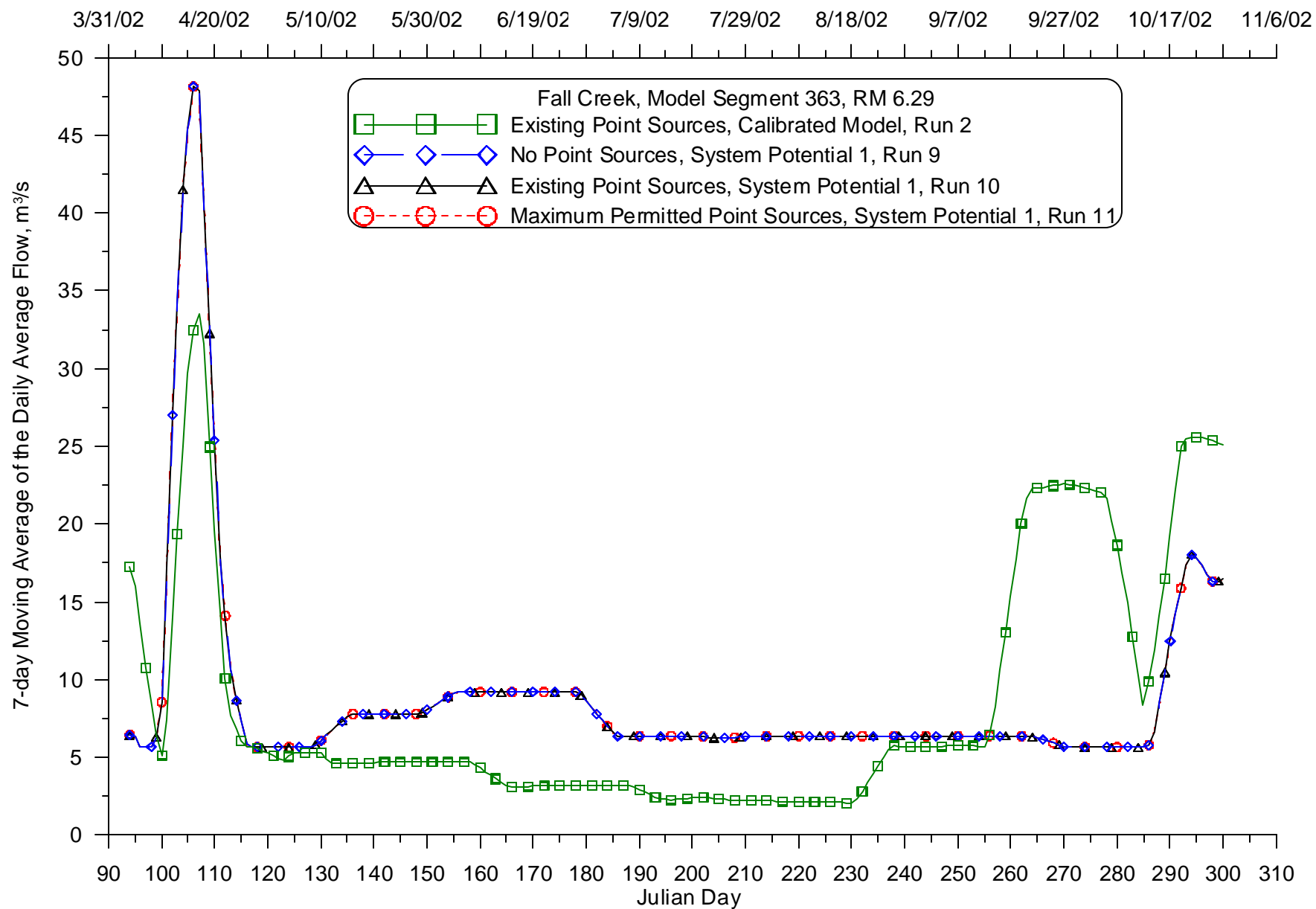
**Figure 292: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Row River at RM 5.51**



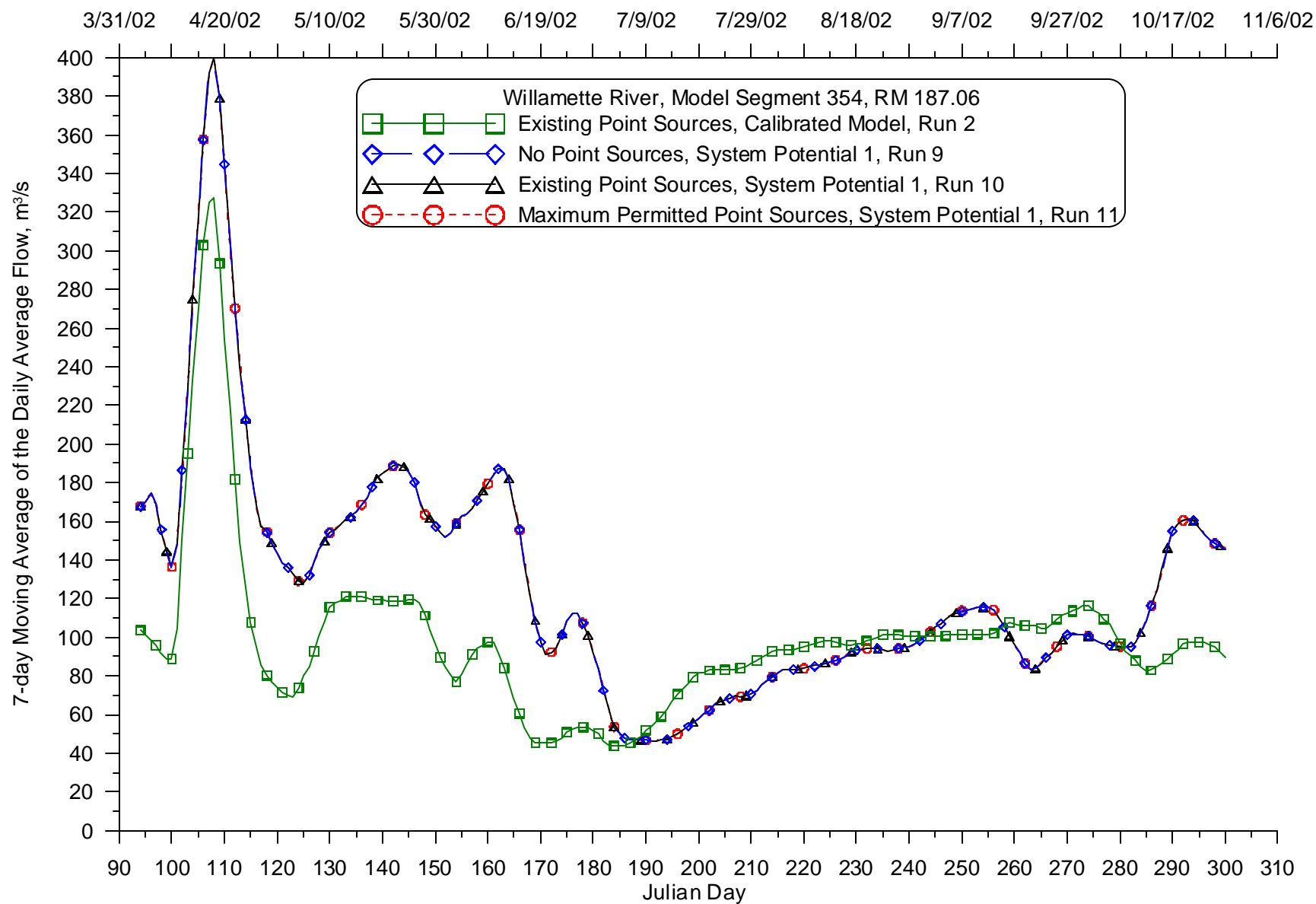
**Figure 293: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Middle Fork Willamette River at RM 13.95**



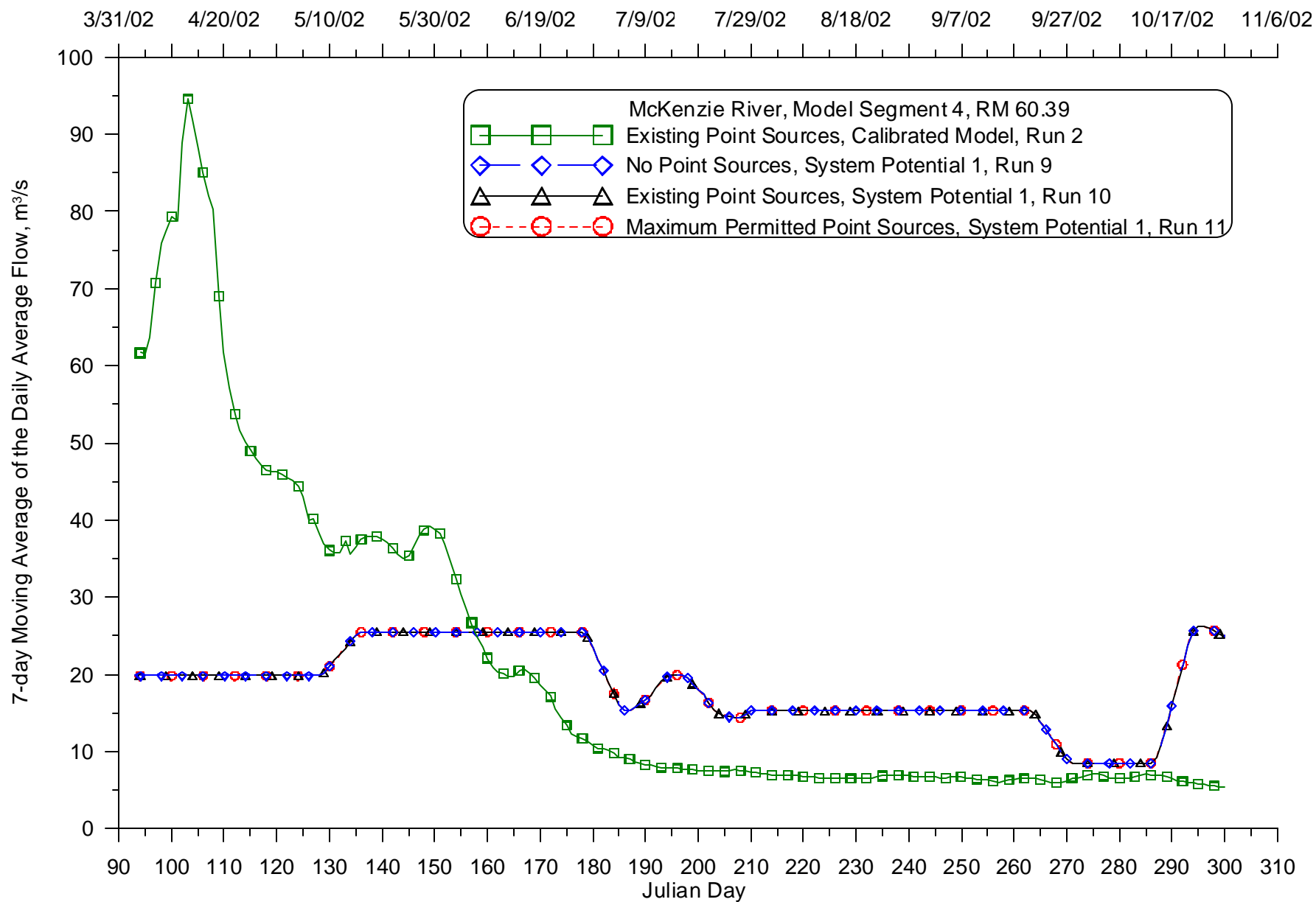
**Figure 294: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Middle Fork Willamette River at RM 11.14**



**Figure 295: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for Fall Creek at RM 6.29**



**Figure 296: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 187.06**



**Figure 297: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the McKenzie River at RM 60.39**

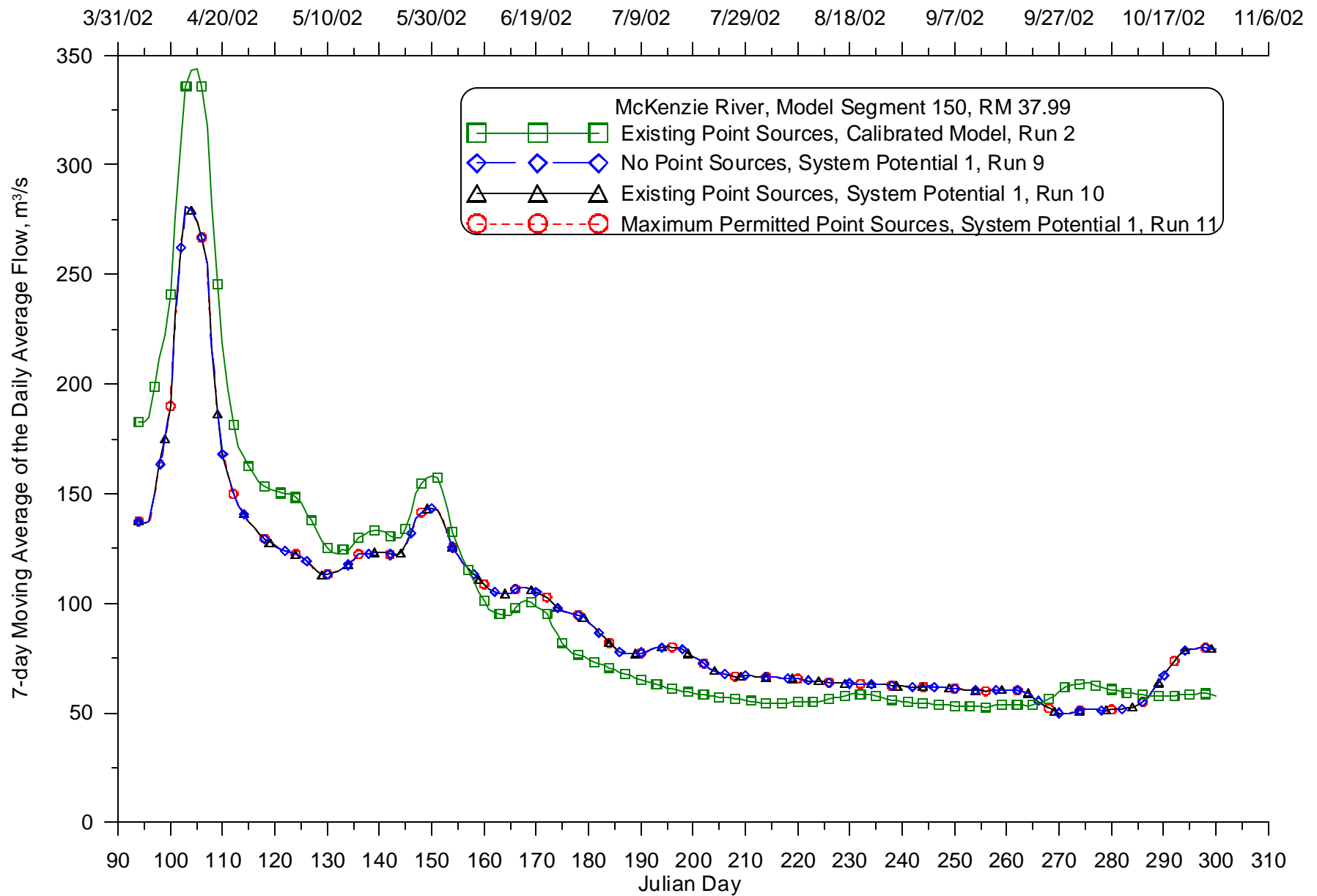
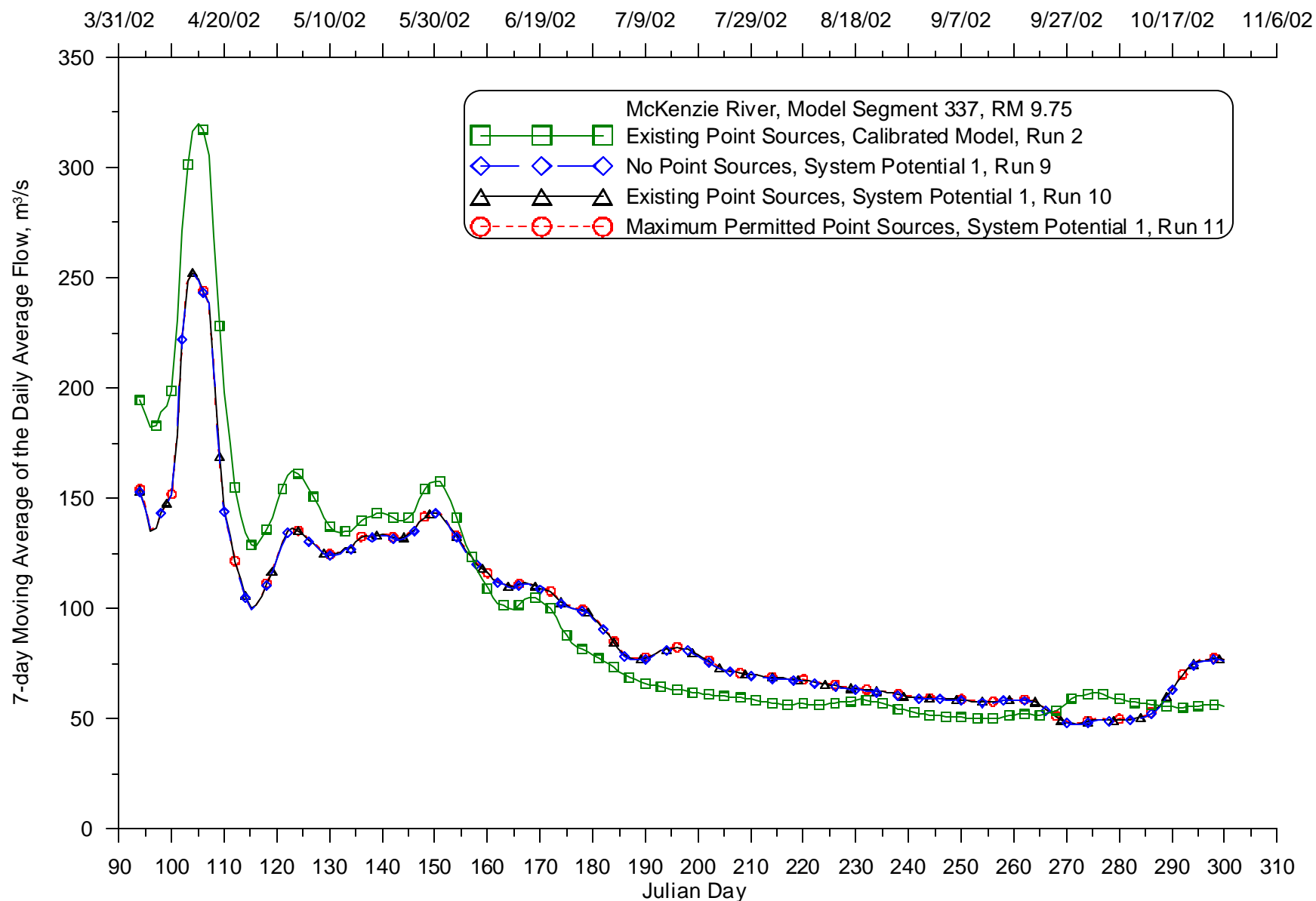
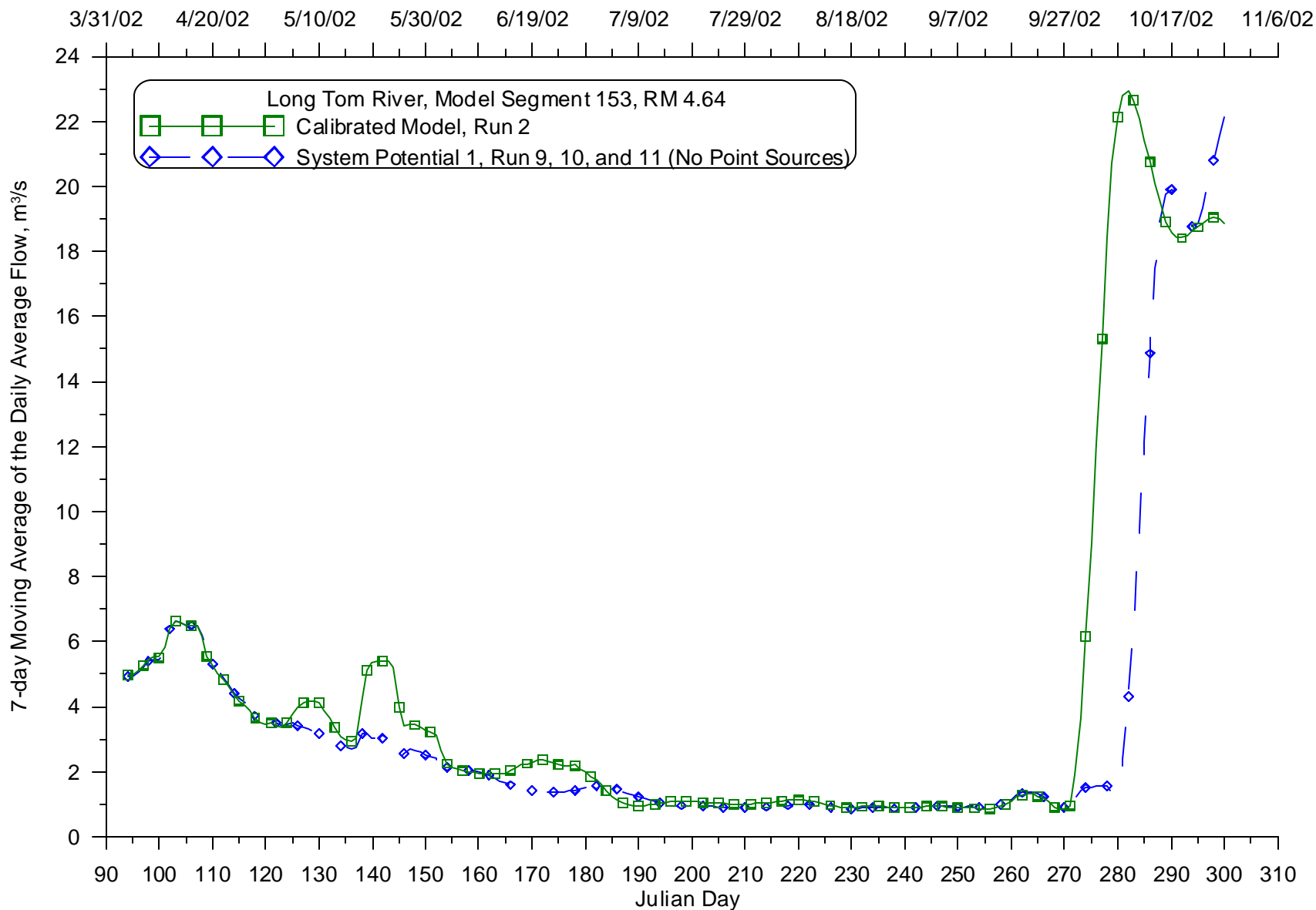


Figure 298: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the McKenzie River at RM 37.99

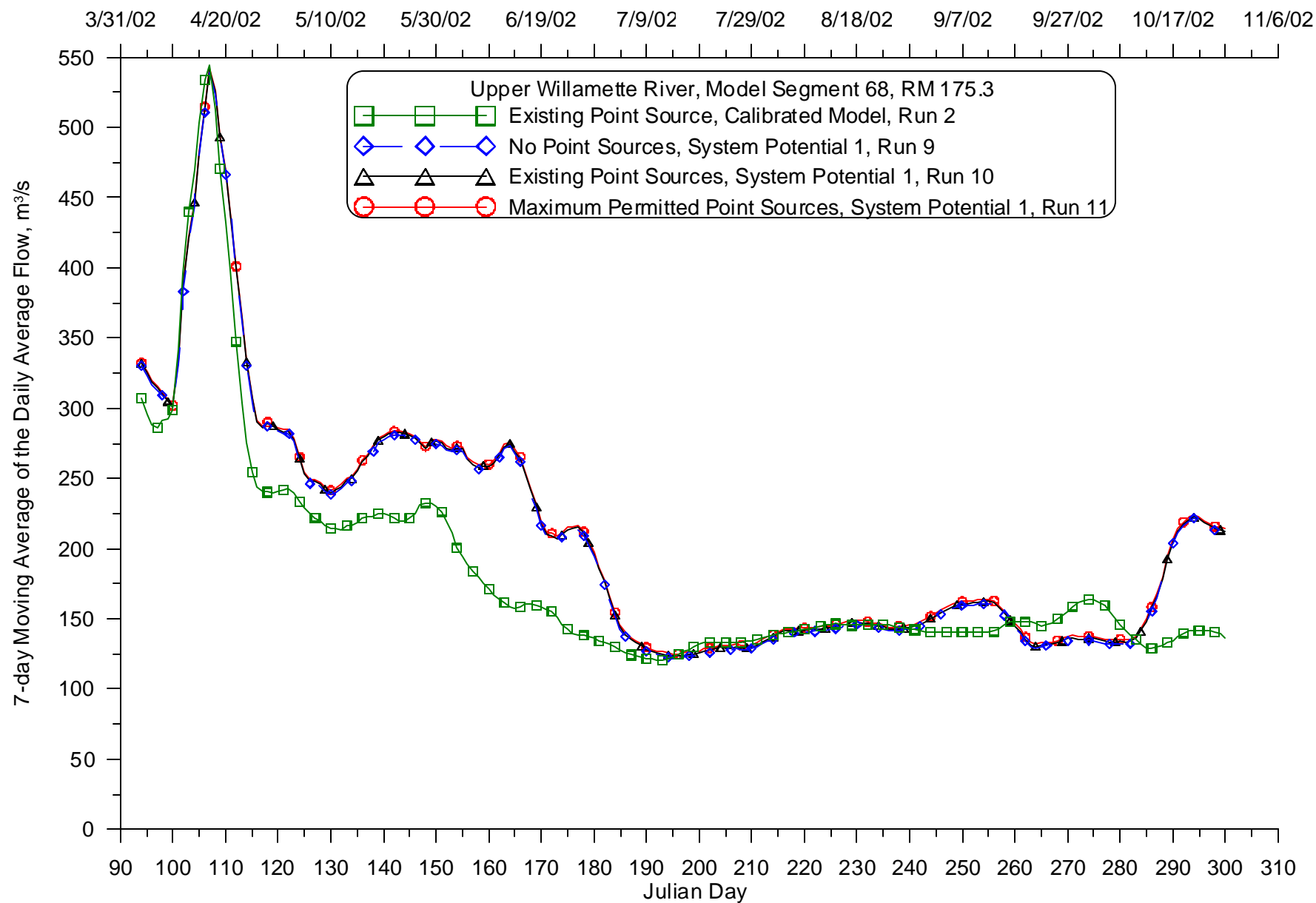




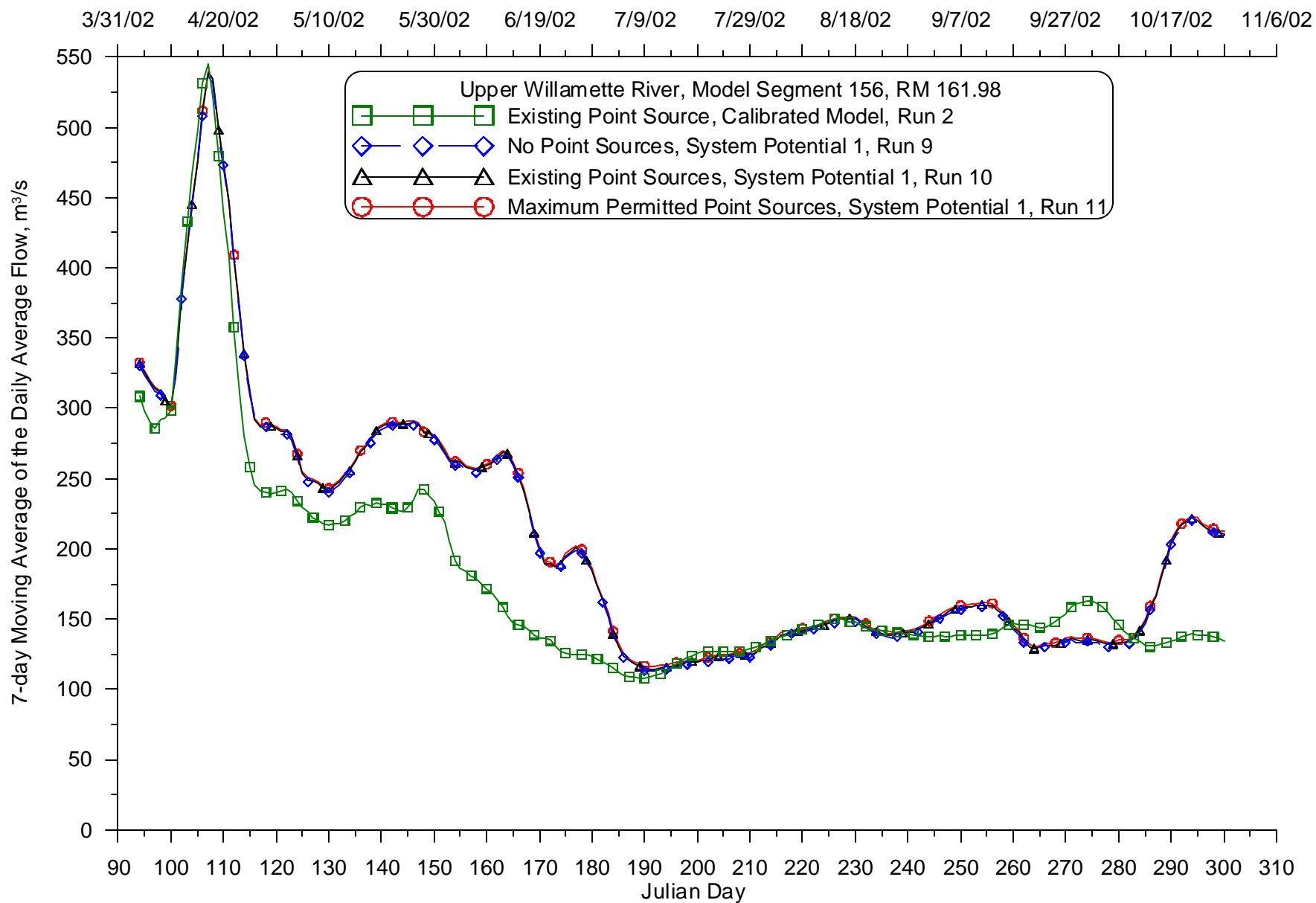
**Figure 299: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the McKenzie River at RM 9.75**



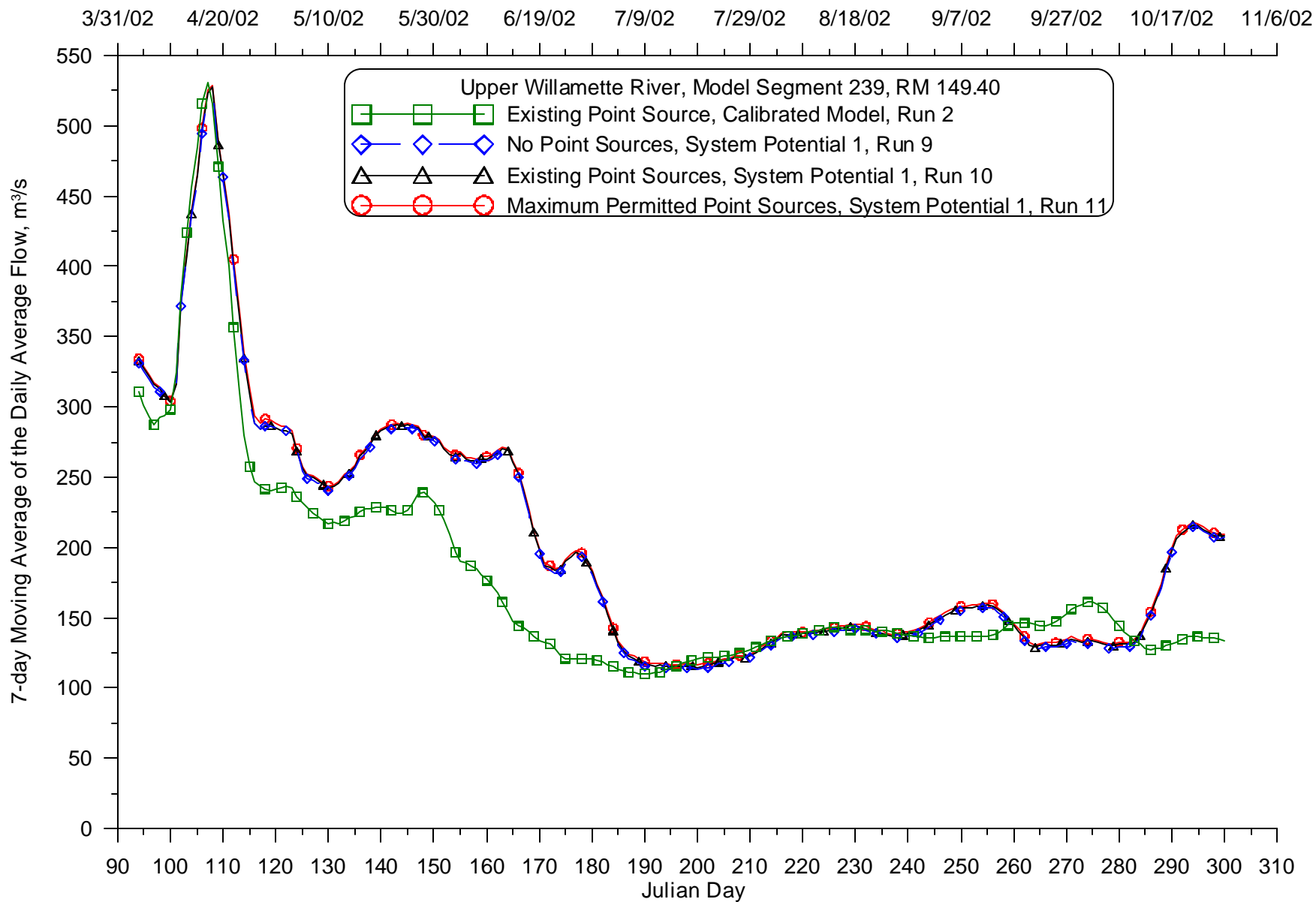
**Figure 300: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Long Tom River at RM 4.64**



**Figure 301: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 175.3**



**Figure 302: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 161.98**



**Figure 303: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 149.4**

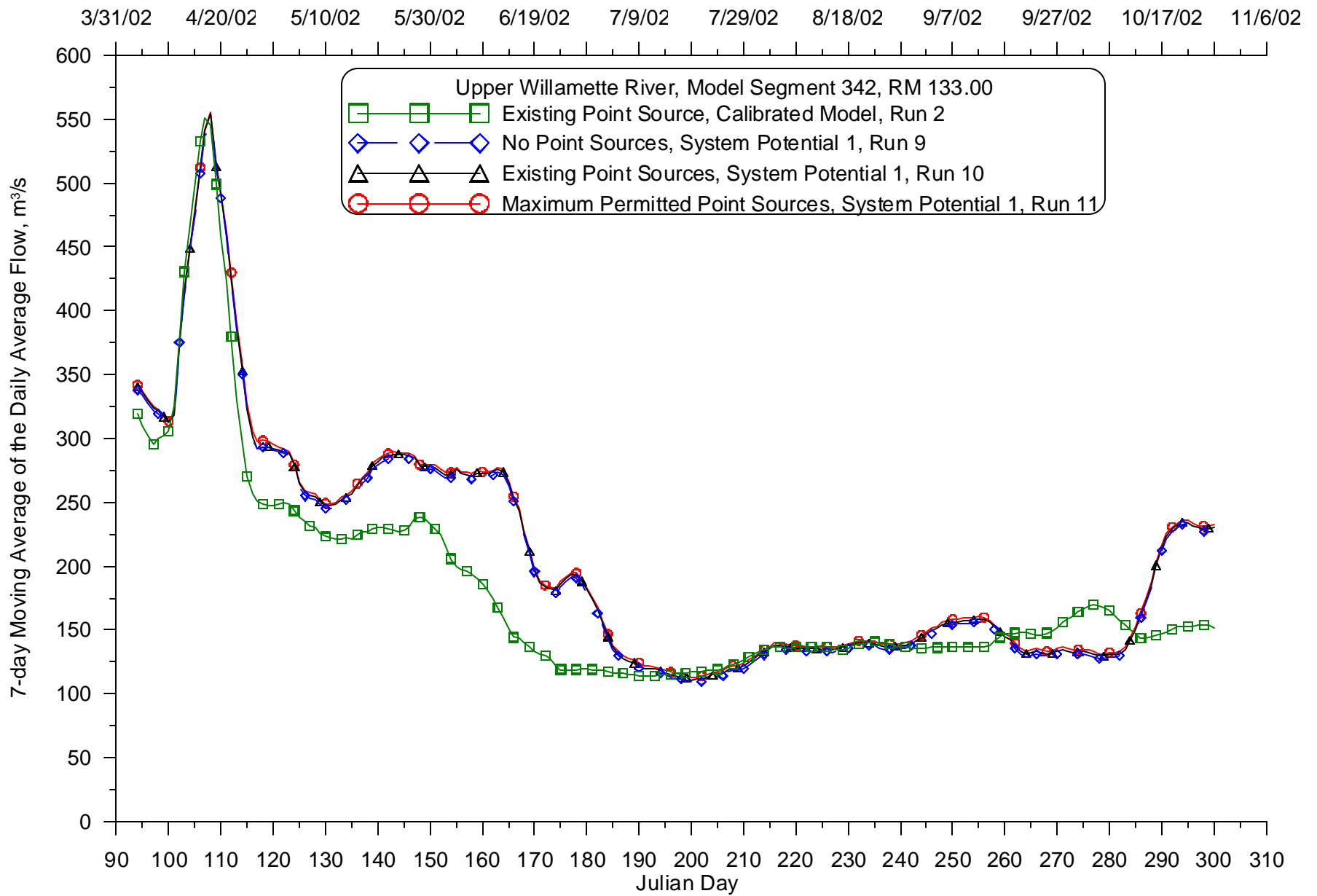


Figure 304: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 133

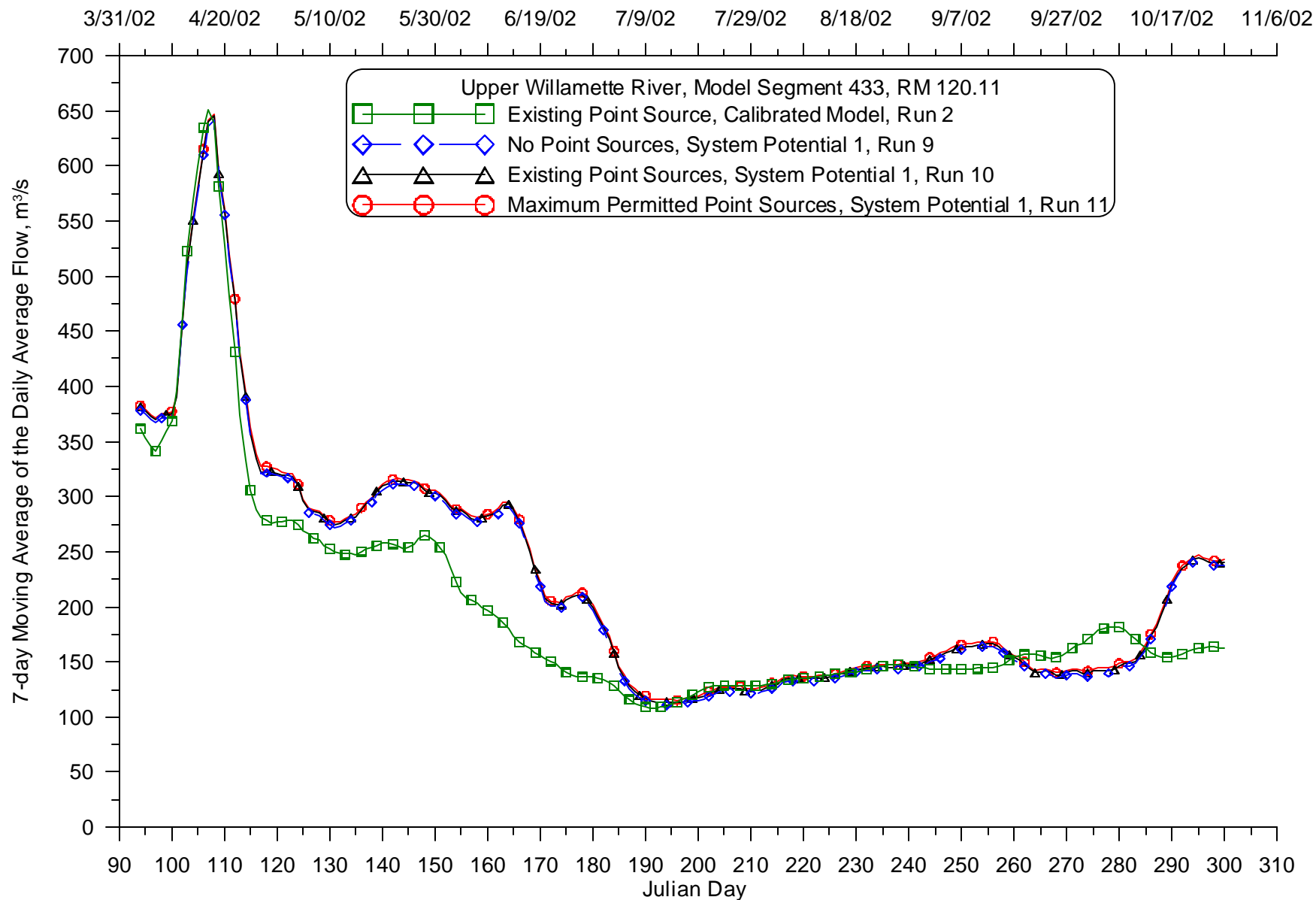


Figure 305: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 120.11

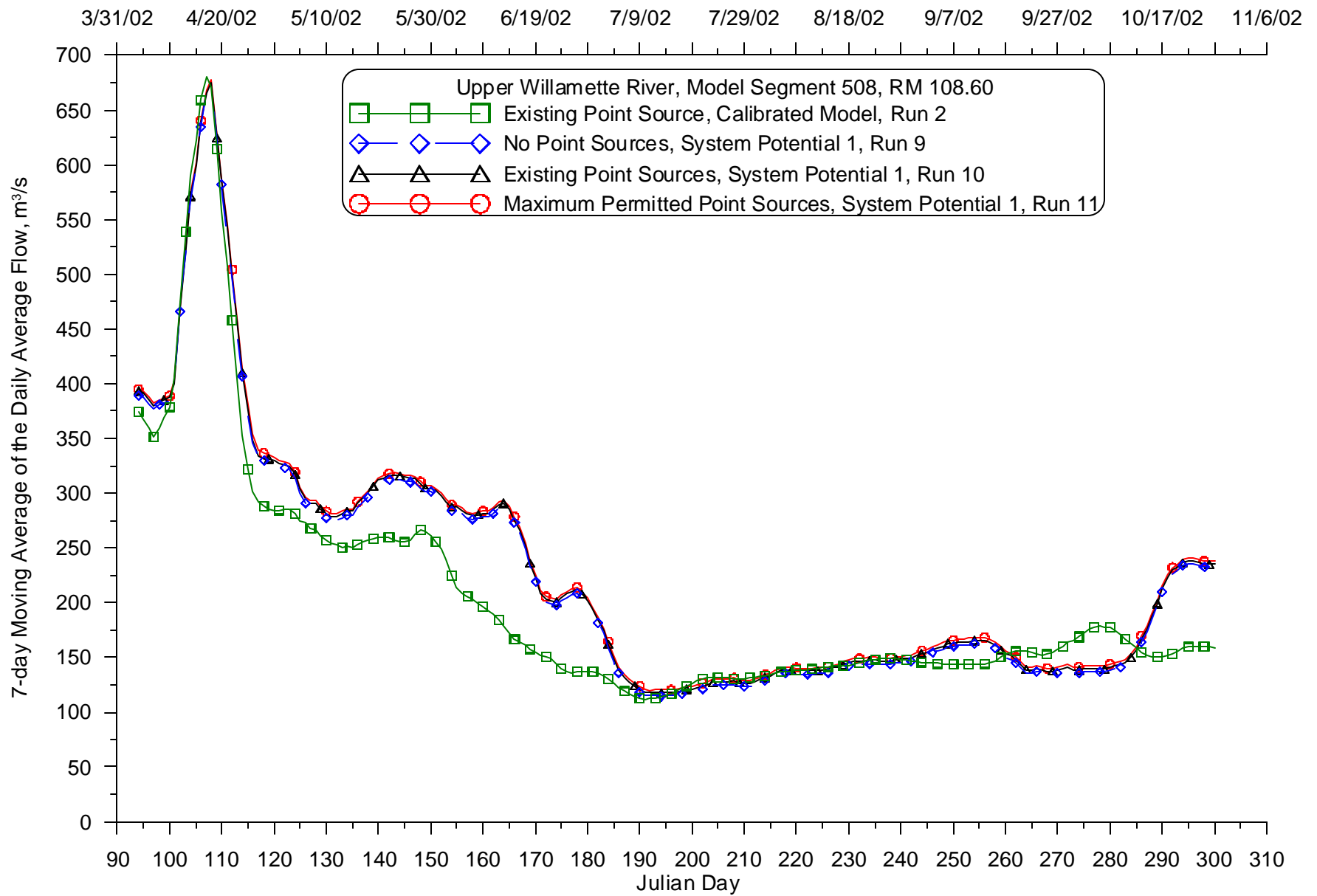


Figure 306: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 108.6



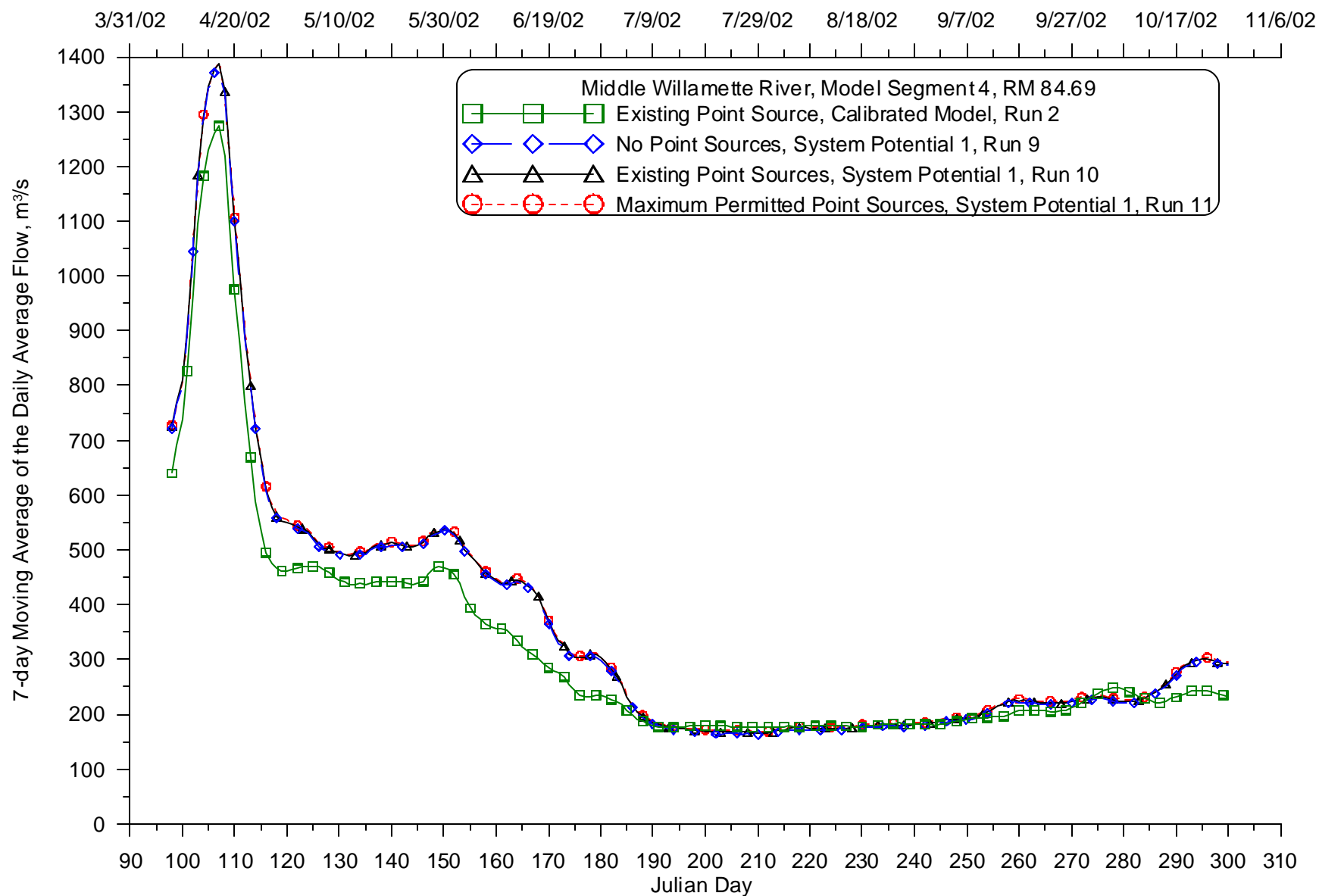
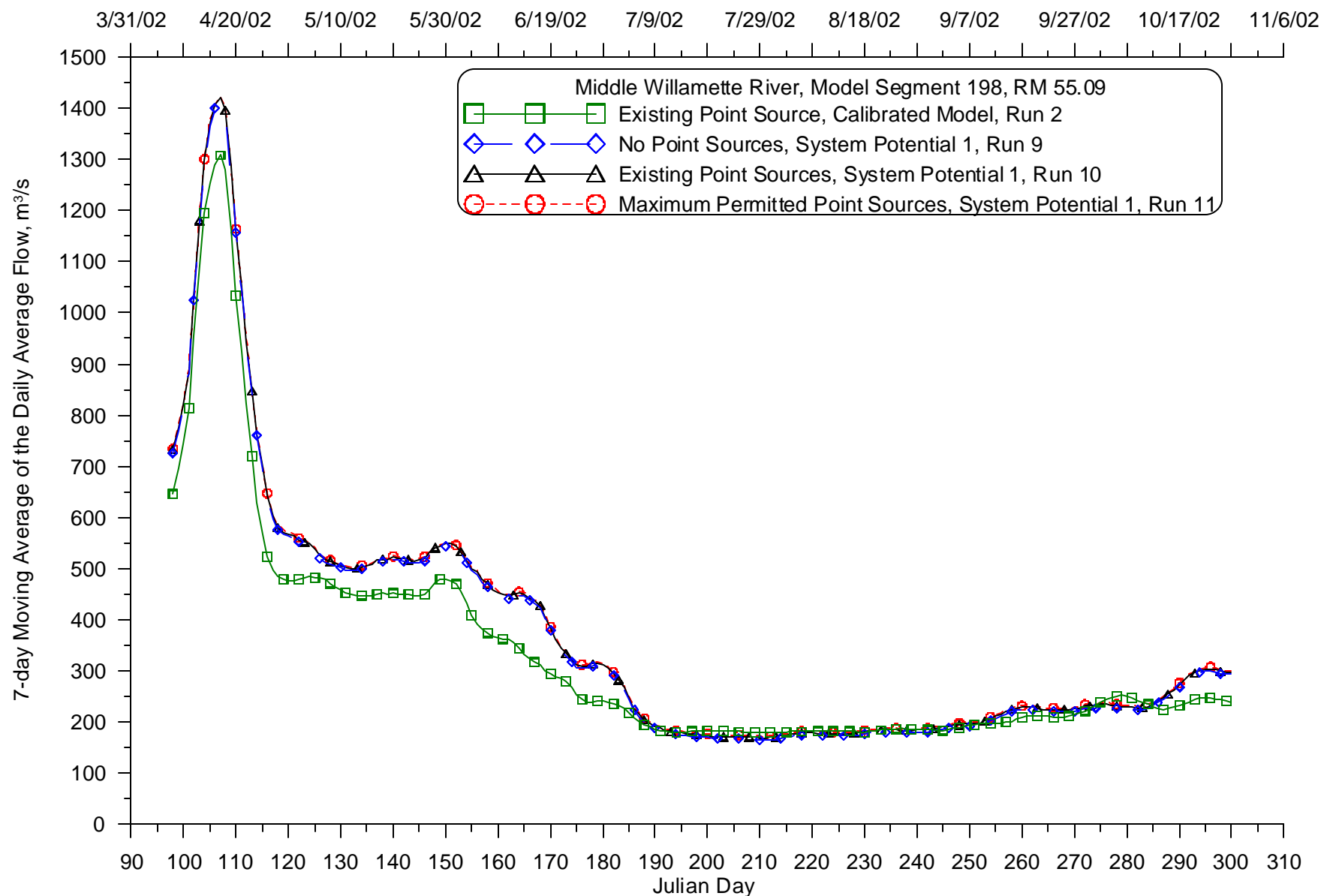
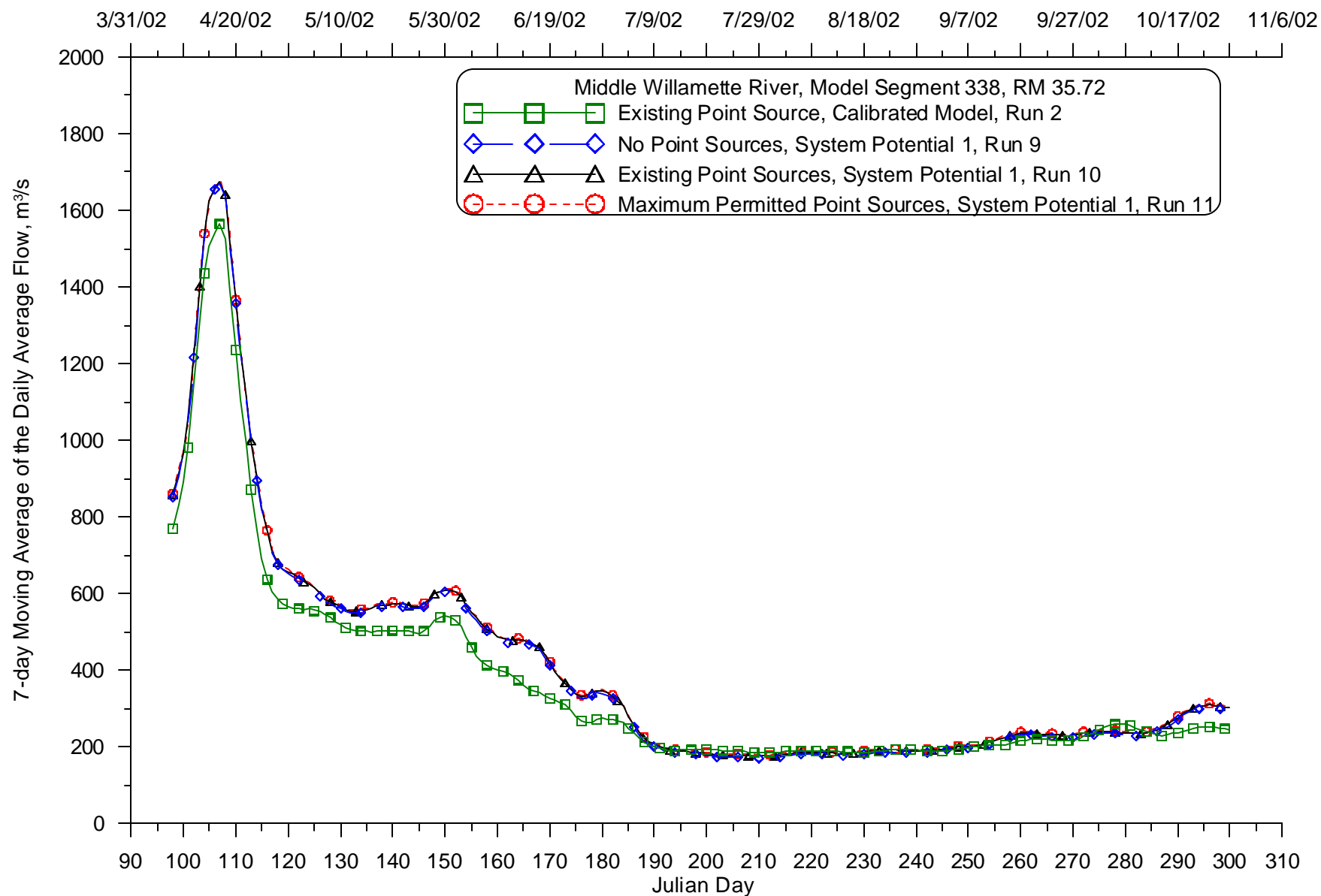


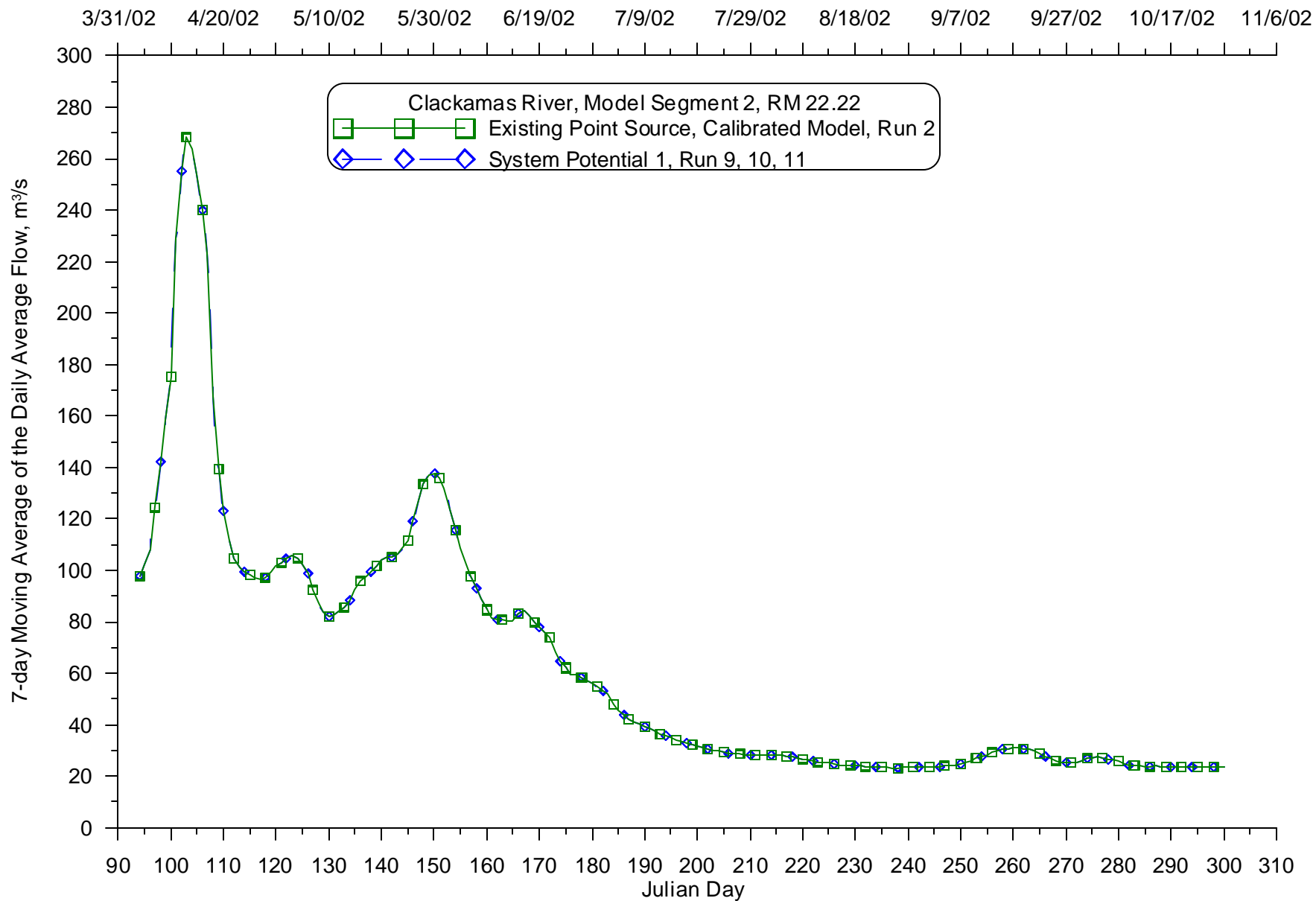
Figure 307: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 84.69



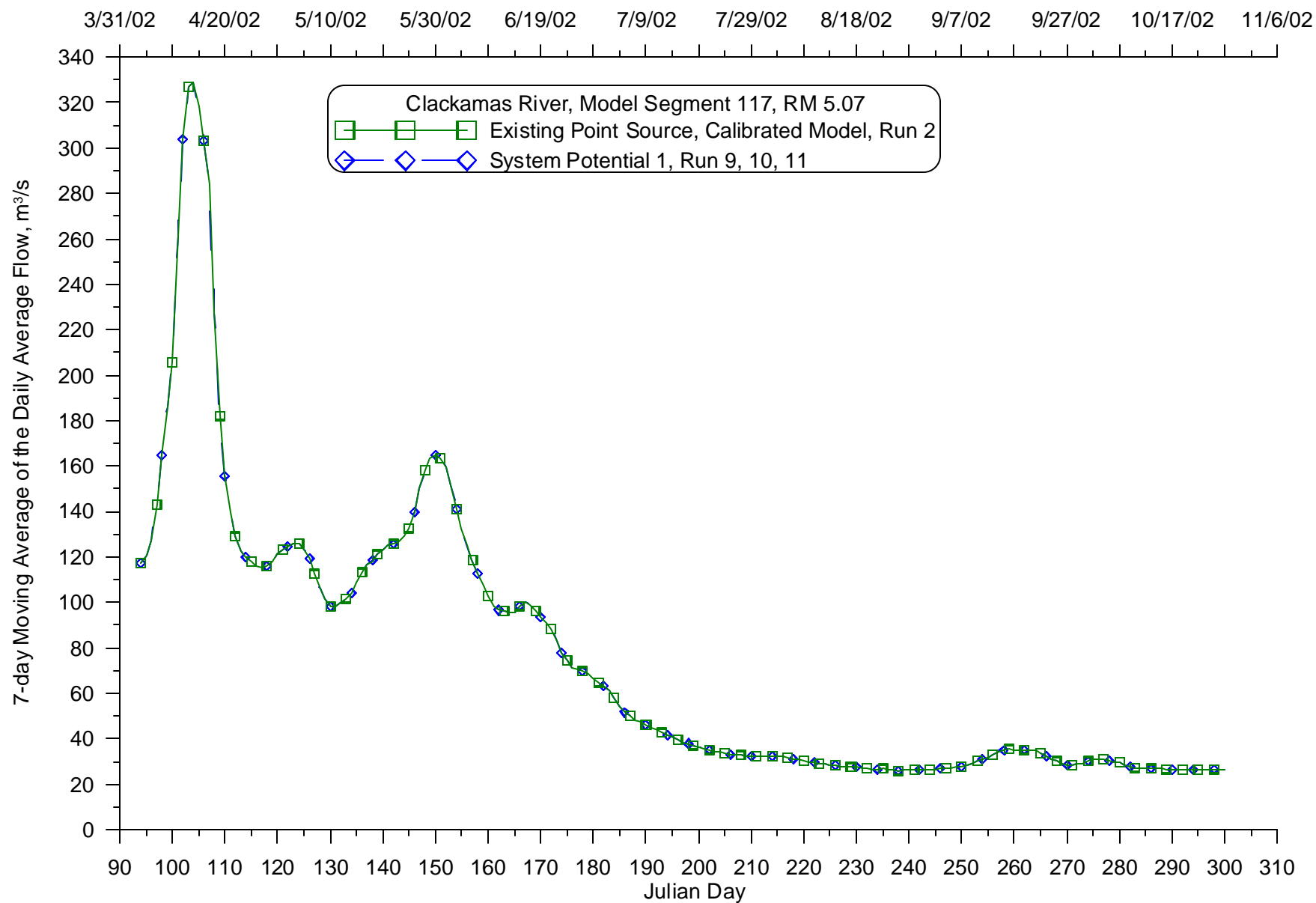
**Figure 308: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 55.09**



**Figure 309: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 35.72**



**Figure 310: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Clackamas River at RM 22.22**



**Figure 311: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Clackamas River at RM 5.07**

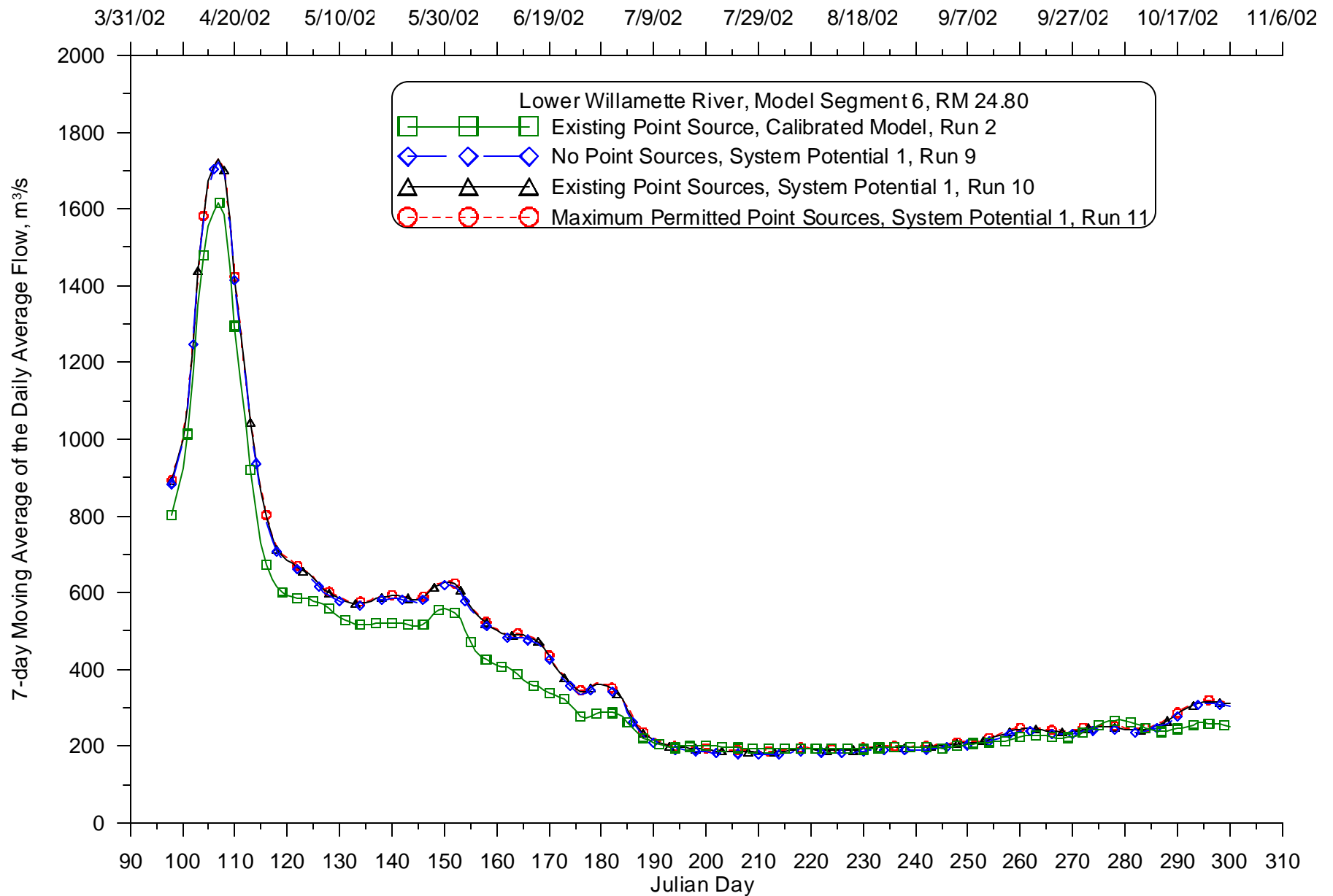
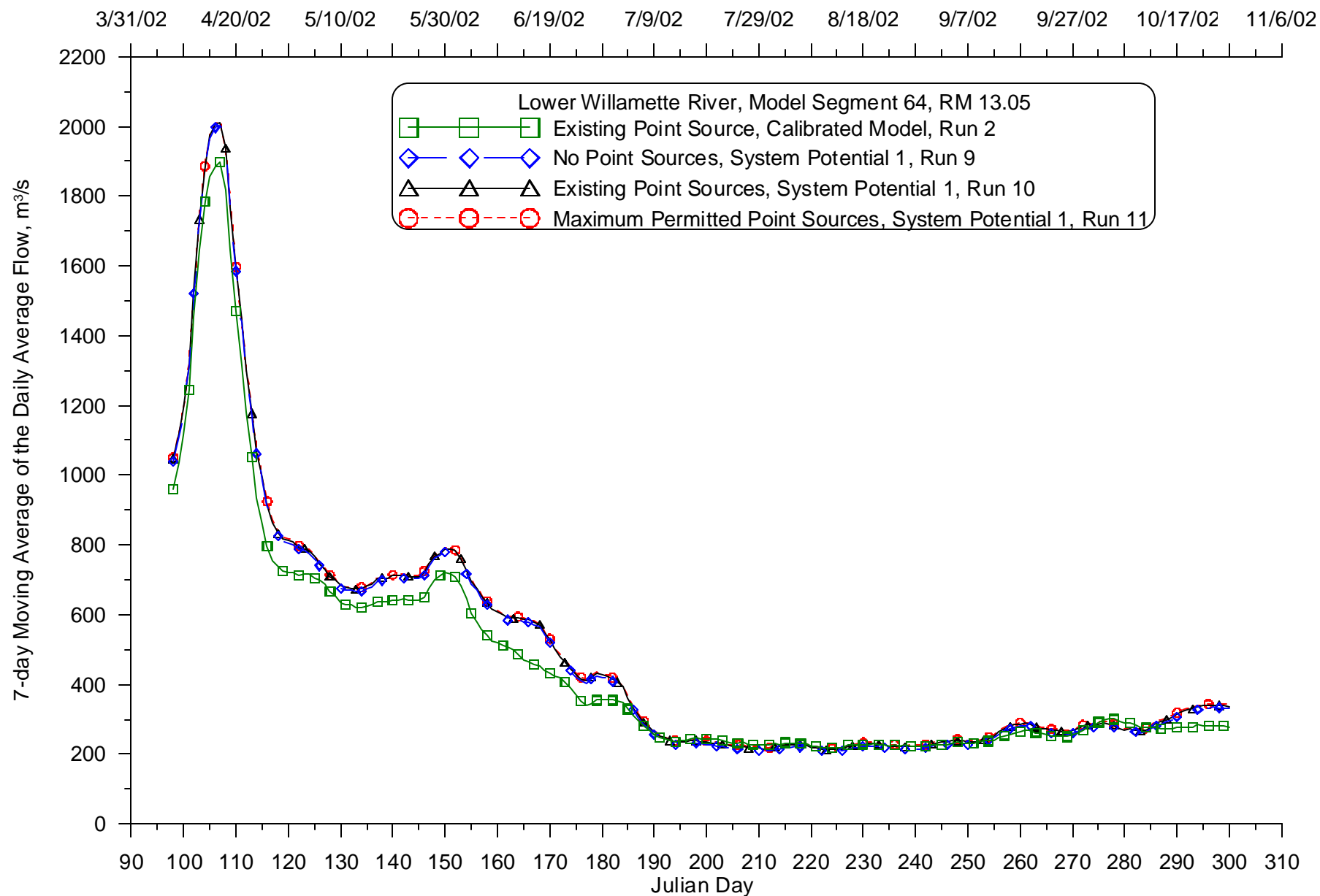
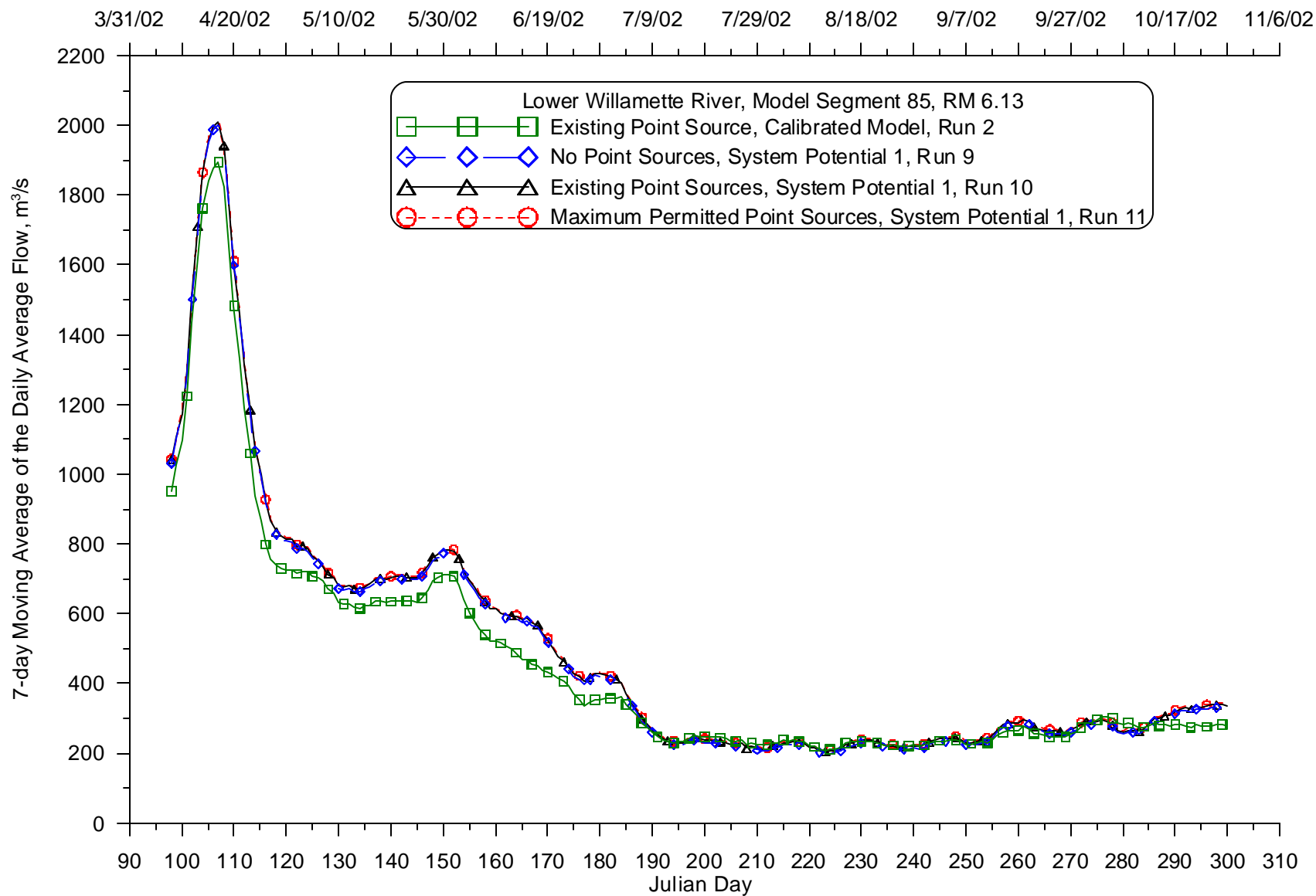


Figure 312: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 24.8



**Figure 313: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 13.05**



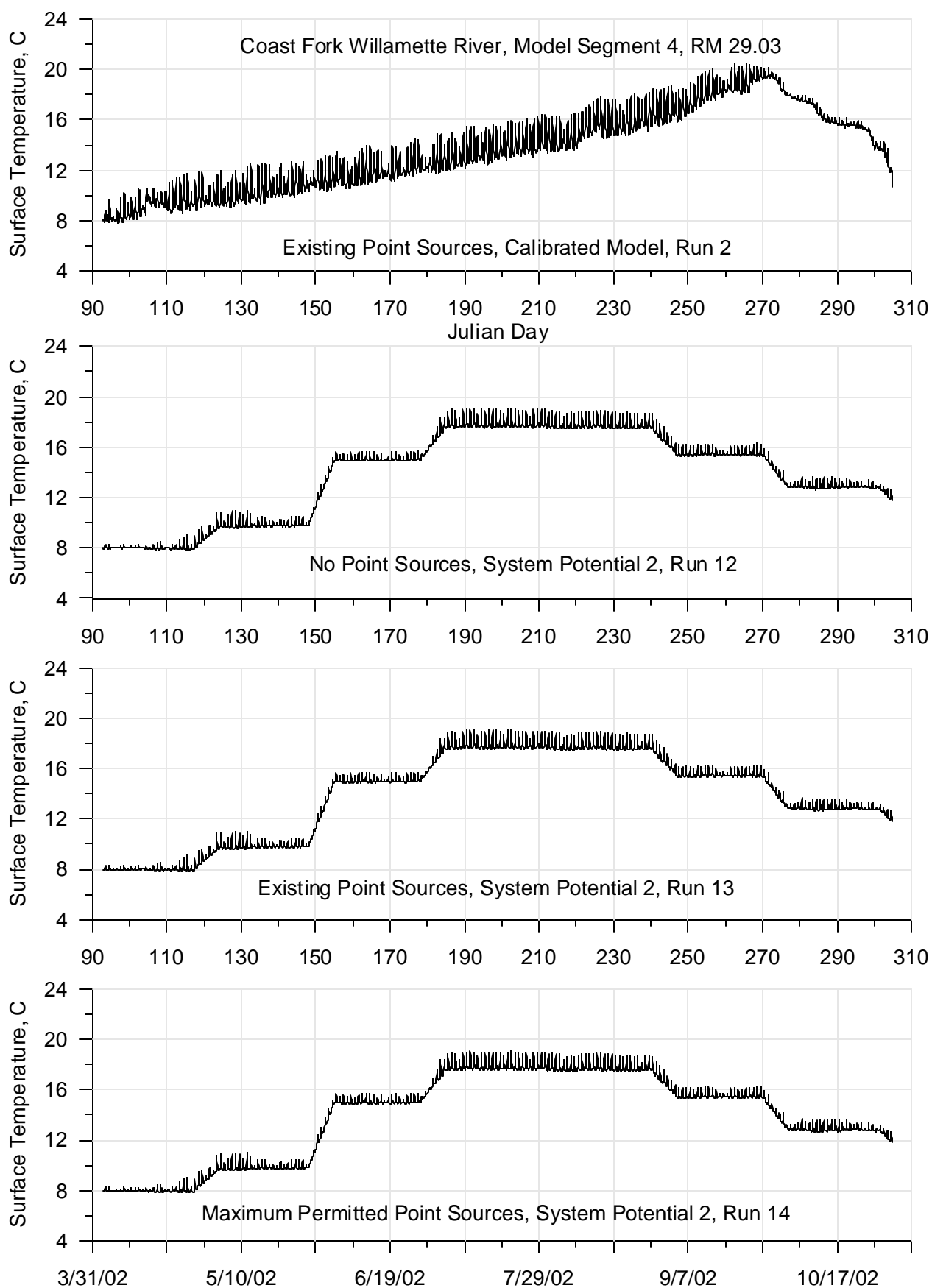
**Figure 314: Calibrated model and System Potential 1 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 6.13**



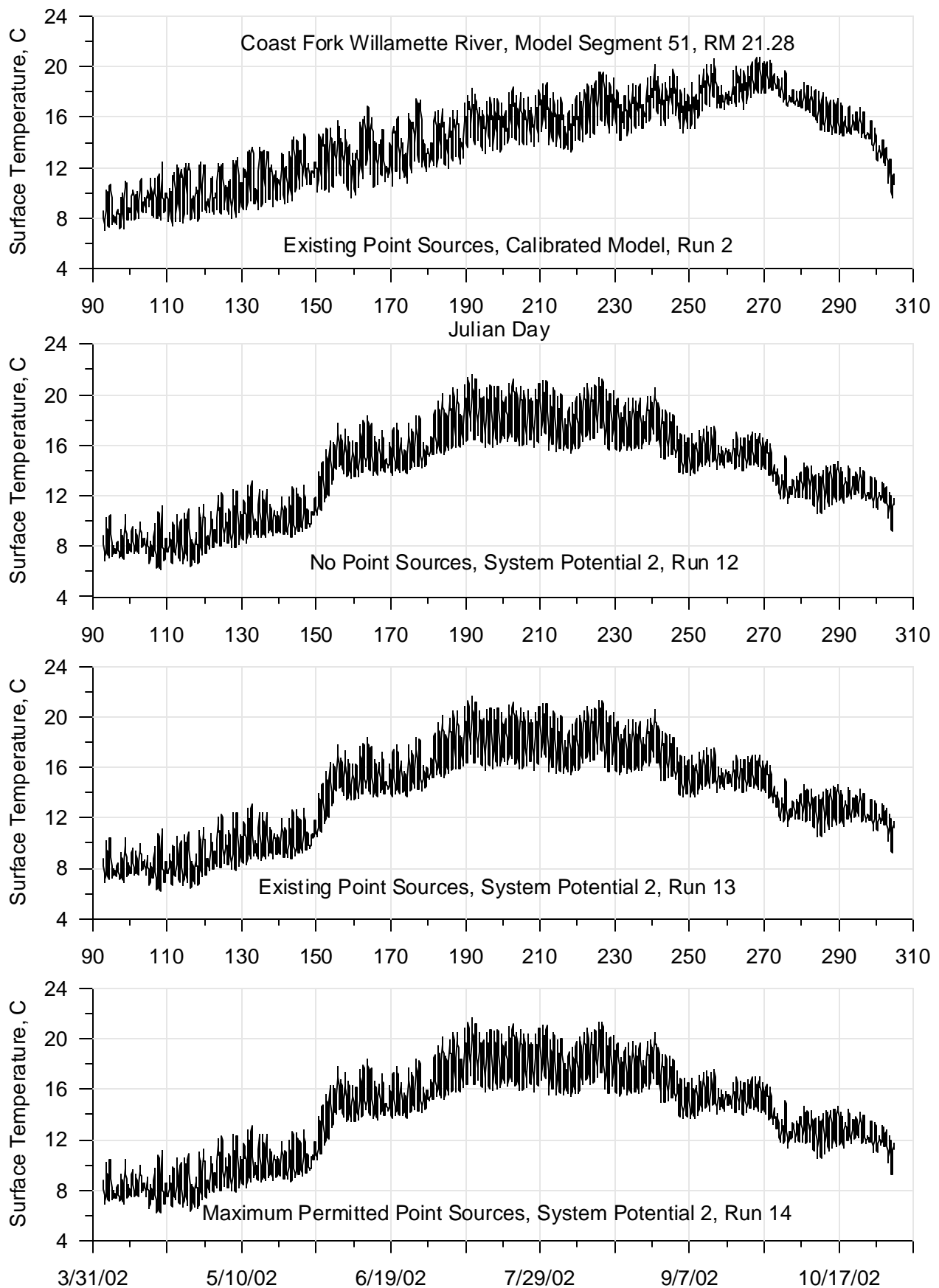
## ***System Potential 2, 2002***

System Potential 2 (ODEQ, 2003) was run for the summer of 2002 for three scenarios with varying discharges from the large point sources in the Willamette River system. The point sources were simulated as having no discharge, their current discharge in 2001, and their maximum permitted discharge. These results were then compared with the results of the calibrated model in a series of time series plots. There are four types of time series output for each of the 21 locations identified above in Table 2: continuous temperature, continuous flow, the seven-day moving average of the daily maximum temperature, and the seven-day average of daily average flow.

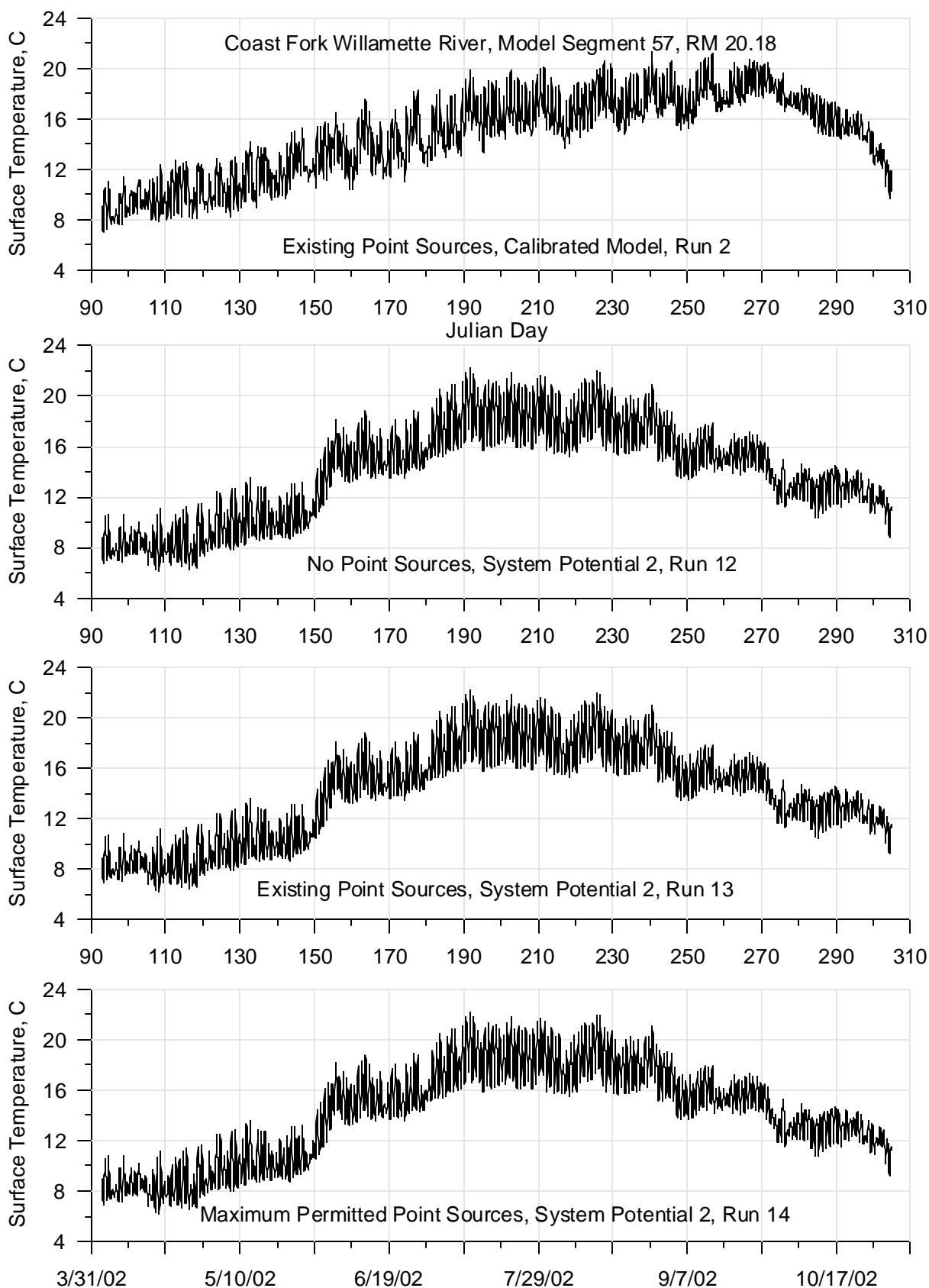
### **Continuous Temperature**



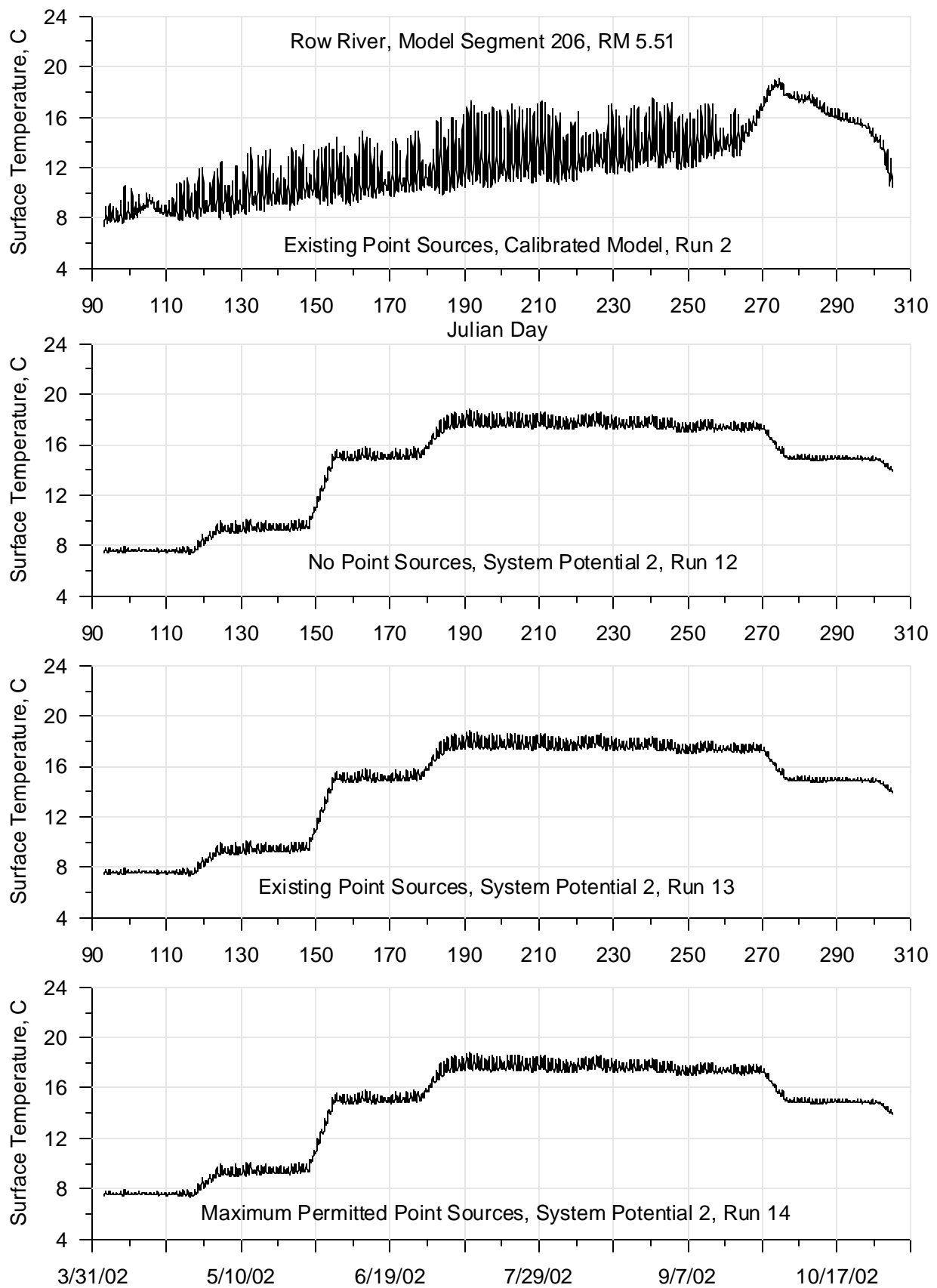
**Figure 315: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Coast Fork Willamette River at RM 29.03**



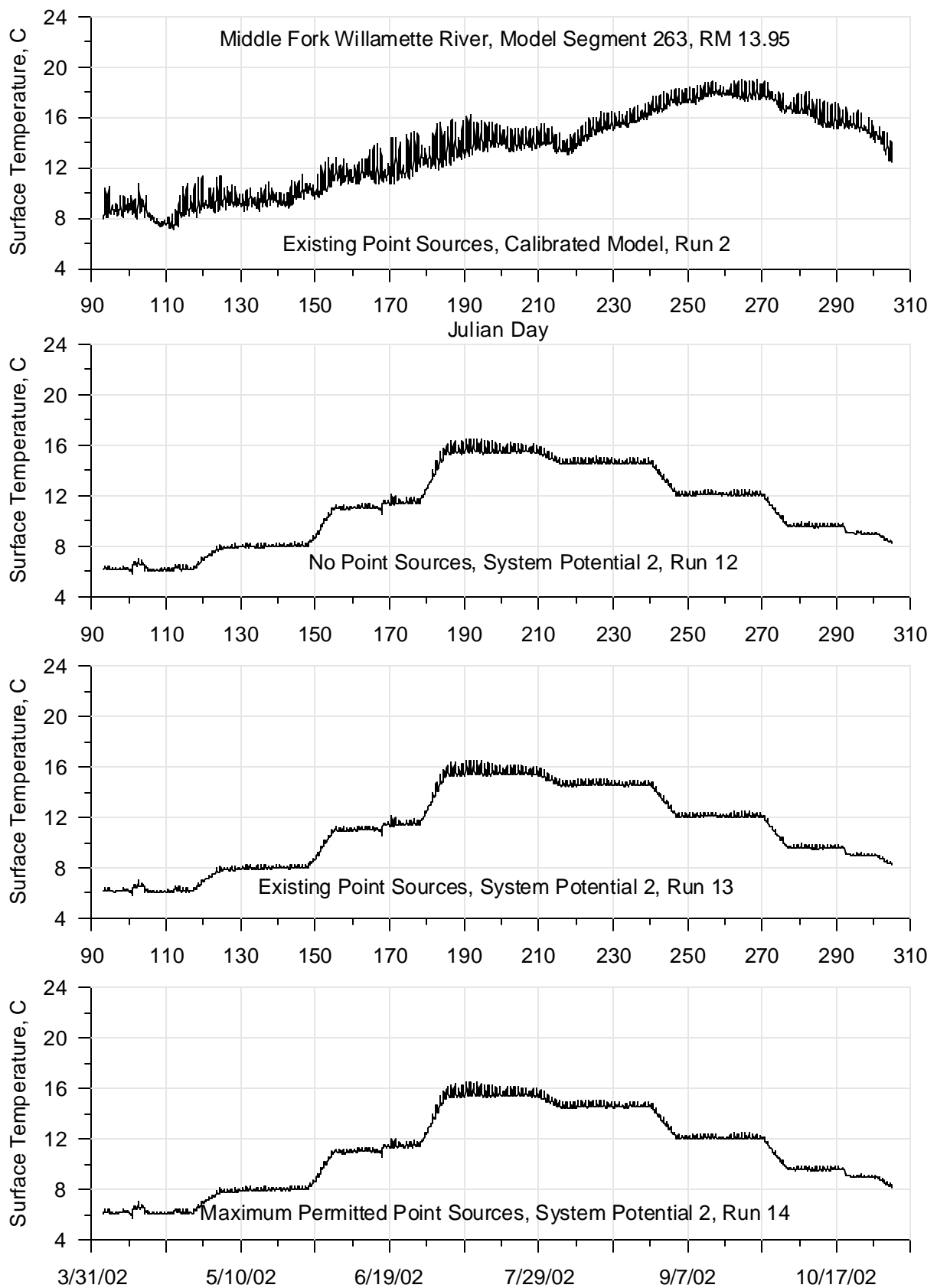
**Figure 316: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Coast Fork Willamette River at RM 21.28**



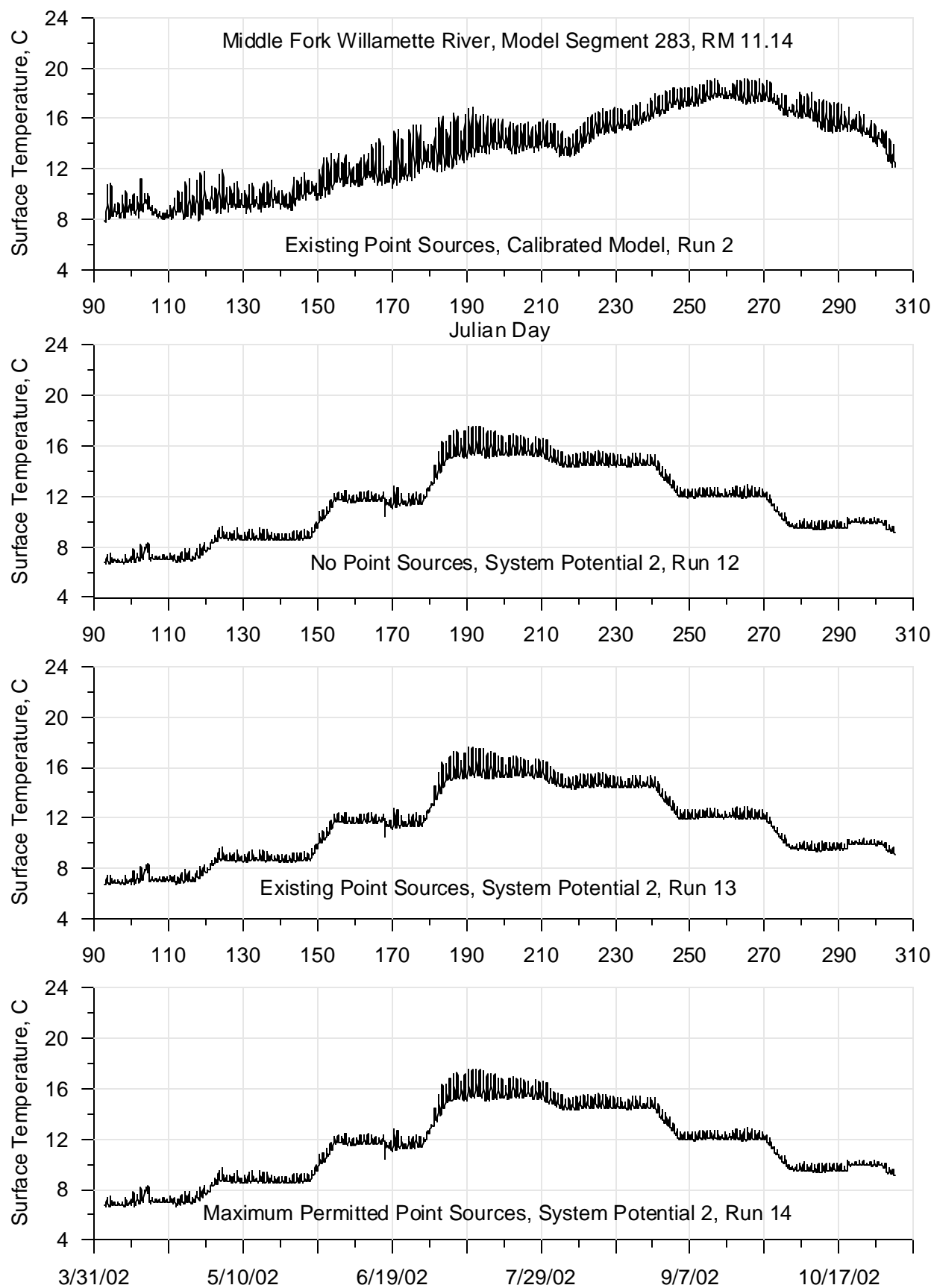
**Figure 317: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Coast Fork Willamette River at RM 20.18**



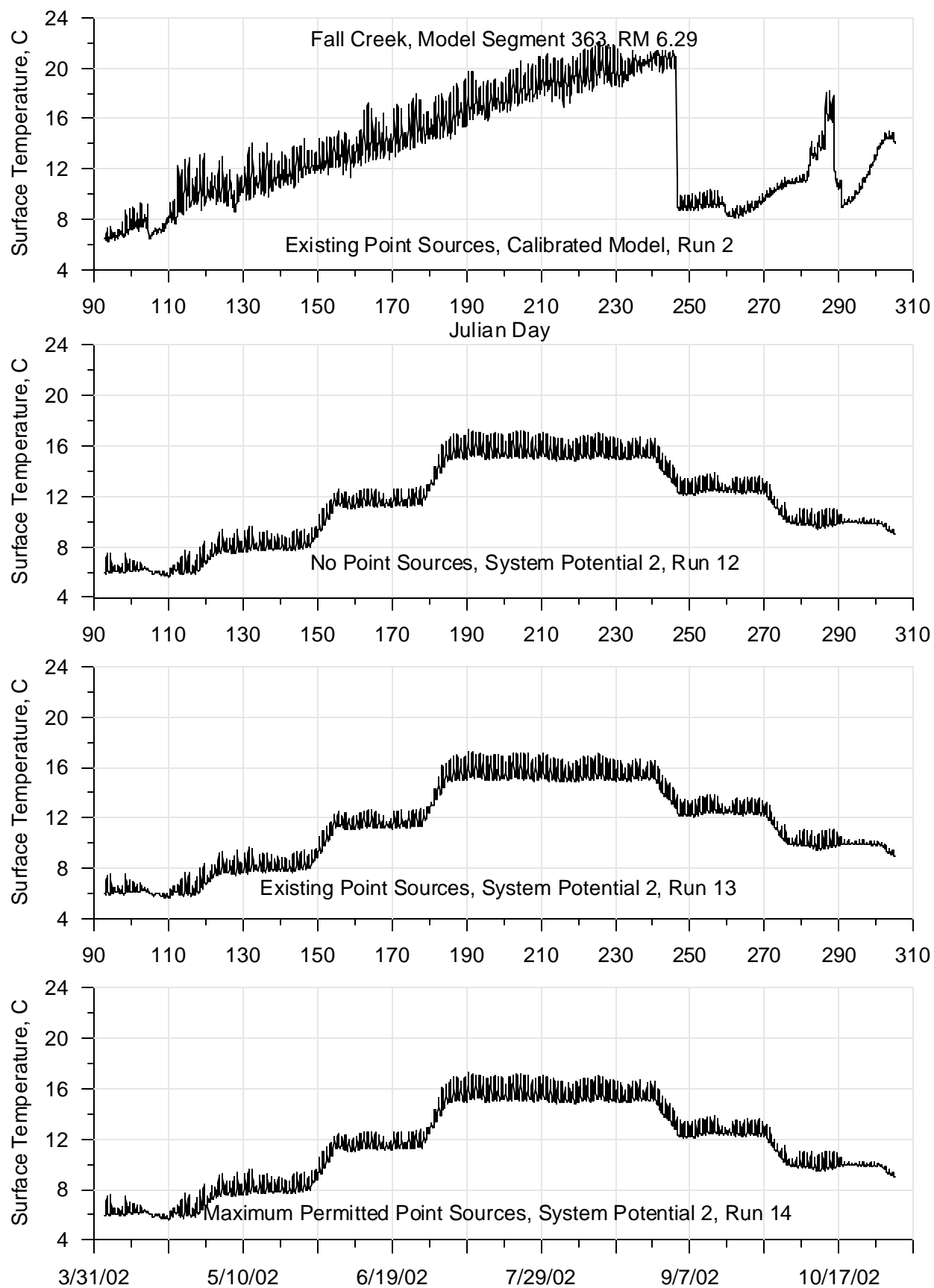
**Figure 318: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Row River at RM 5.51**



**Figure 319: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Middle Fork Willamette River at RM 13.95**

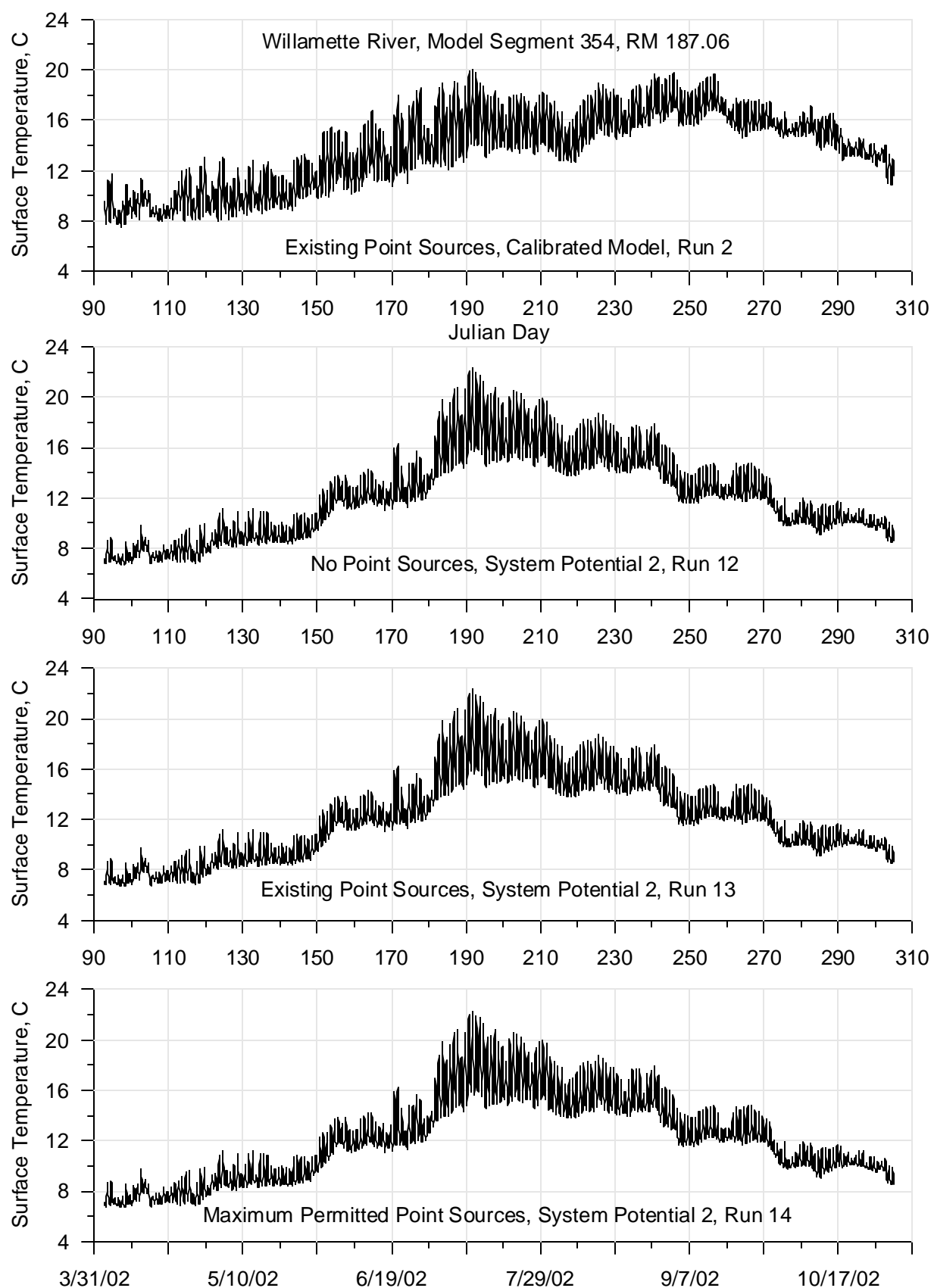


**Figure 320: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Middle Fork Willamette River at RM 11.14**

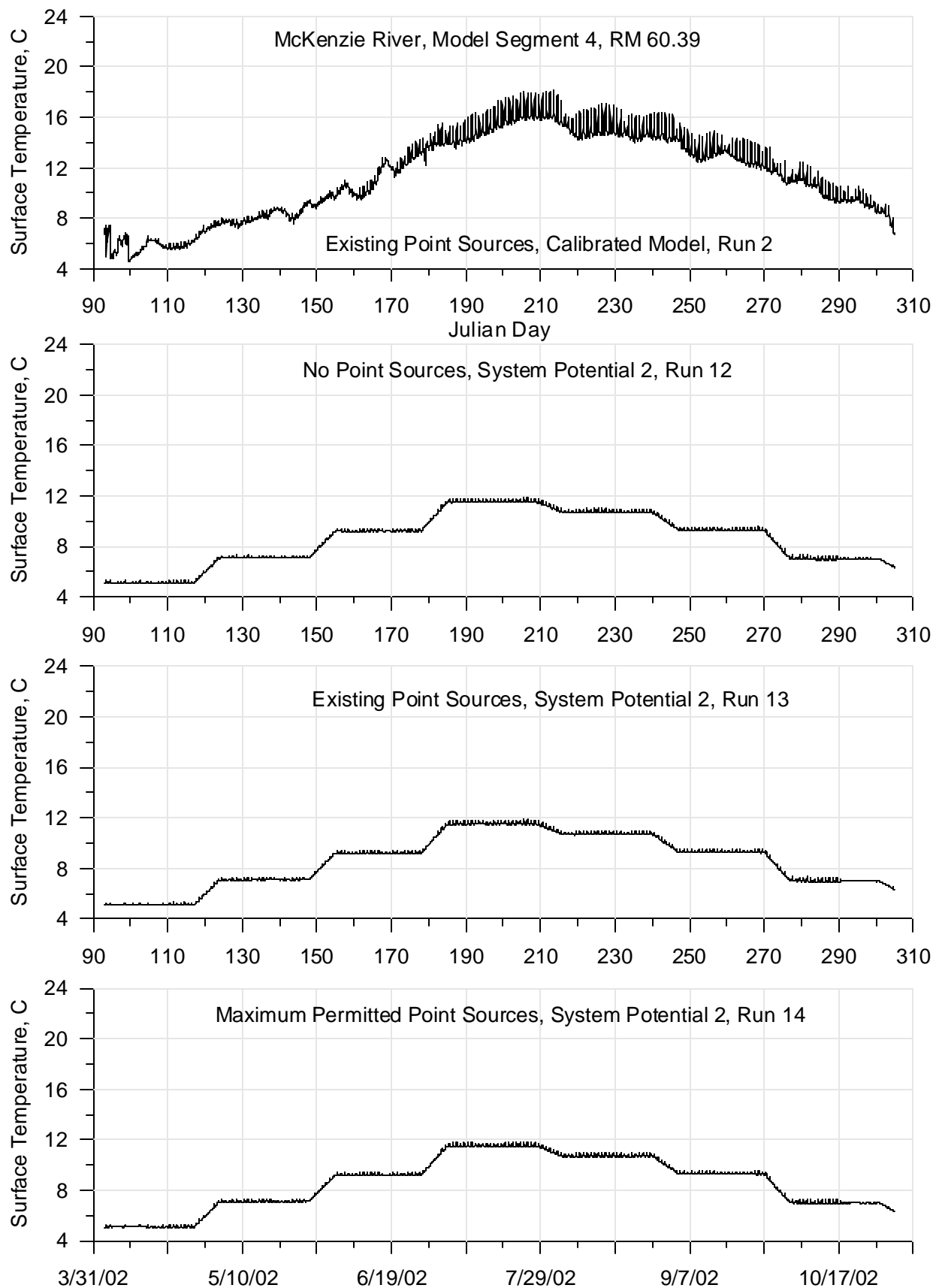


**Figure 321: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for Fall Creek at RM 6.29**

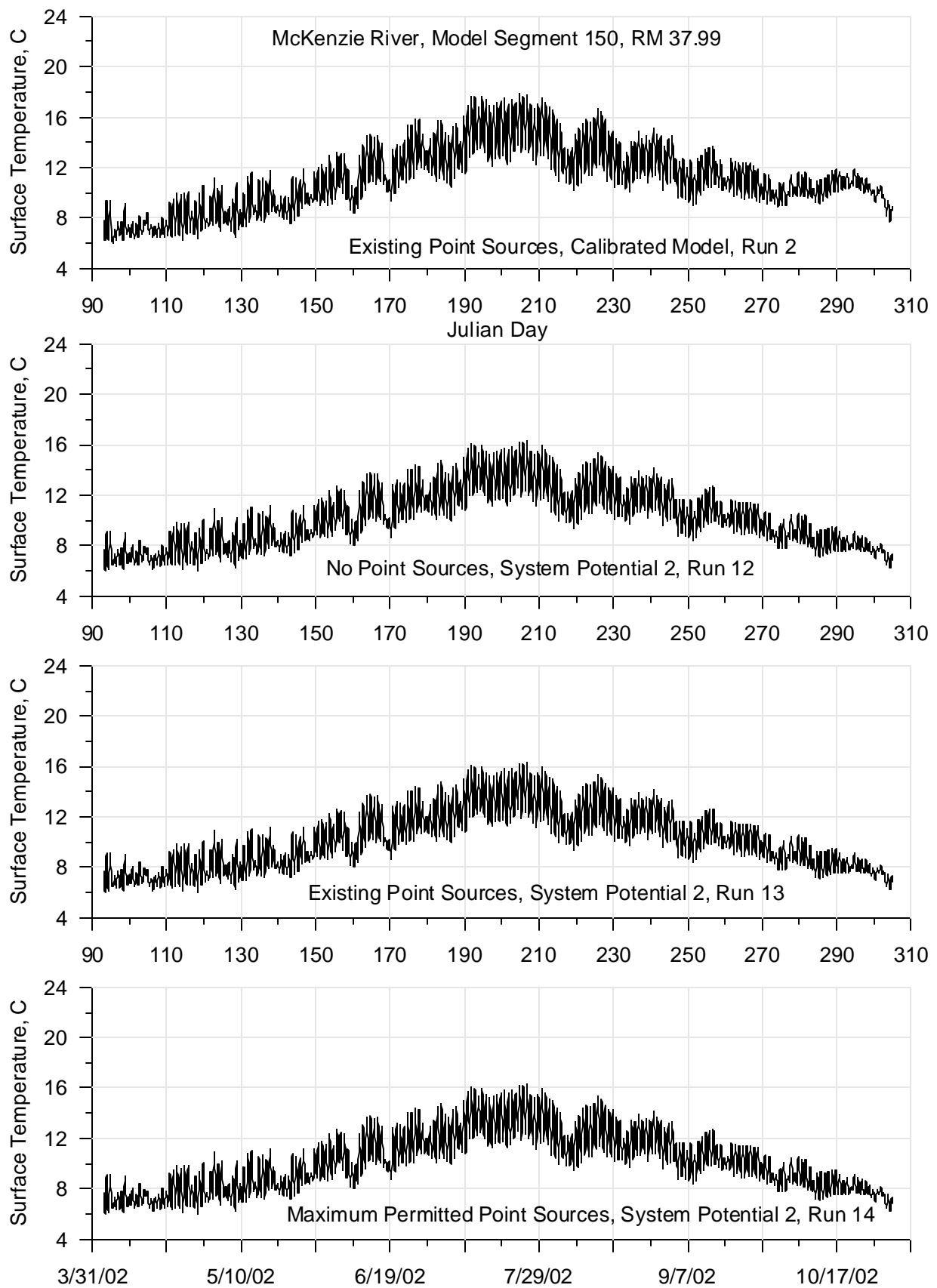




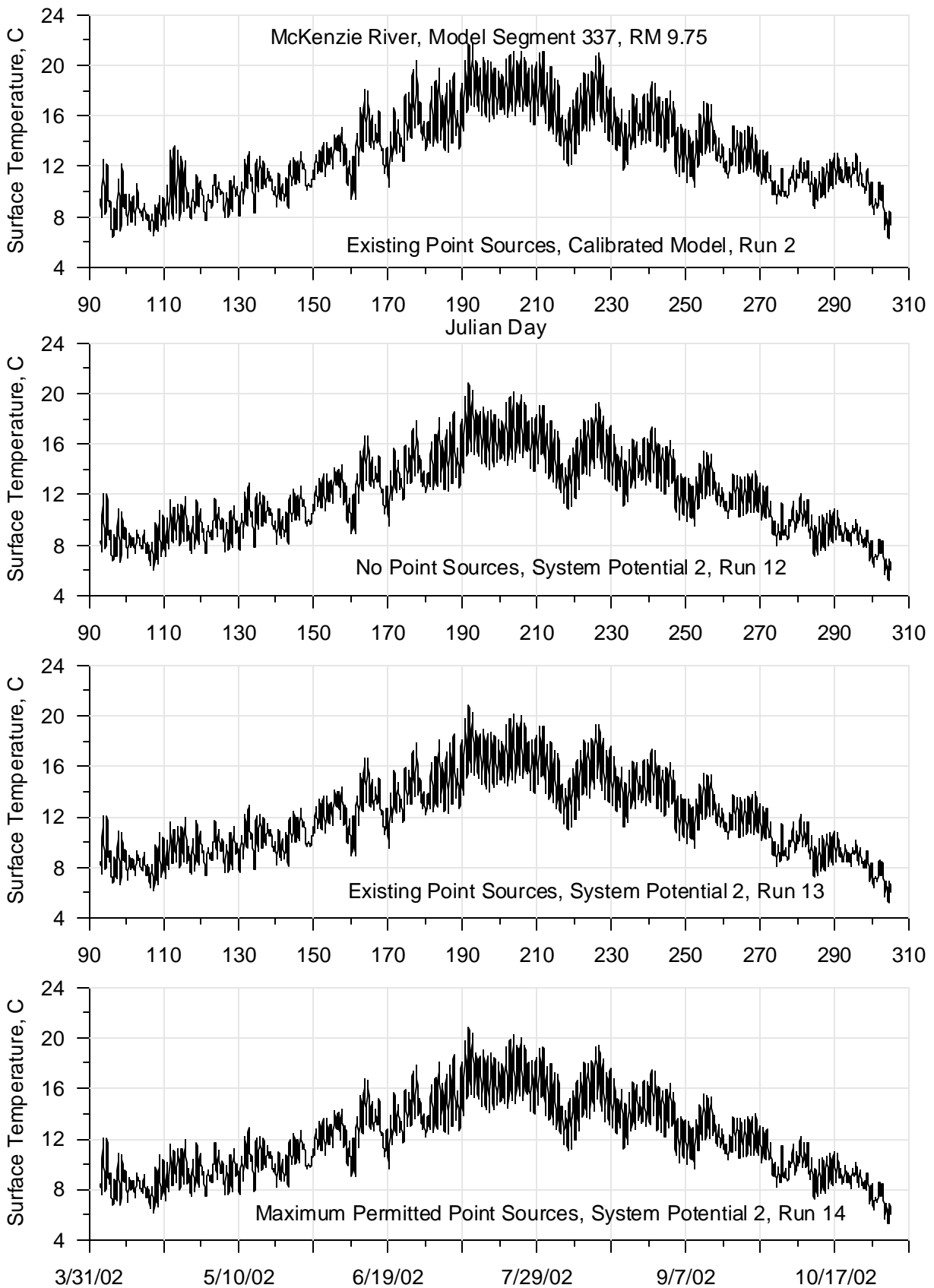
**Figure 322: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 187.06**



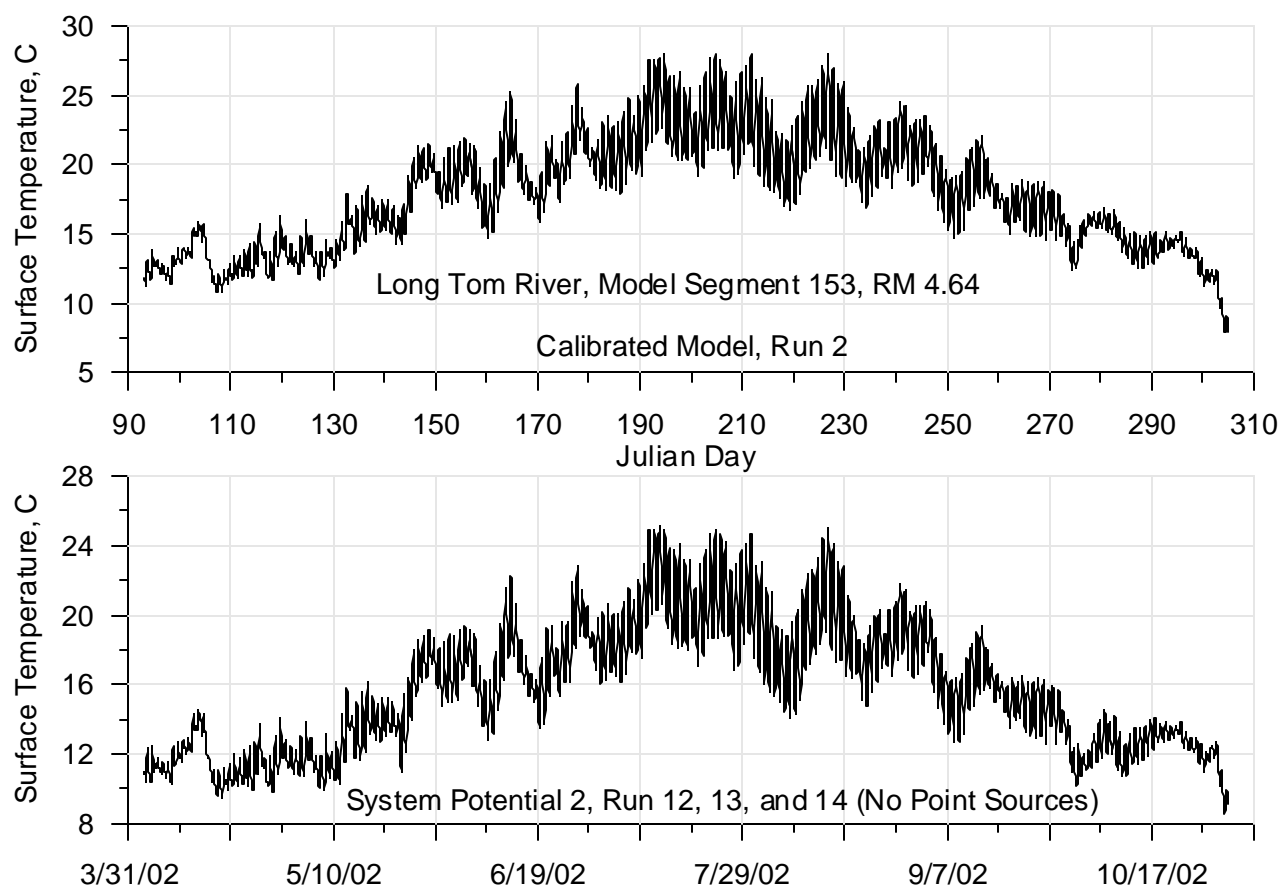
**Figure 323: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the McKenzie River at RM 60.39**



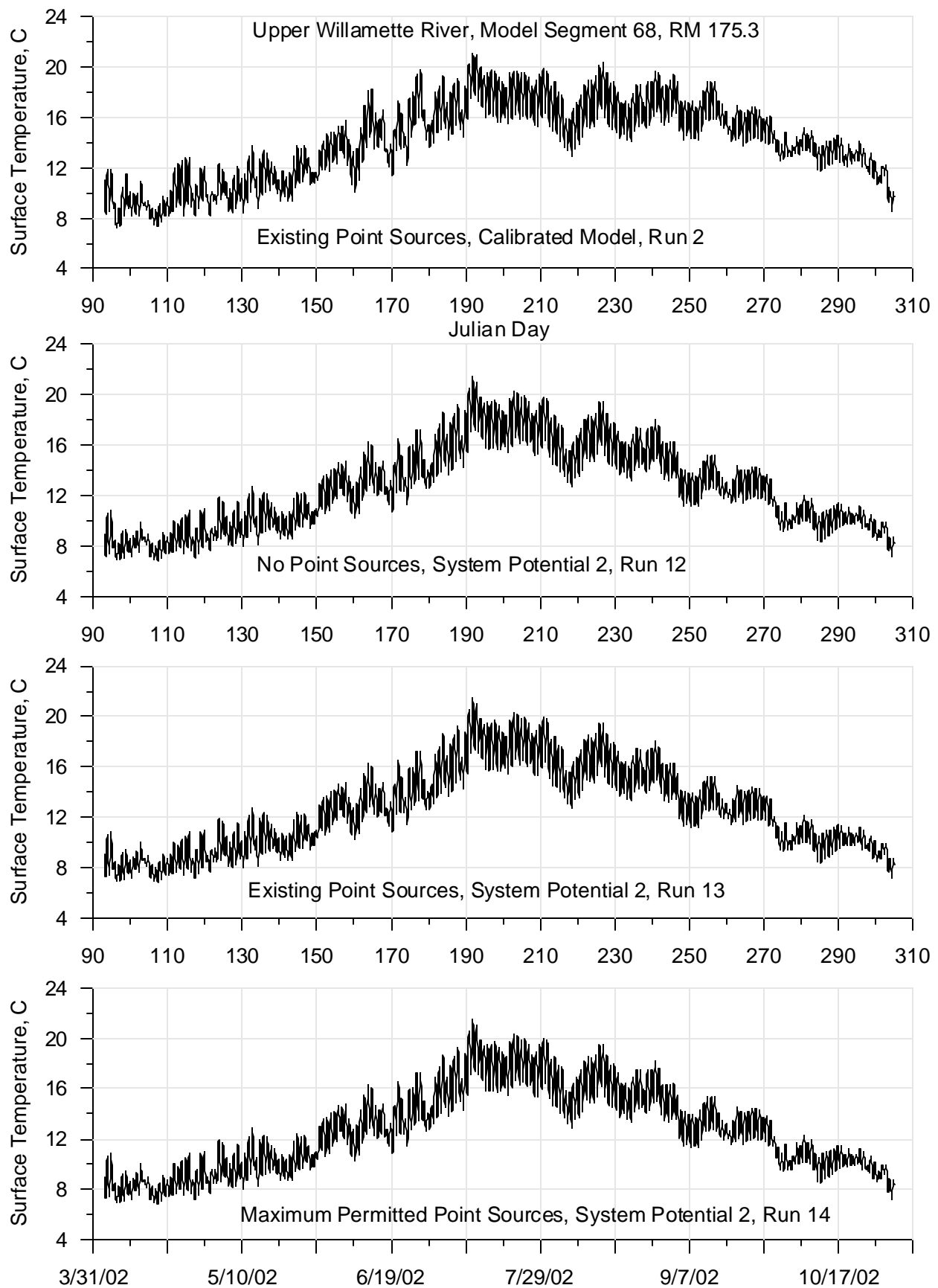
**Figure 324: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the McKenzie River at RM 37.99**



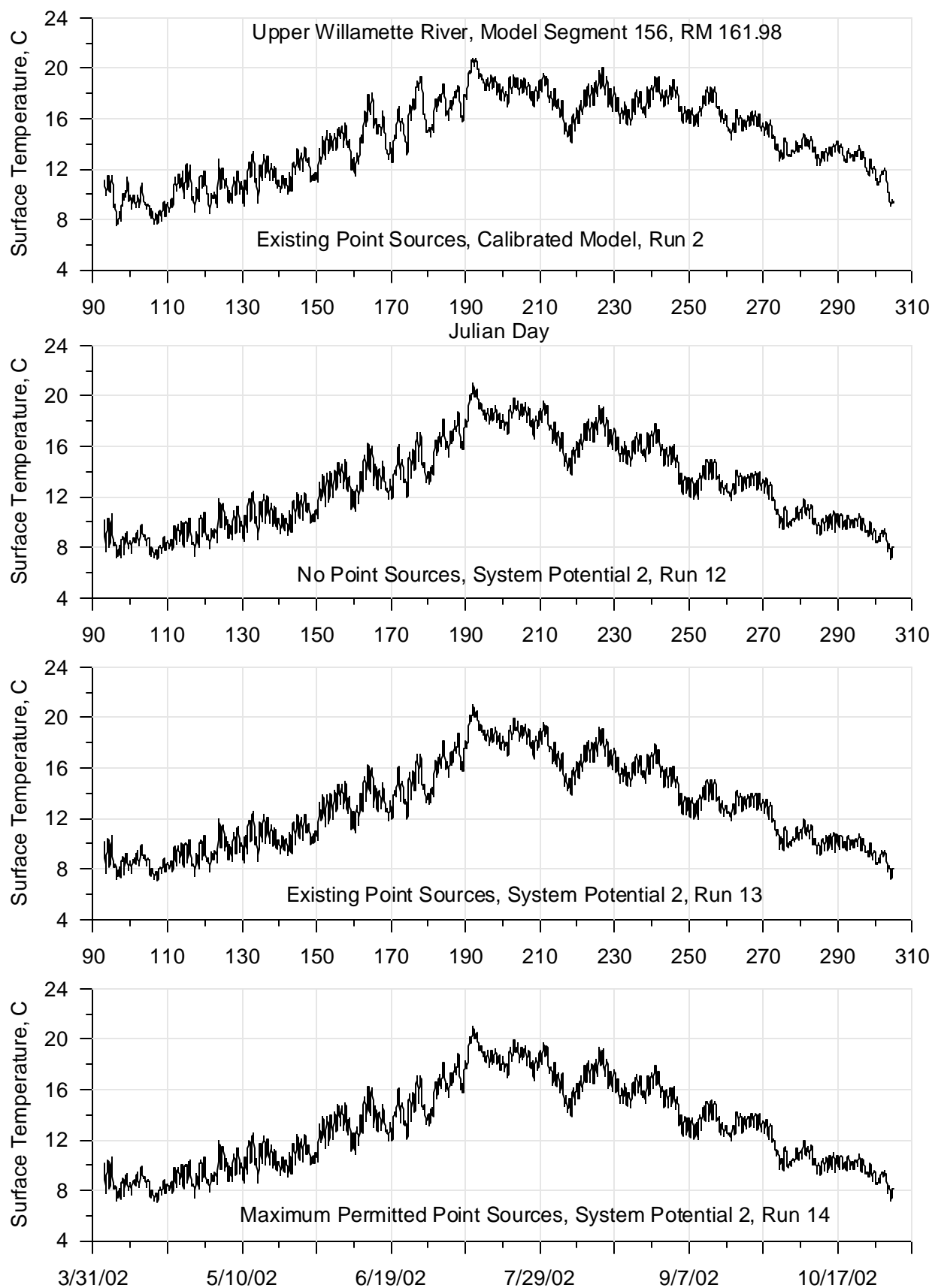
**Figure 325: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the McKenzie River at RM 9.75**



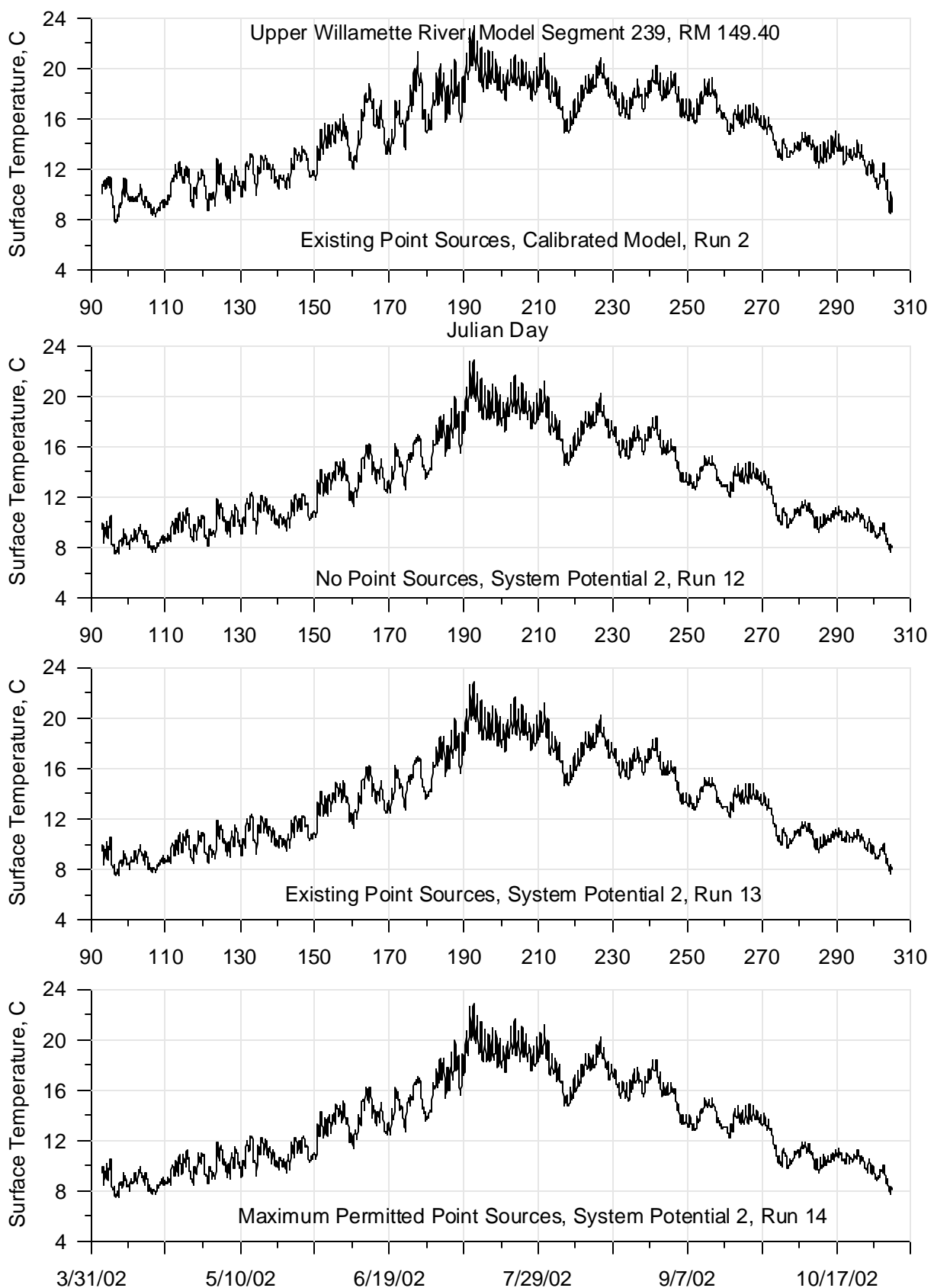
**Figure 326: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Long Tom River at RM 4.64**



**Figure 327: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 175.3**

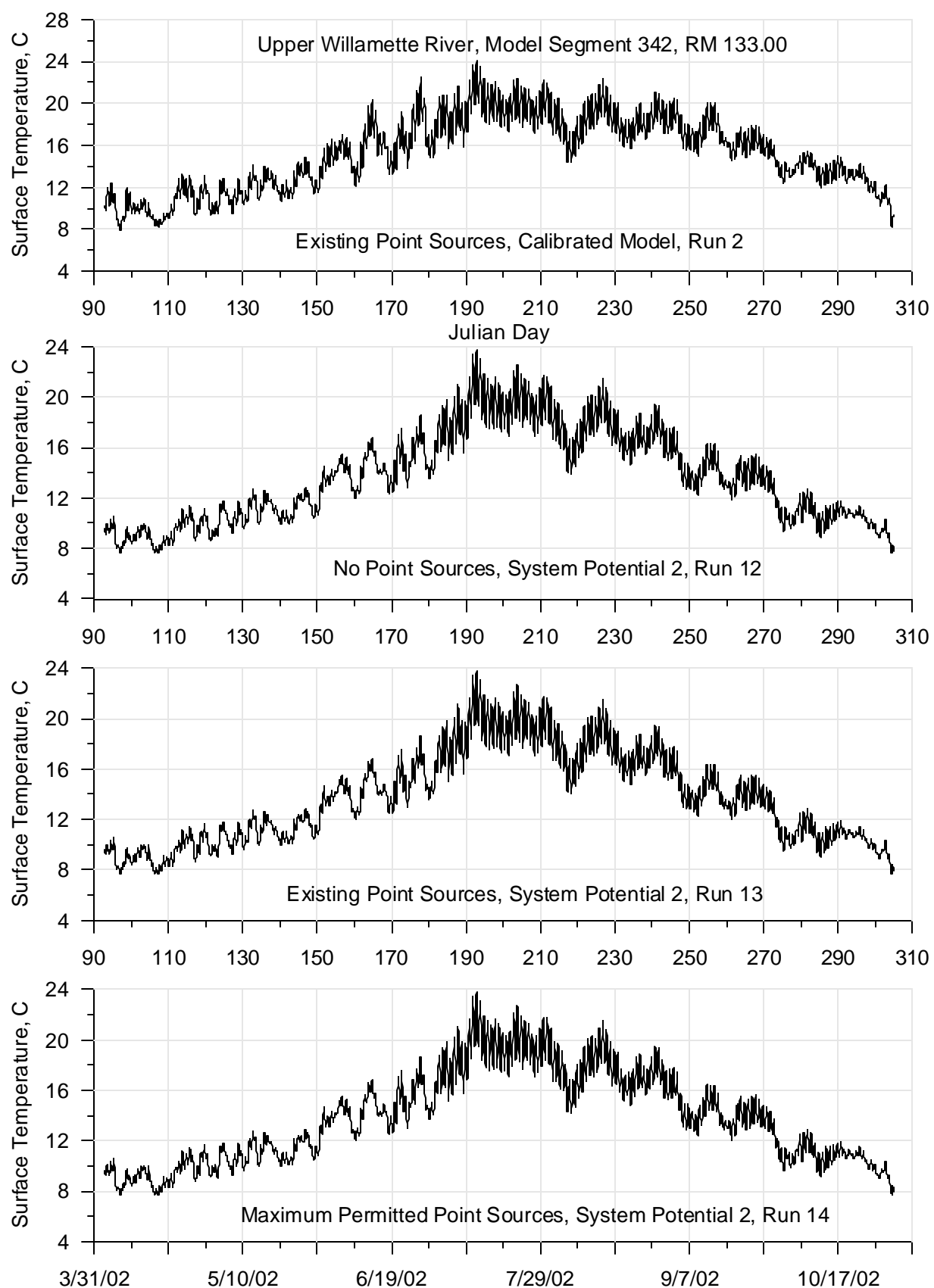


**Figure 328: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 161.98**

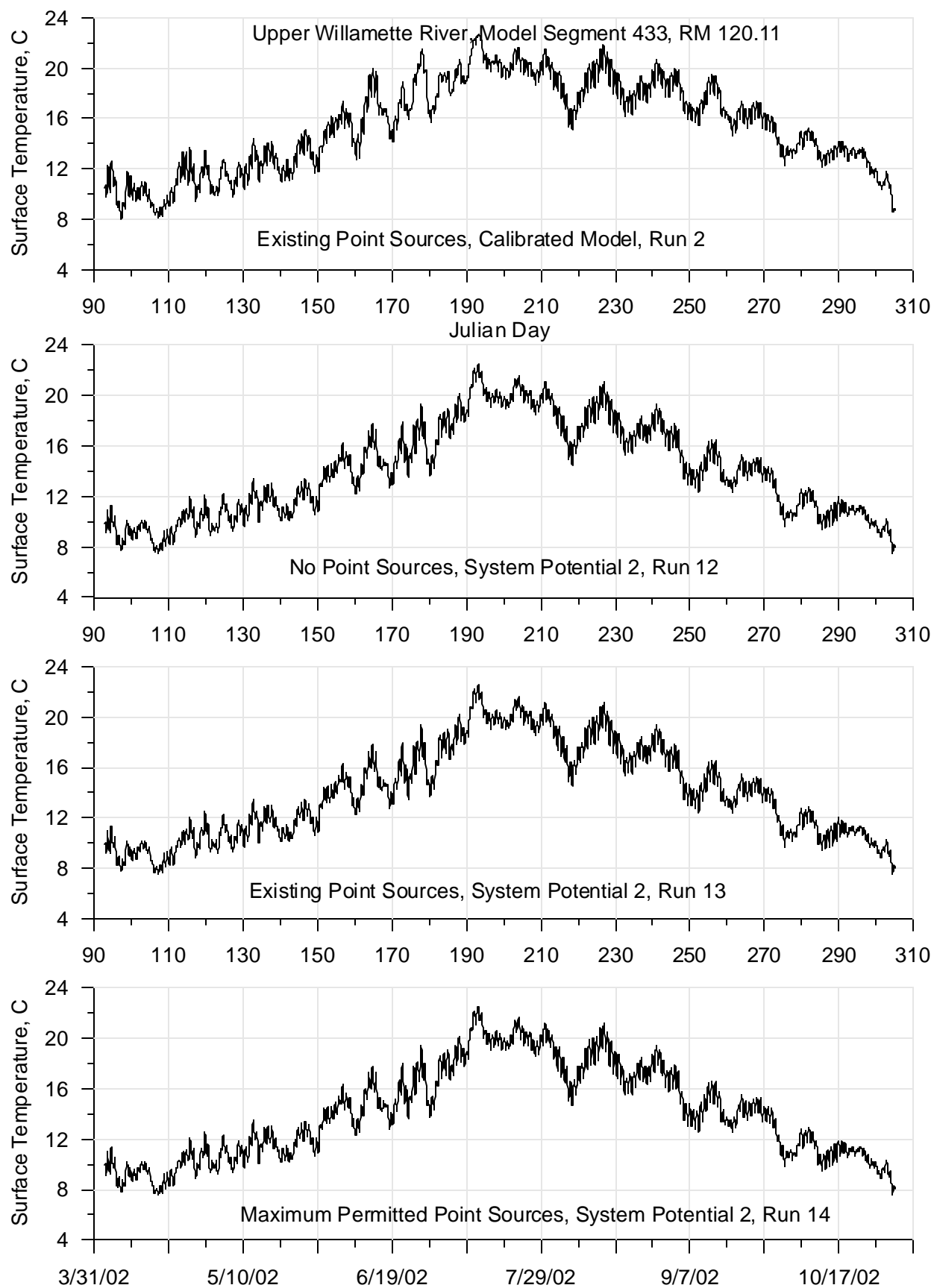


**Figure 329: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 149.4**

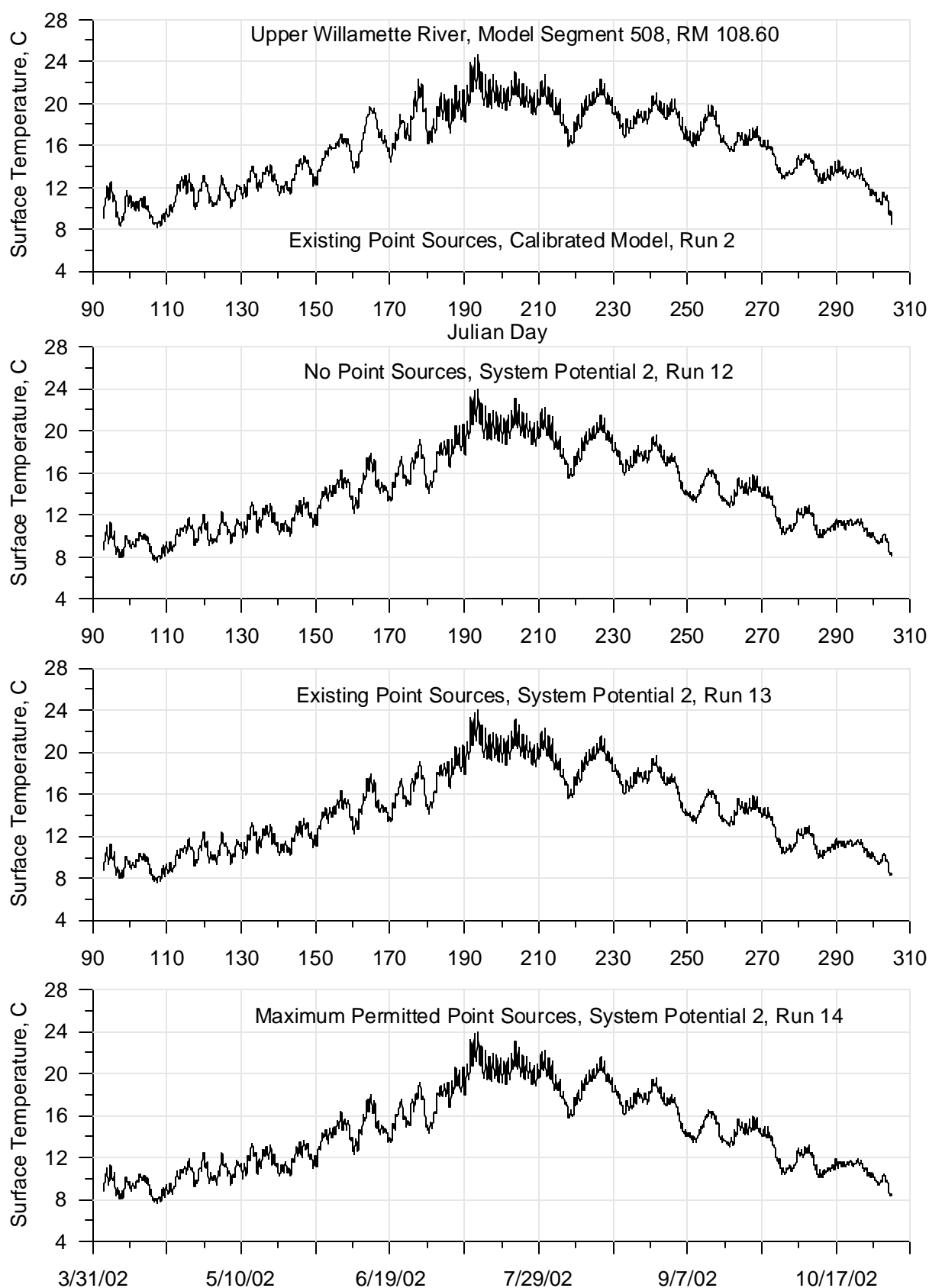




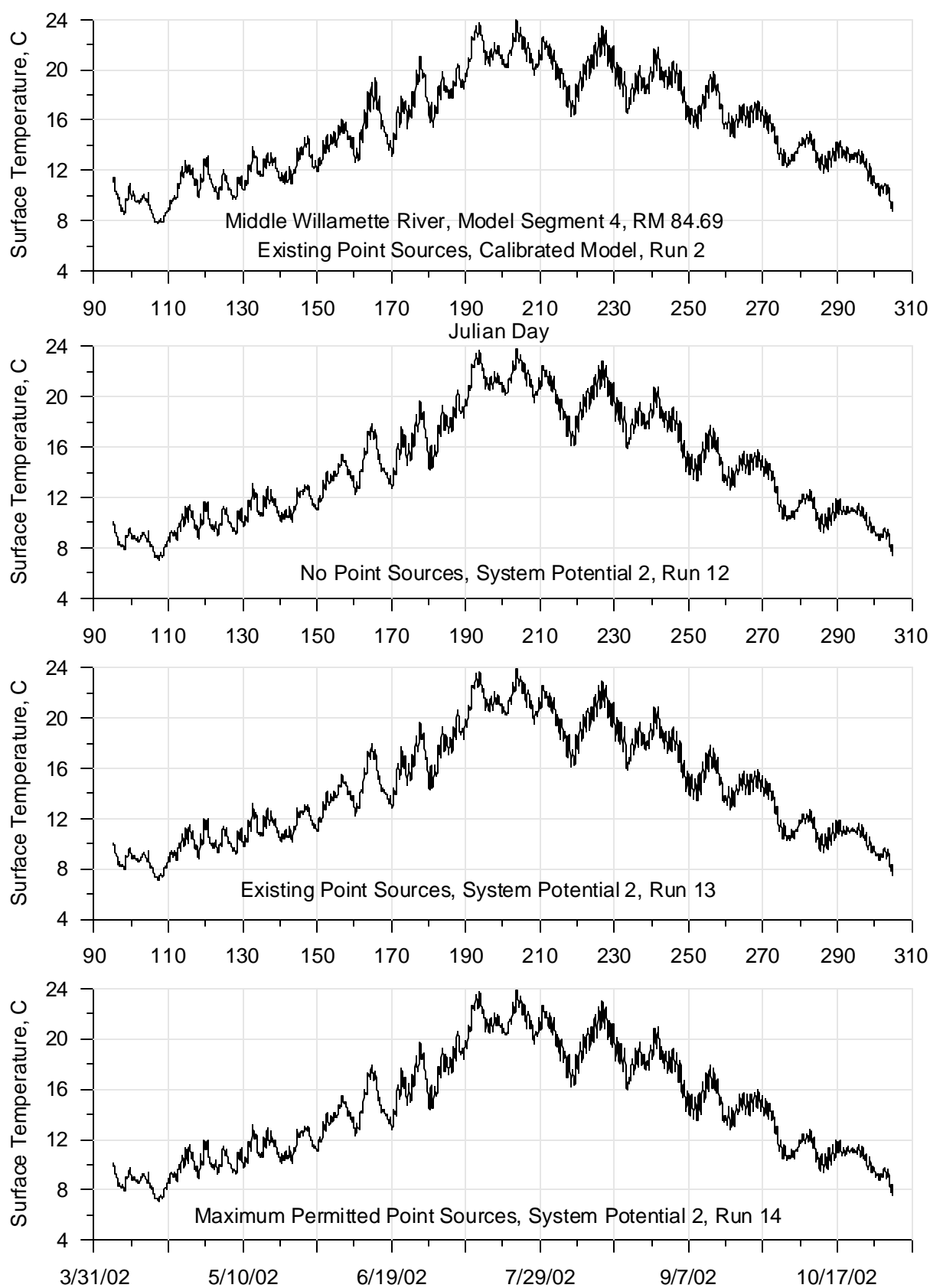
**Figure 330: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 133**



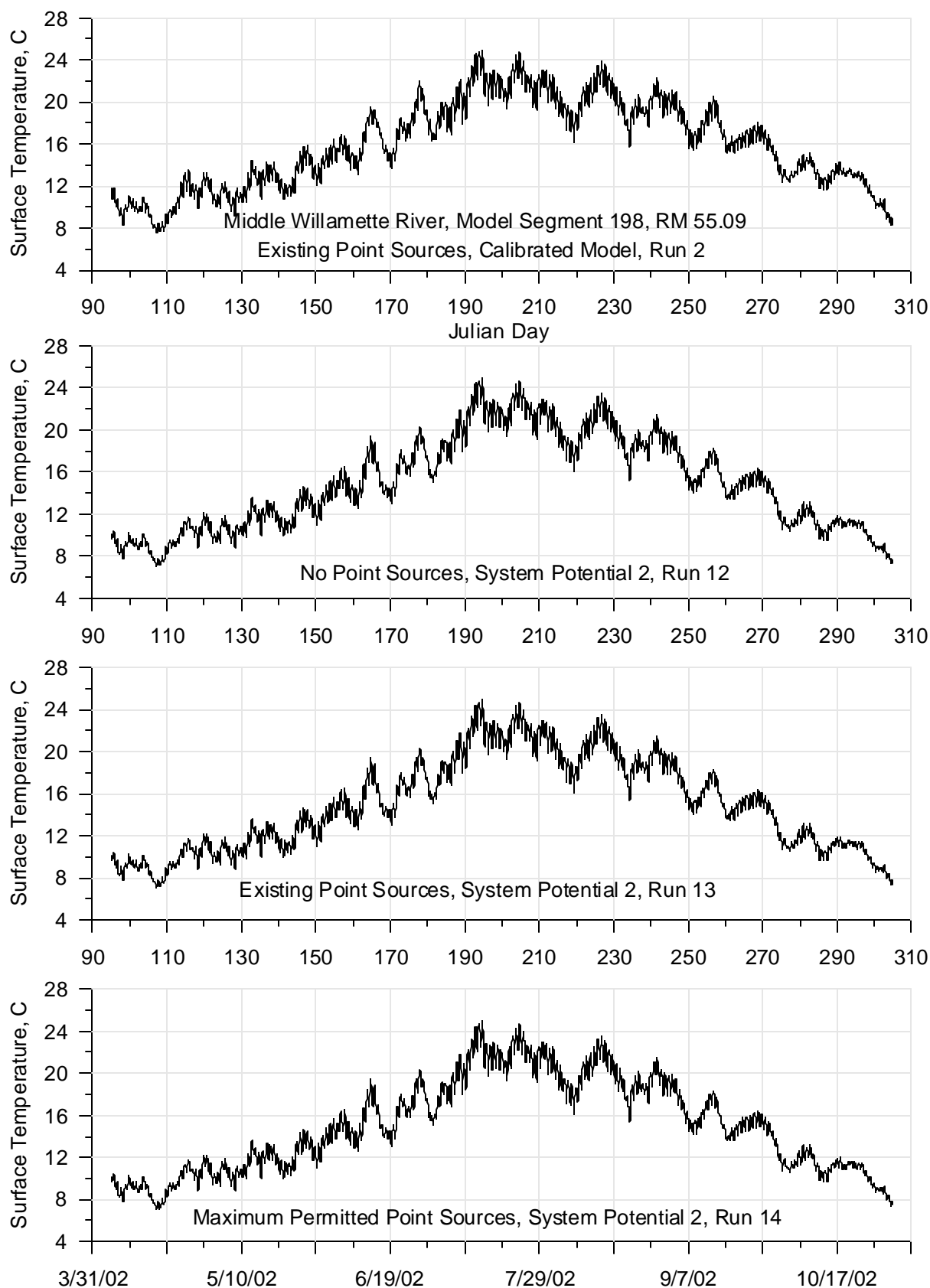
**Figure 331: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 120.11**



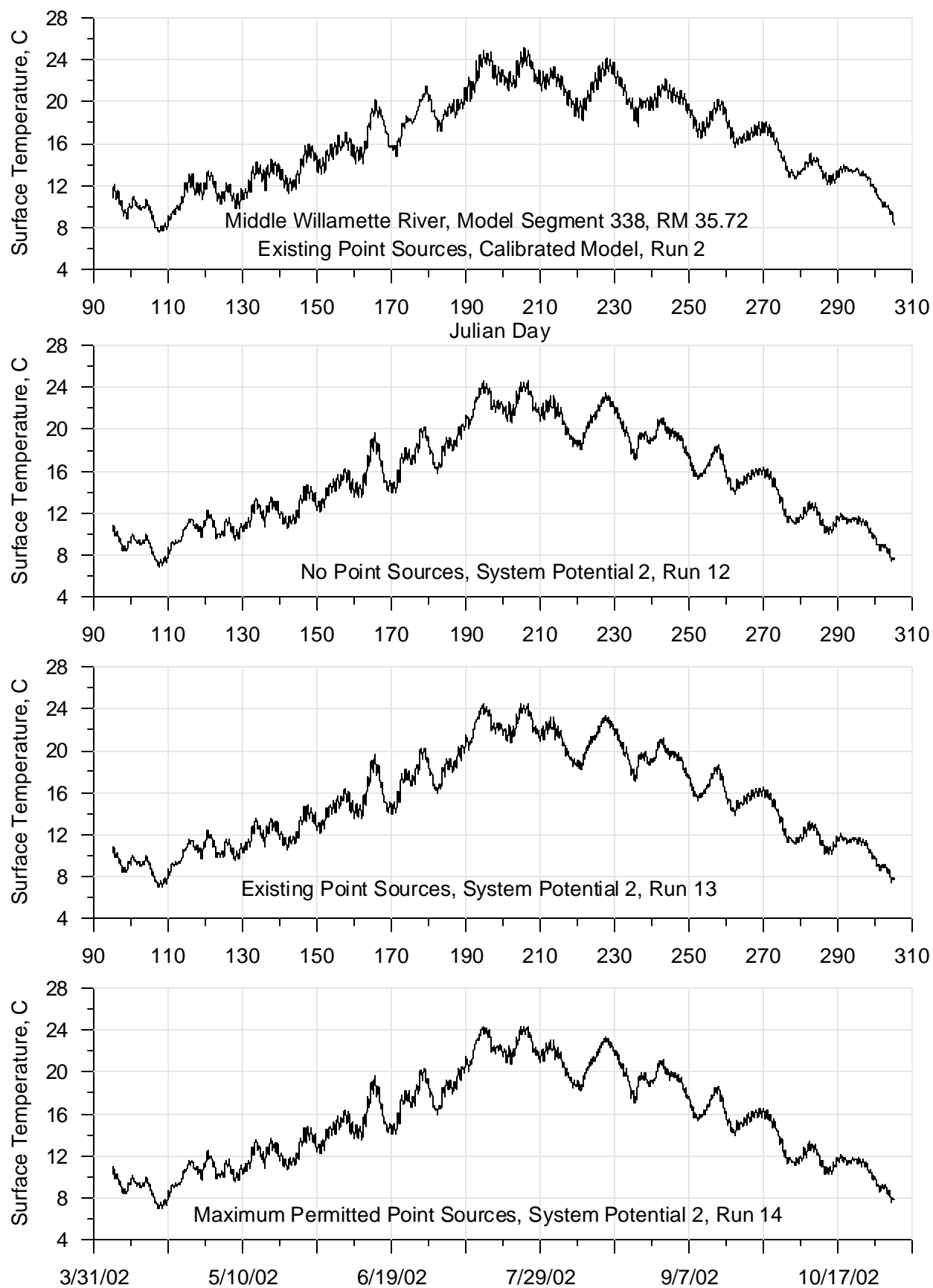
**Figure 332: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 108.6**



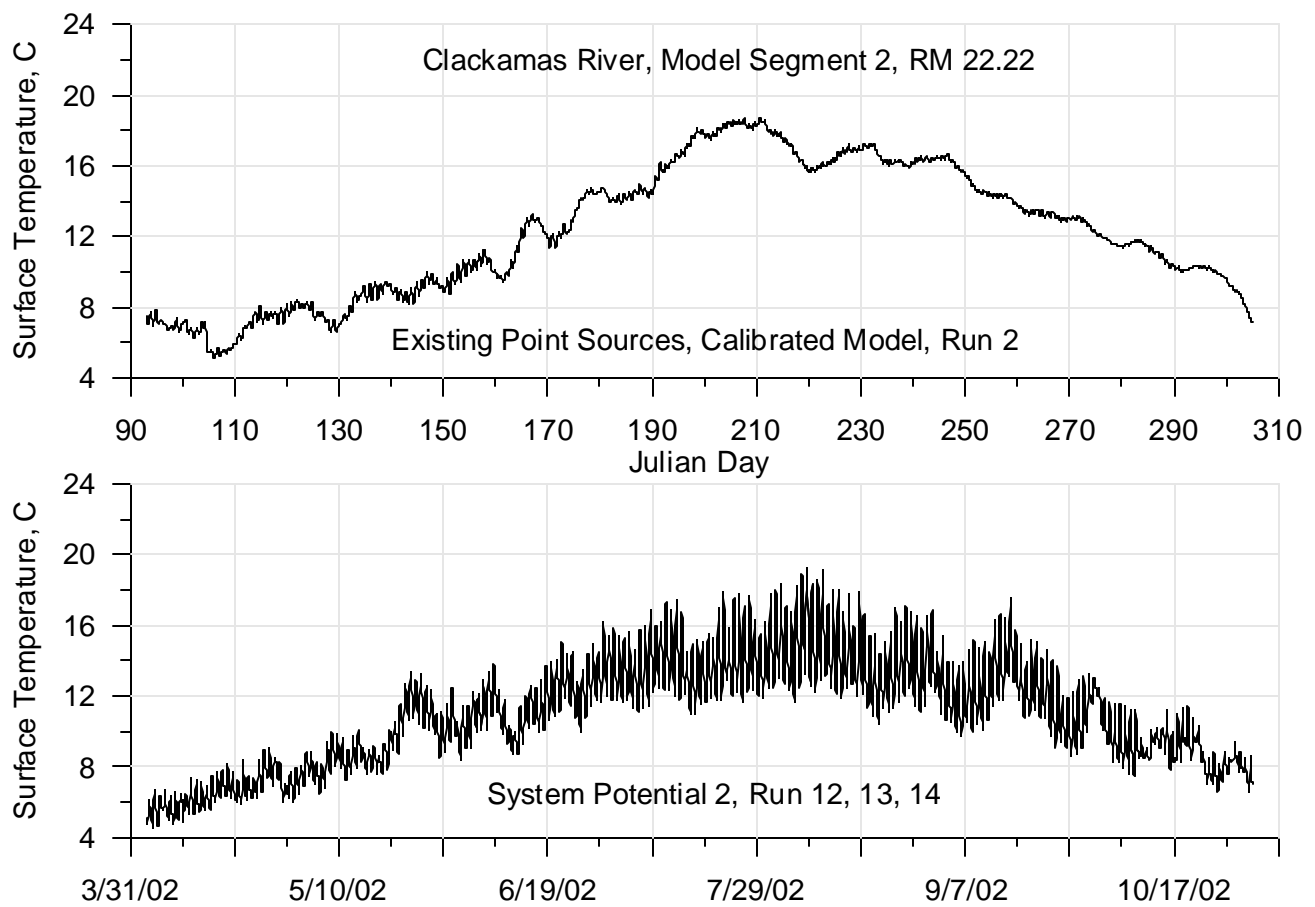
**Figure 333: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 84.69**



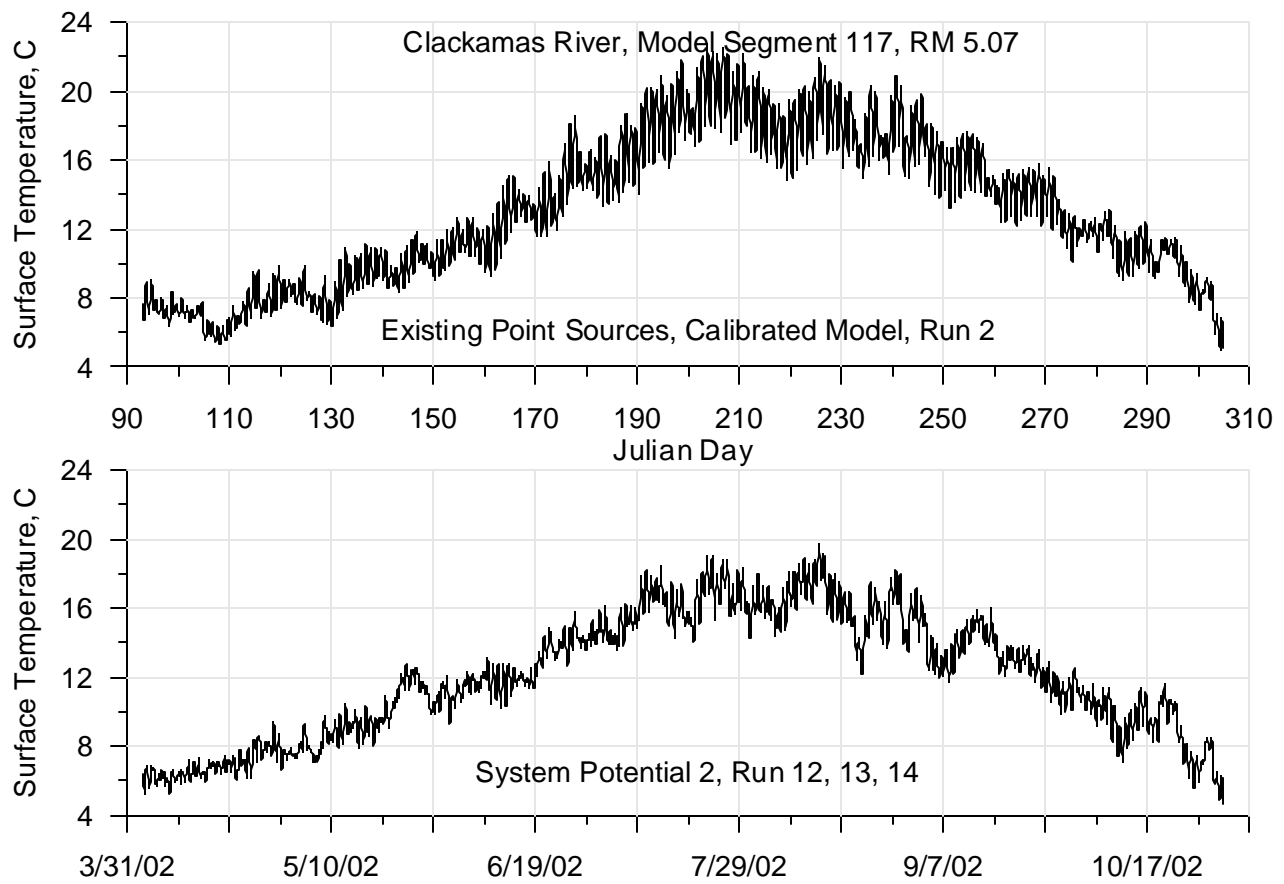
**Figure 334: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 55.09**



**Figure 335: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 35.72**

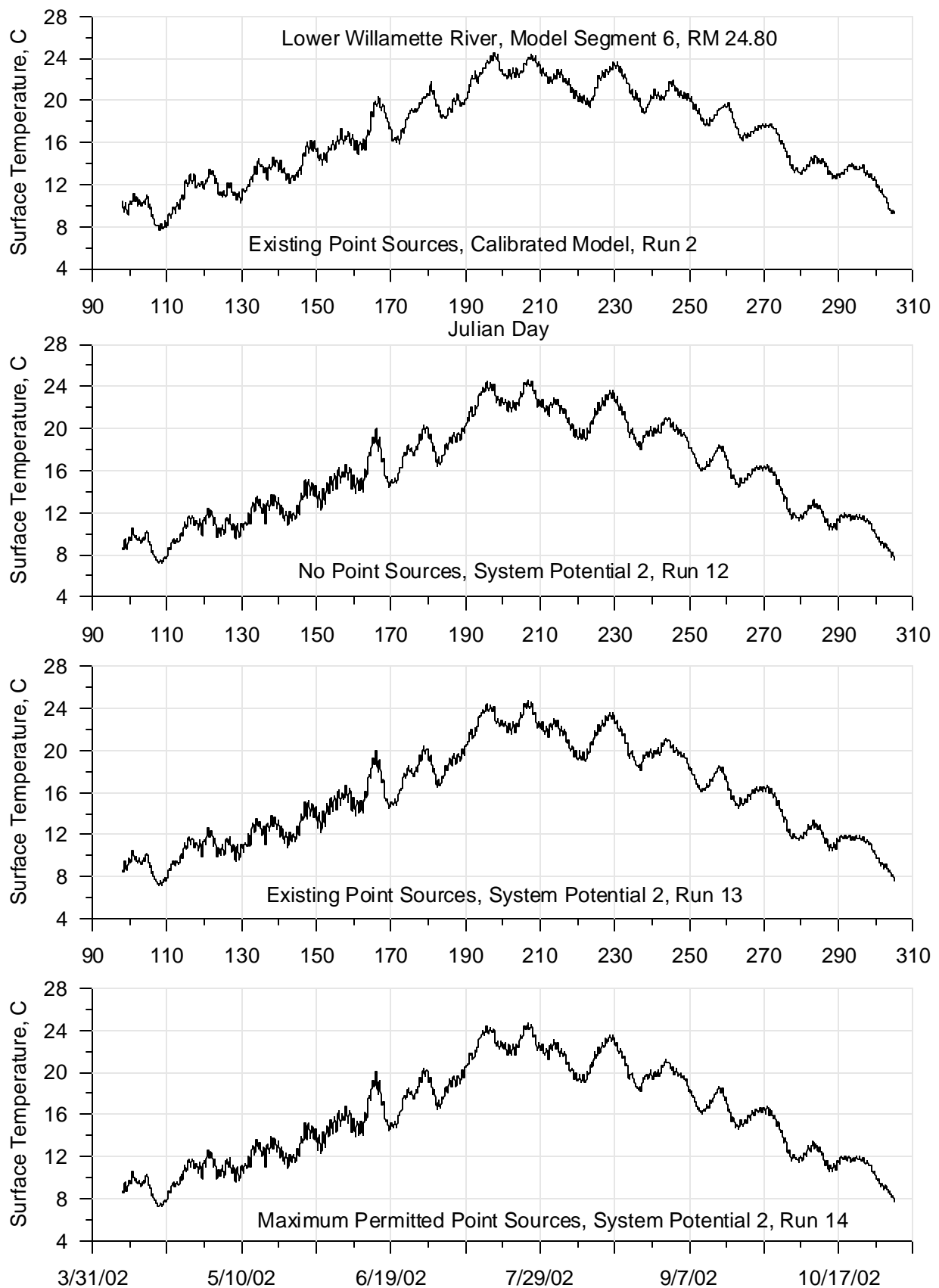


**Figure 336: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Clackamas River at RM 22.22**

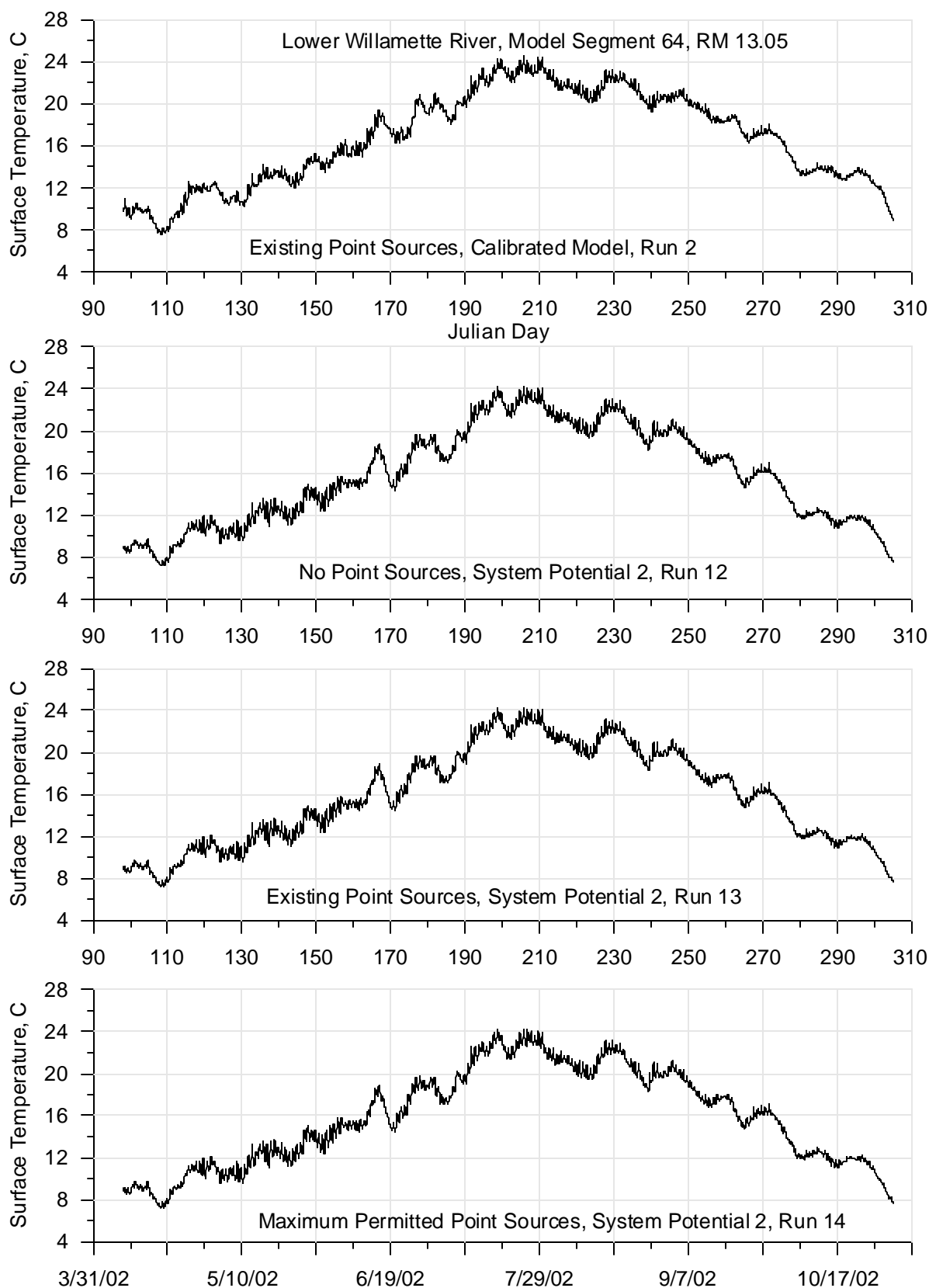


**Figure 337: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Clackamas River at RM 5.07**

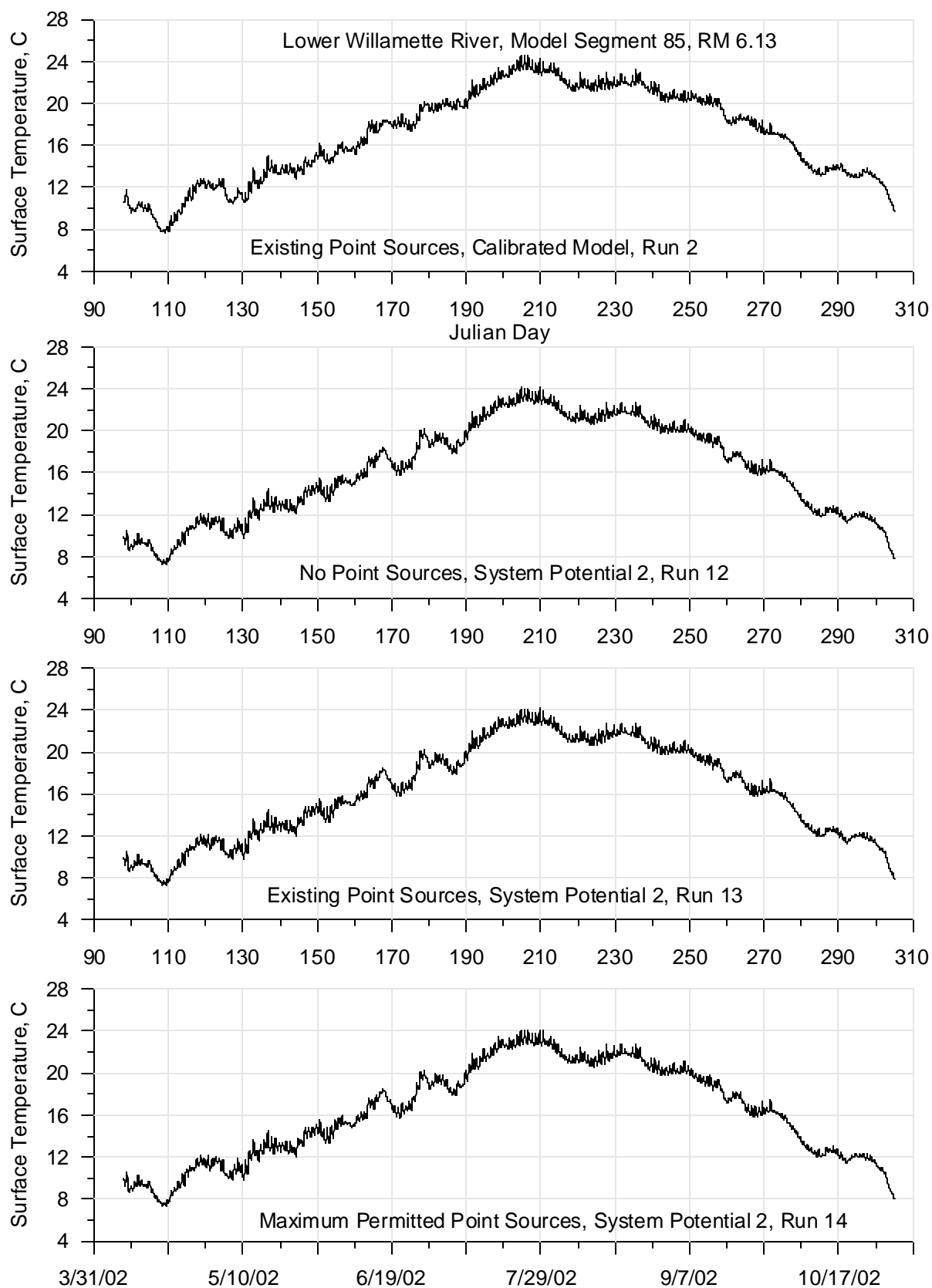




**Figure 338: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 24.8**

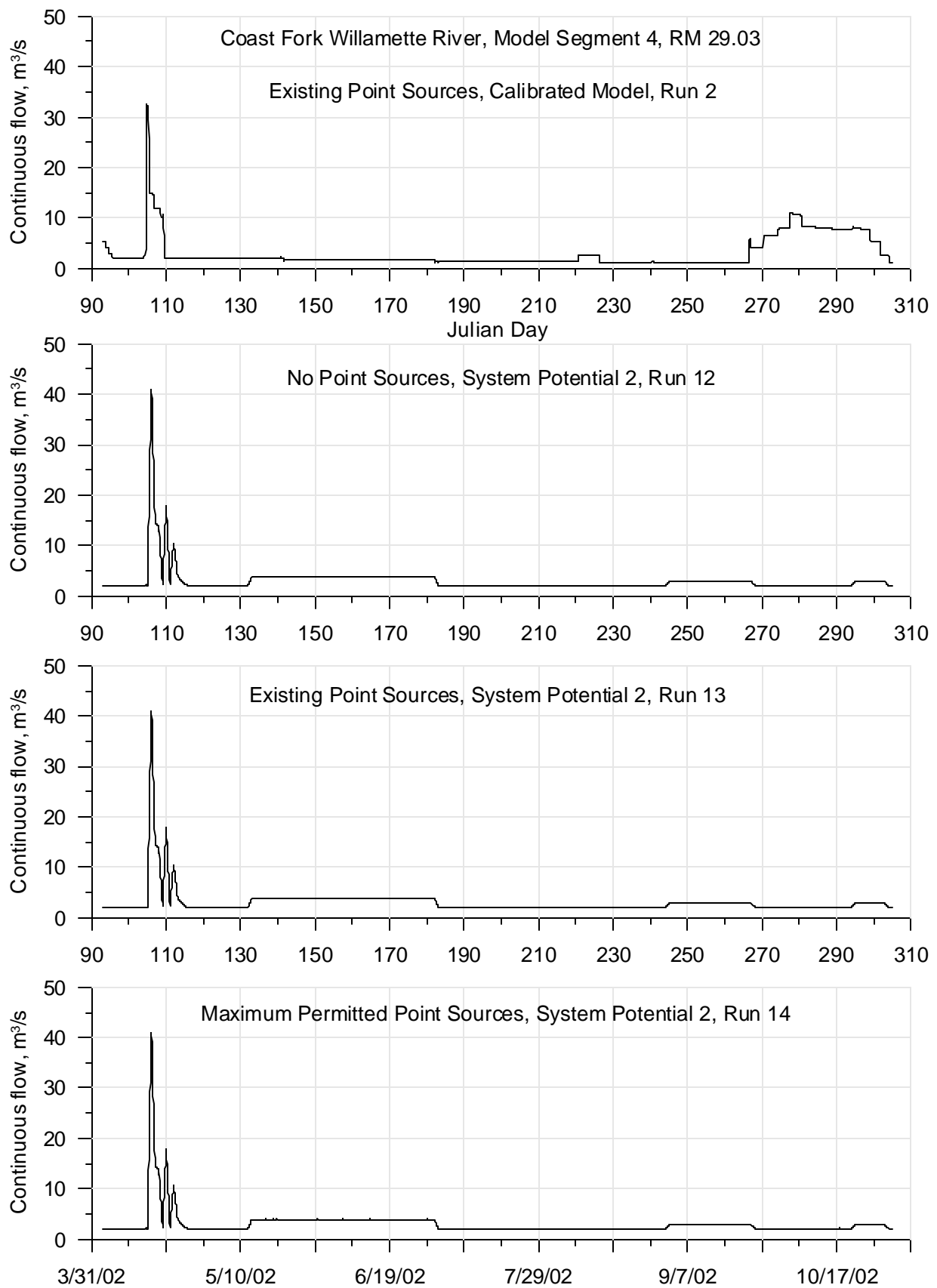


**Figure 339: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 13.05**

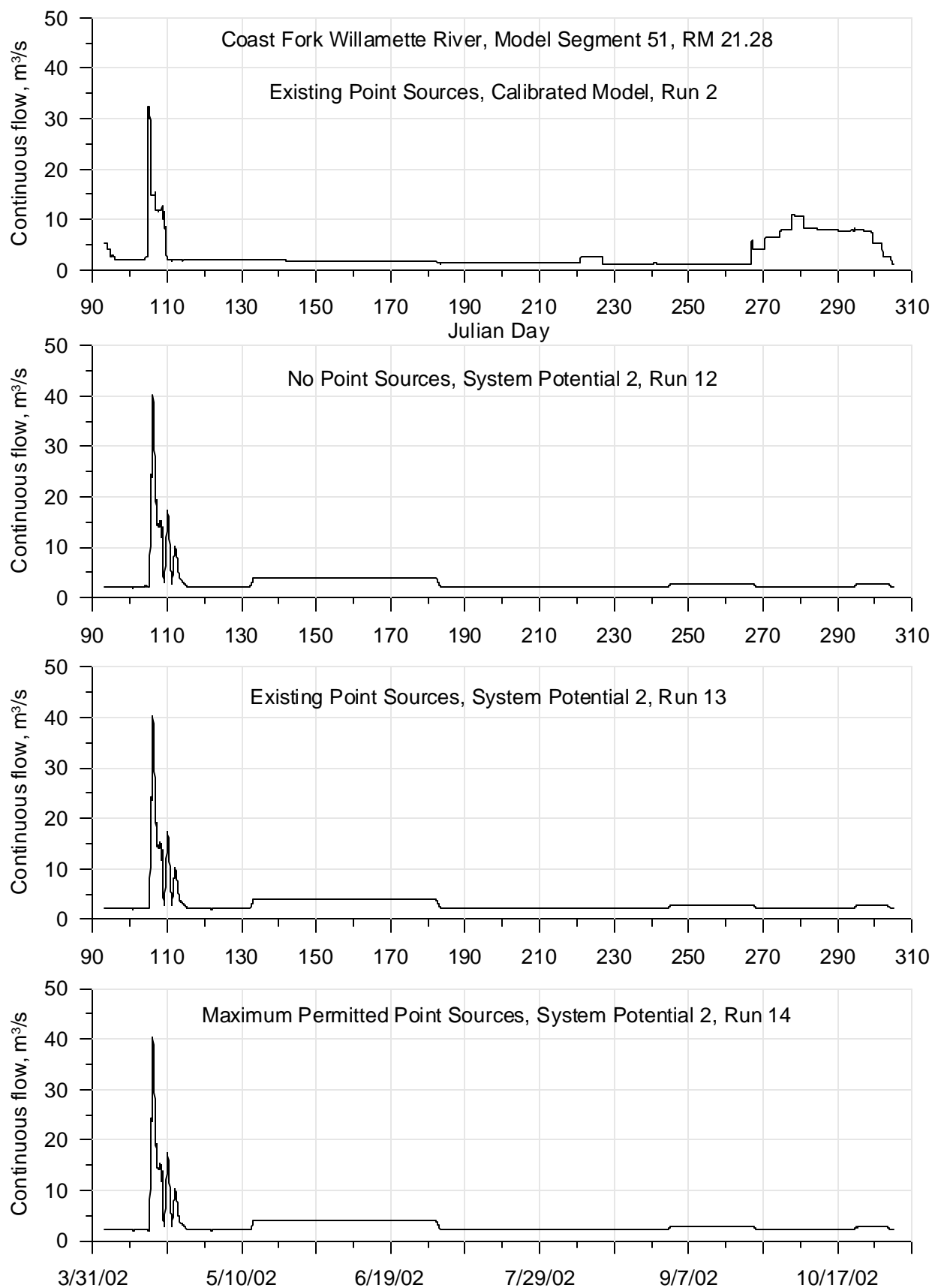


**Figure 340: Calibrated model and System Potential 2 (varying point source discharges) continuous temperature comparison for 2002 for the Willamette River at RM 6.13**

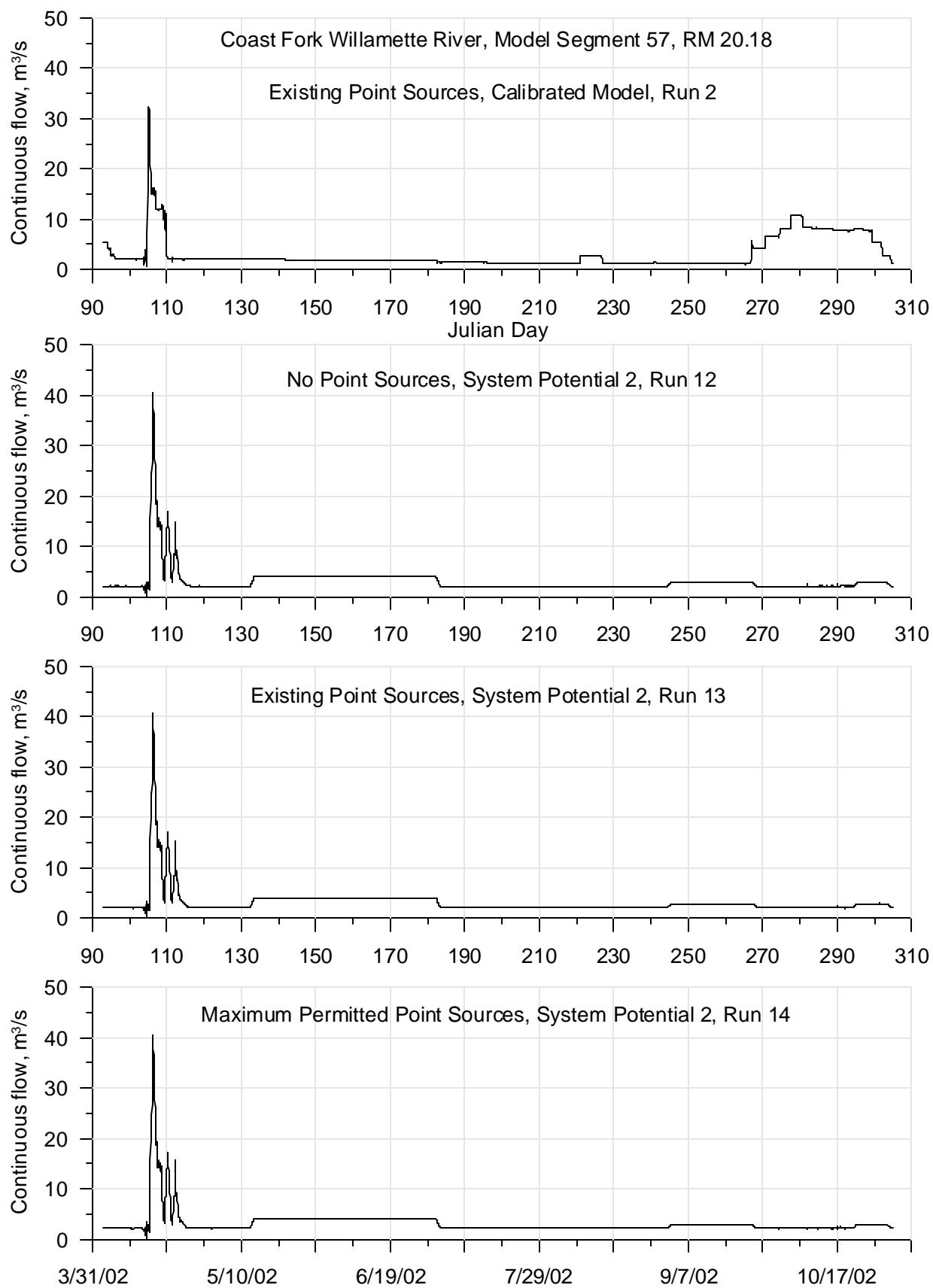
## Continuous Flow



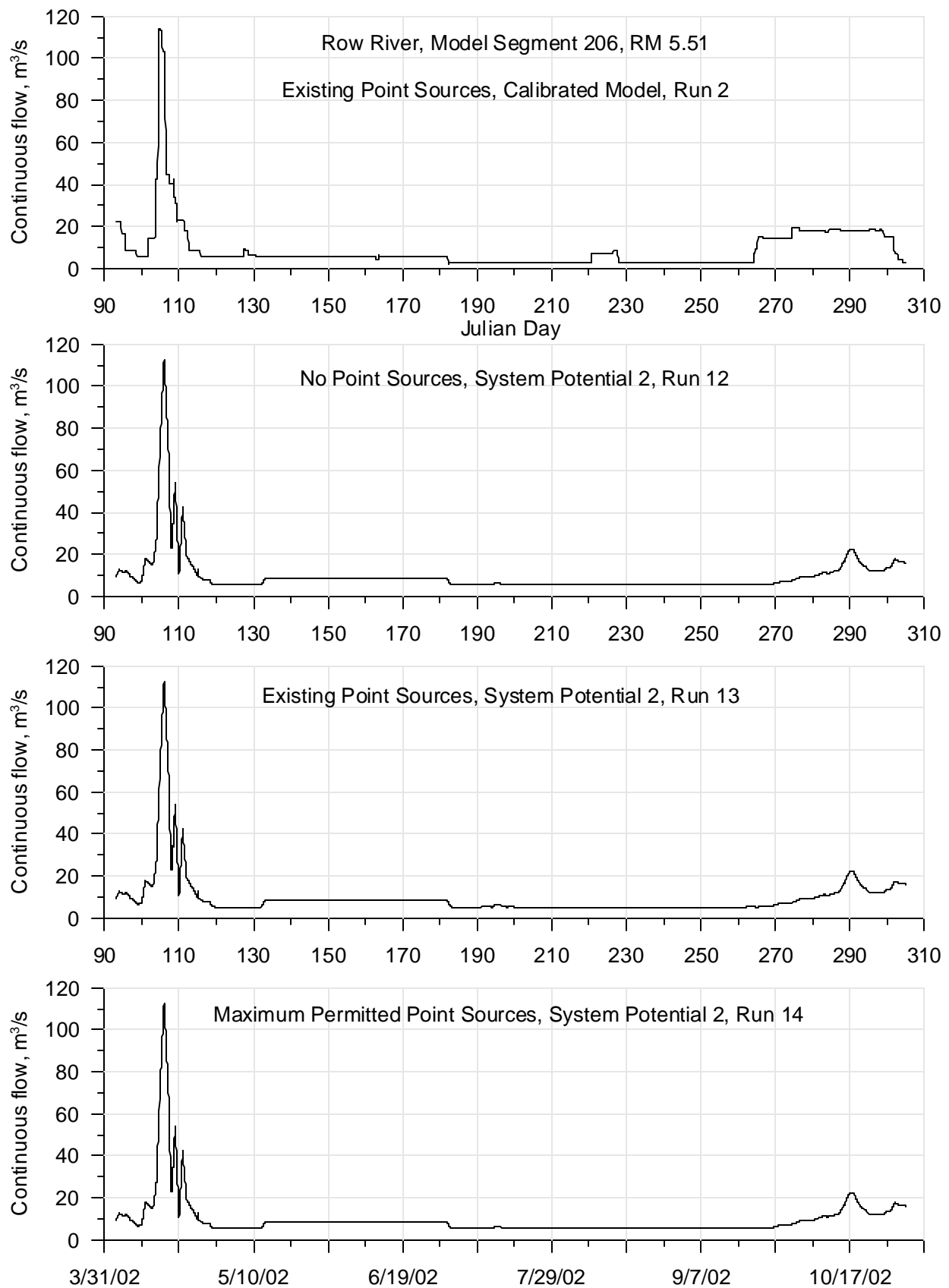
**Figure 341: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Coast Fork Willamette River at RM 29.03**



**Figure 342: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Coast Fork Willamette River at RM 21.28**

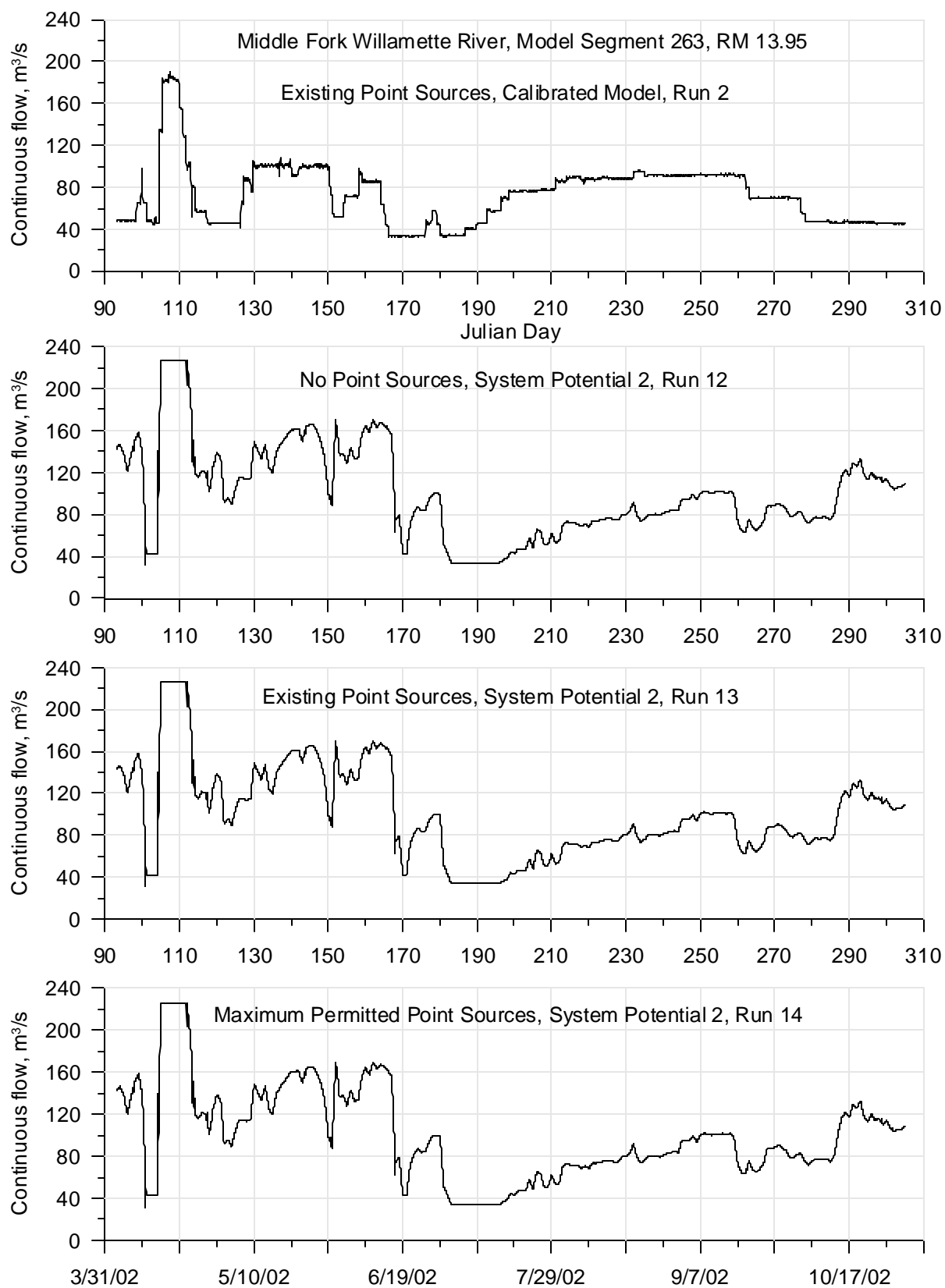


**Figure 343: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Coast Fork Willamette River at RM 20.18**

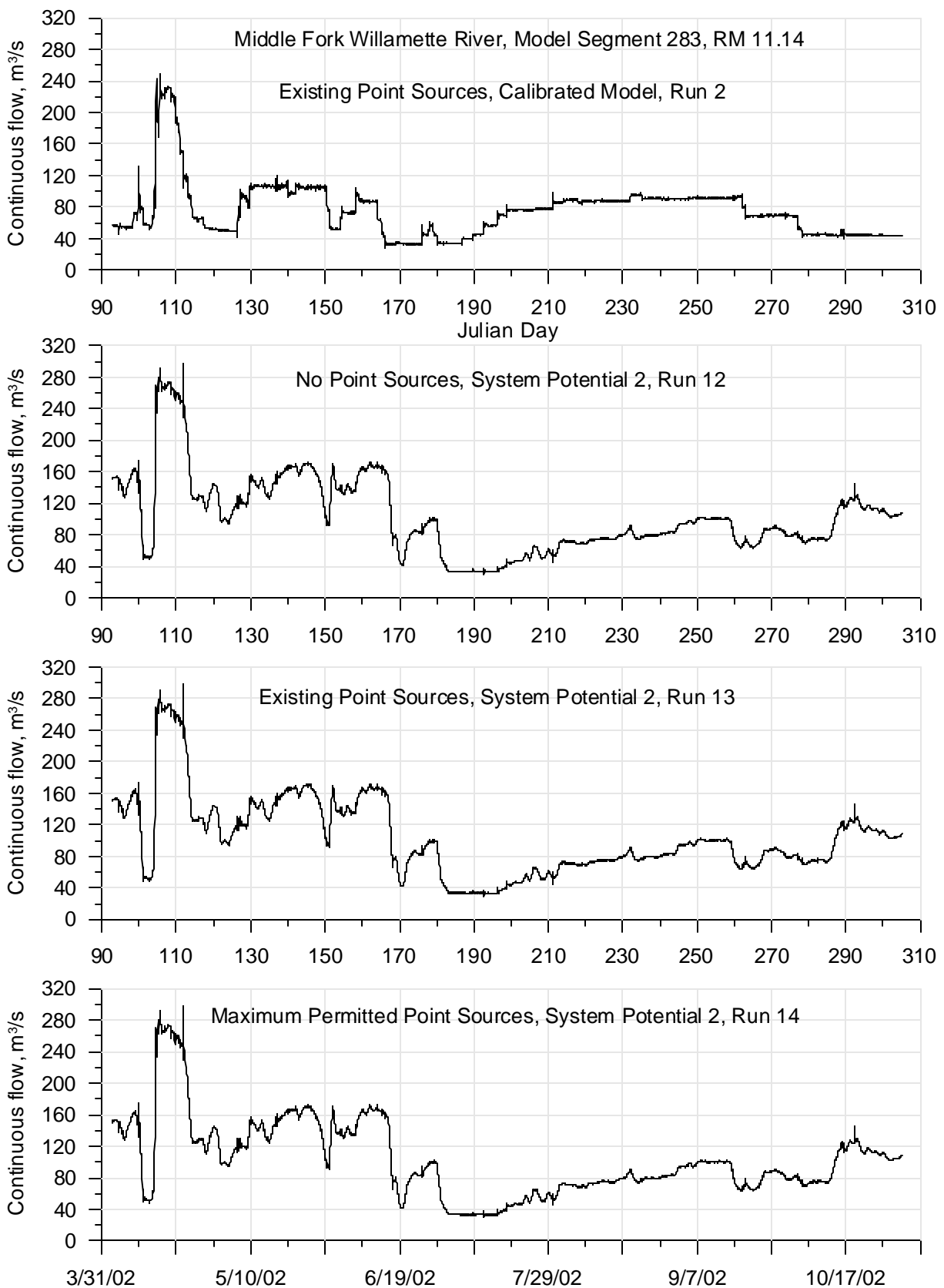


**Figure 344: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Row River at RM 5.51**

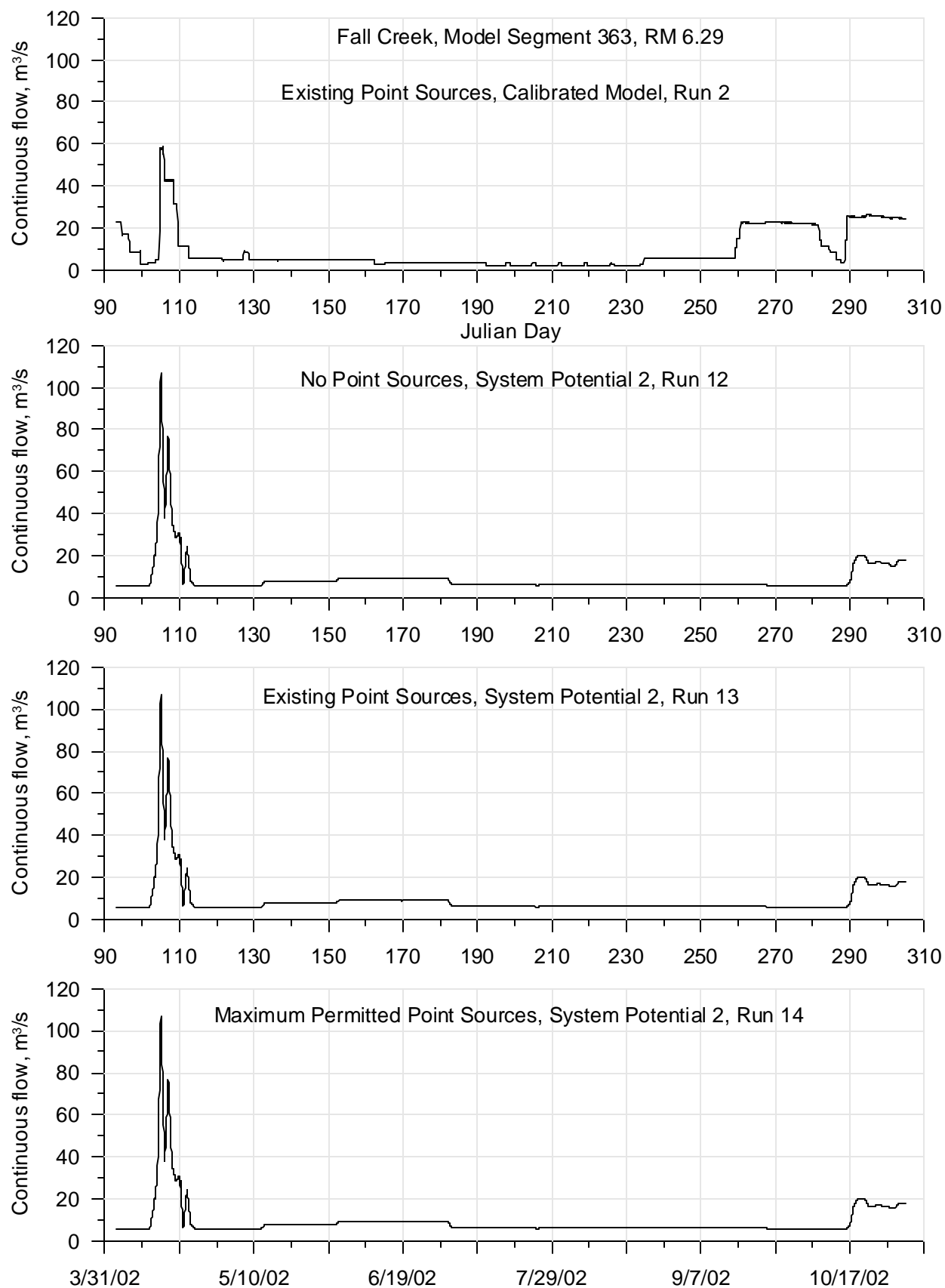




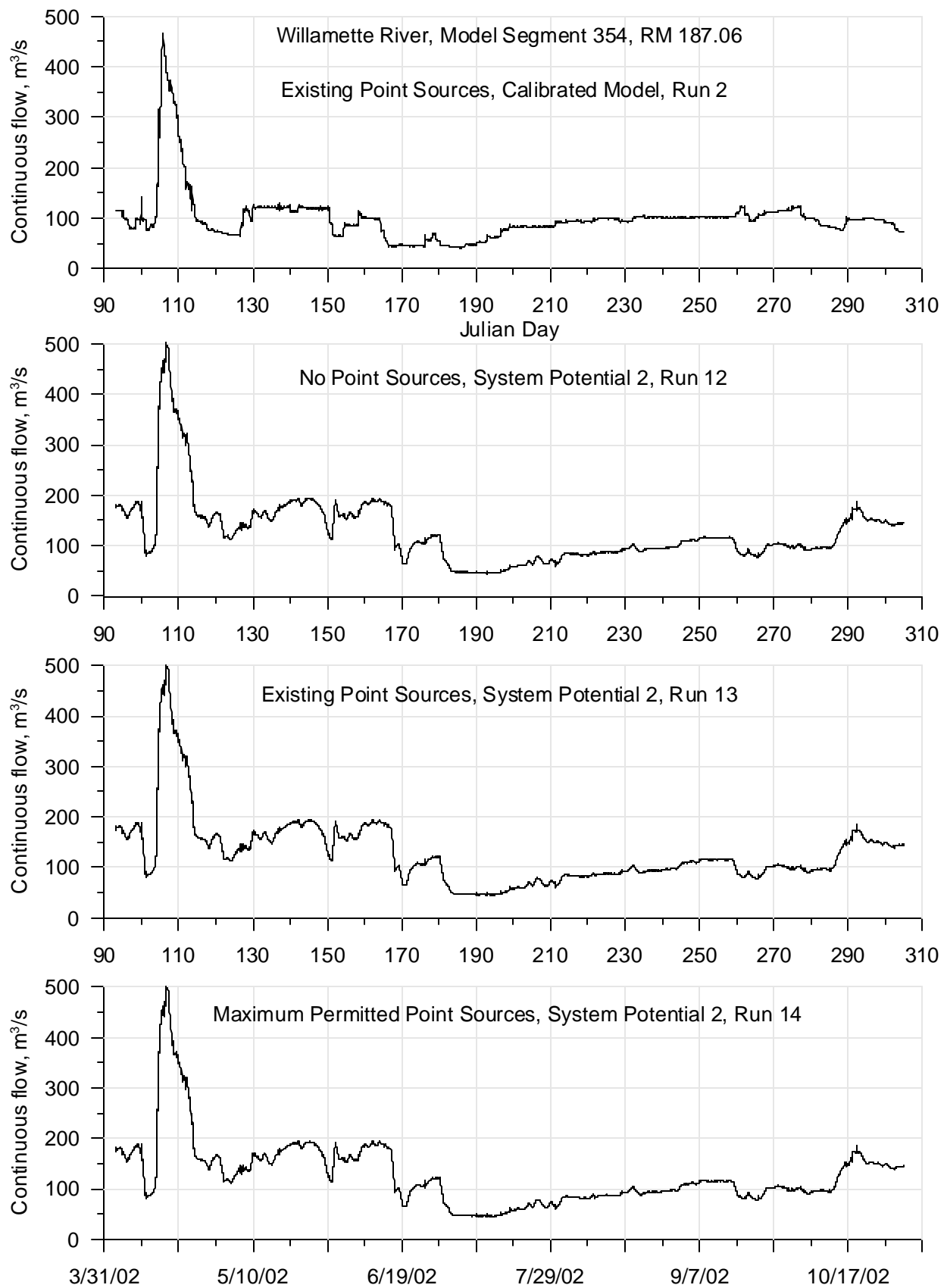
**Figure 345: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Middle Fork Willamette River at RM 13.95**



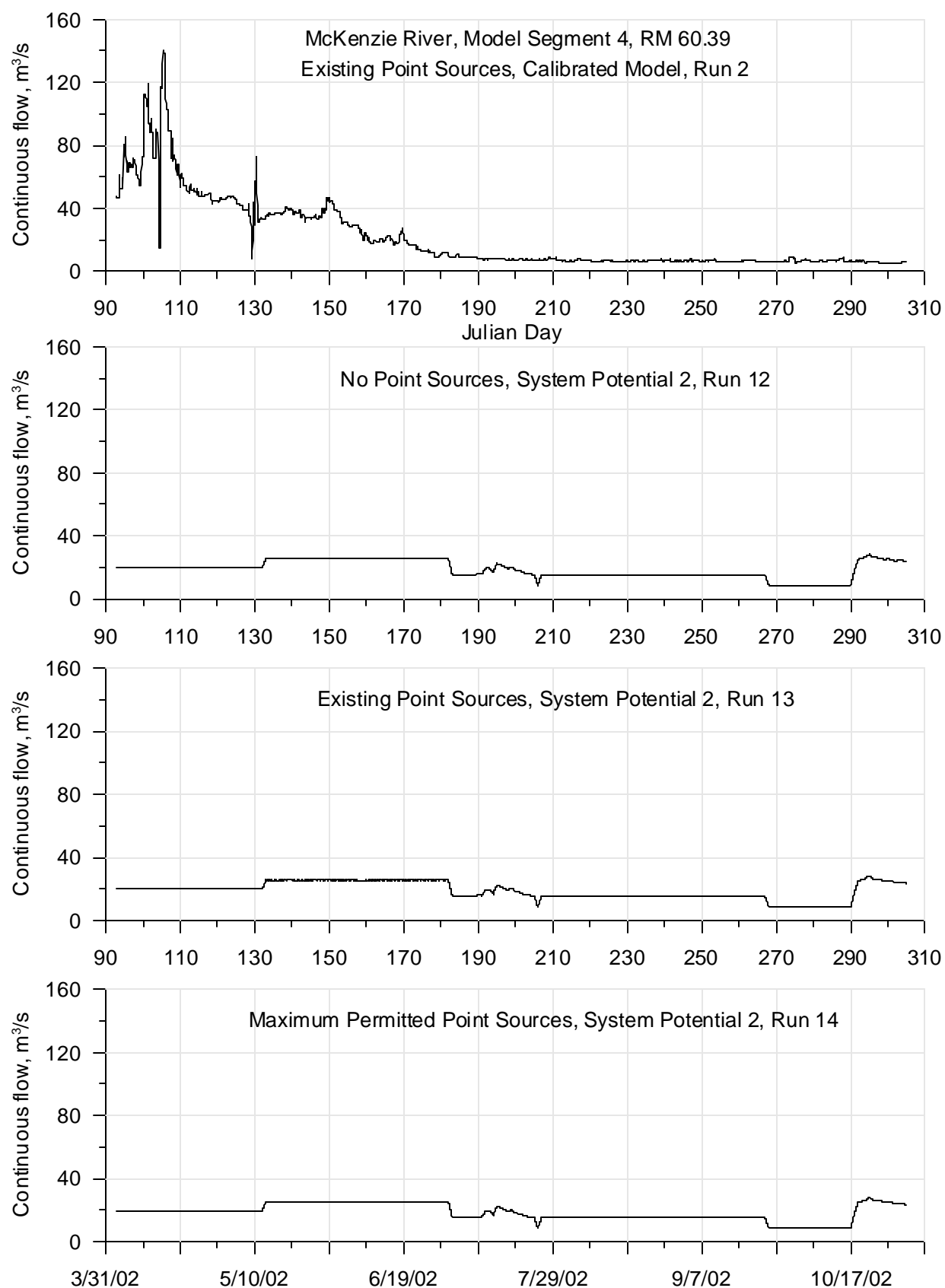
**Figure 346: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Middle Fork Willamette River at RM 11.14**



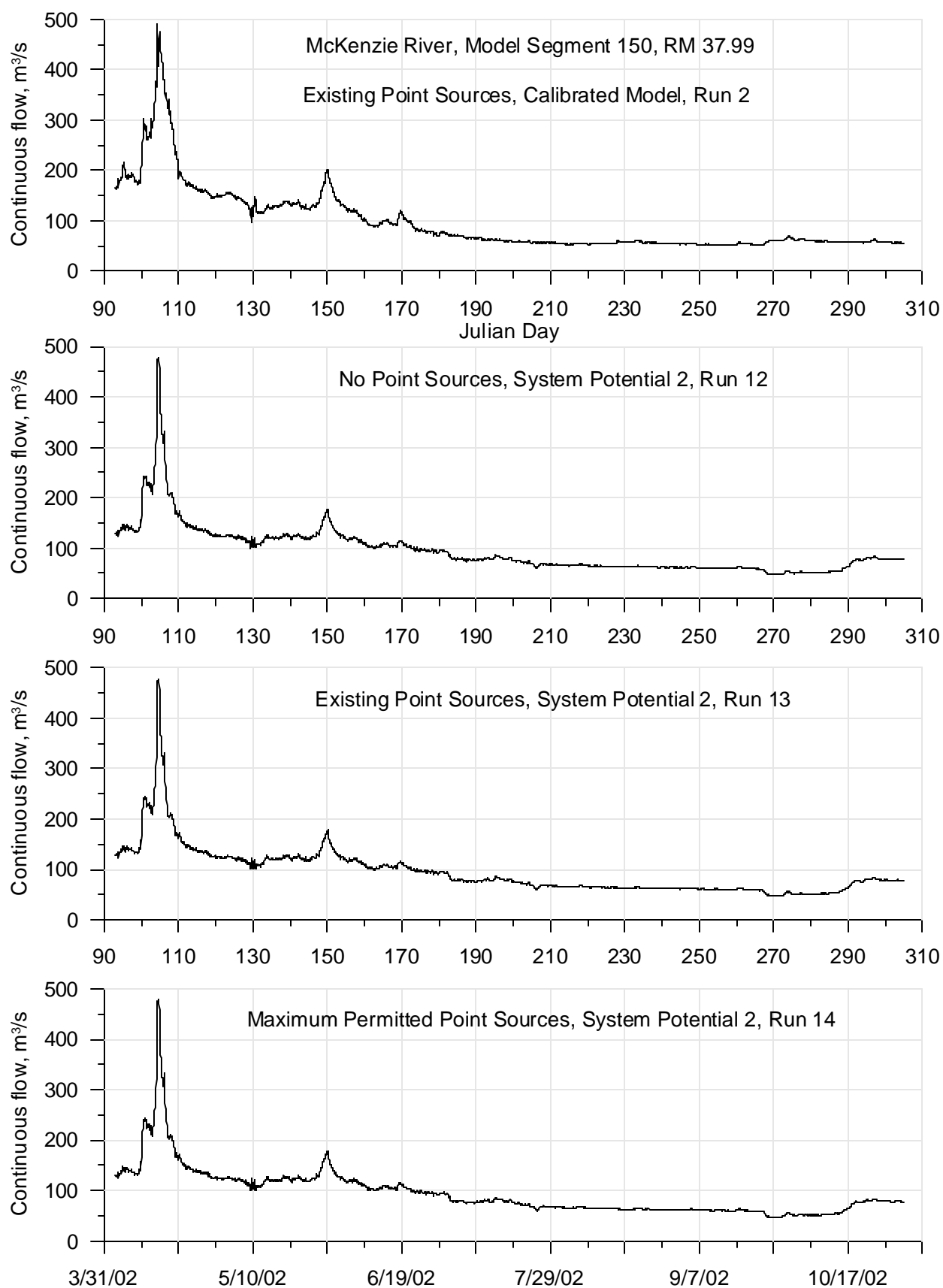
**Figure 347: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for Fall Creek at RM 6.29**



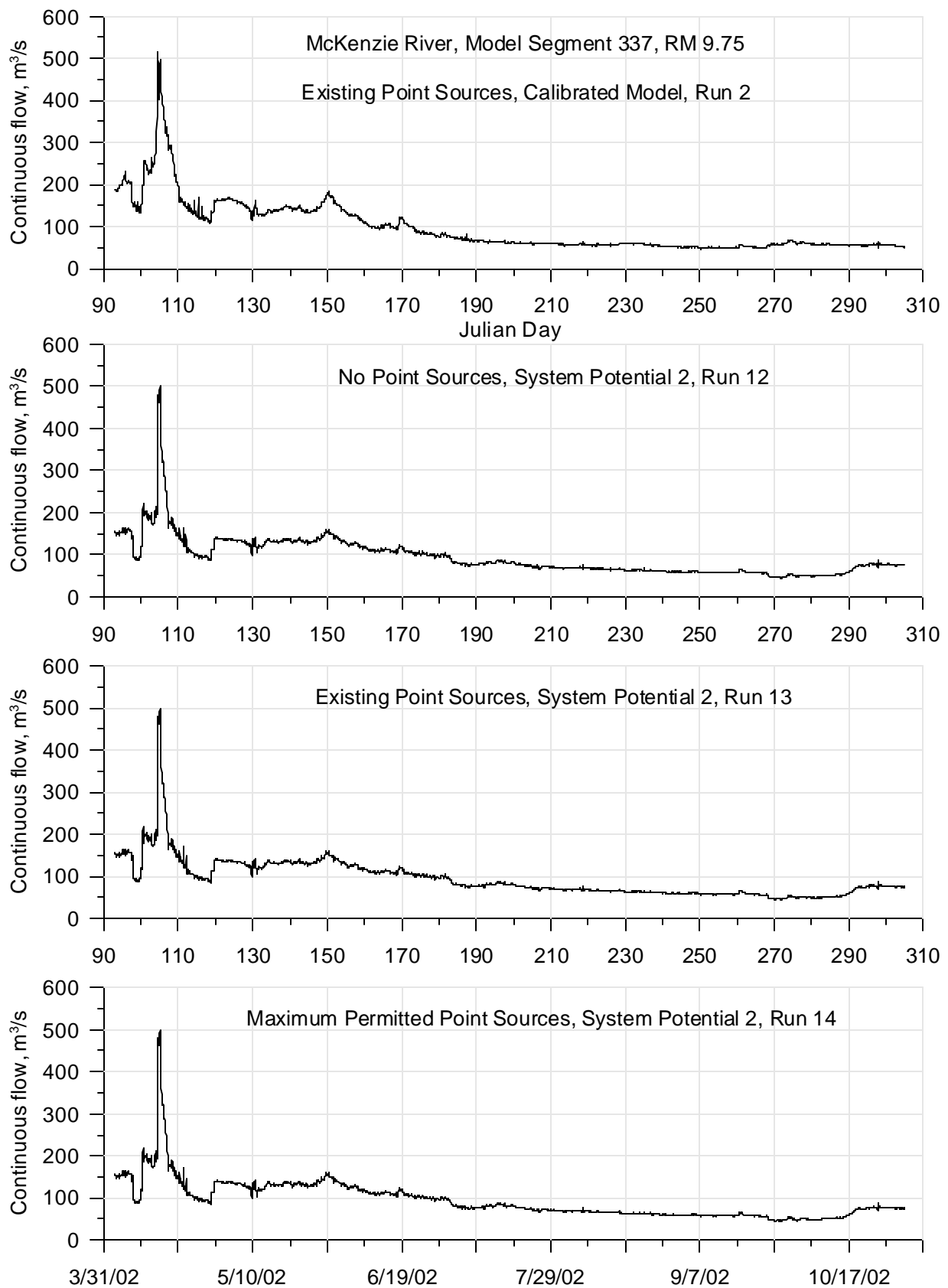
**Figure 348: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 187.06**



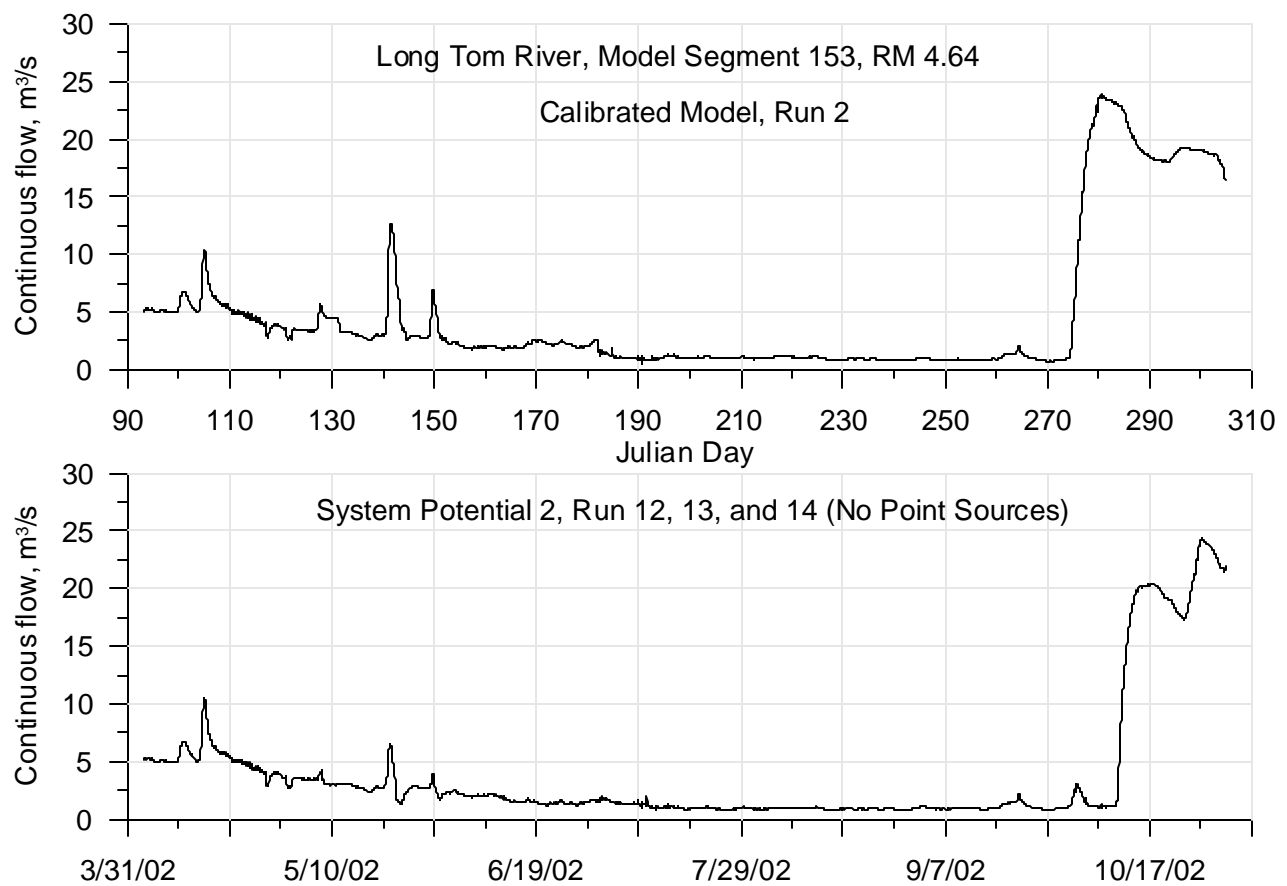
**Figure 349: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the McKenzie River at RM 60.39**



**Figure 350: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the McKenzie River at RM 37.99**

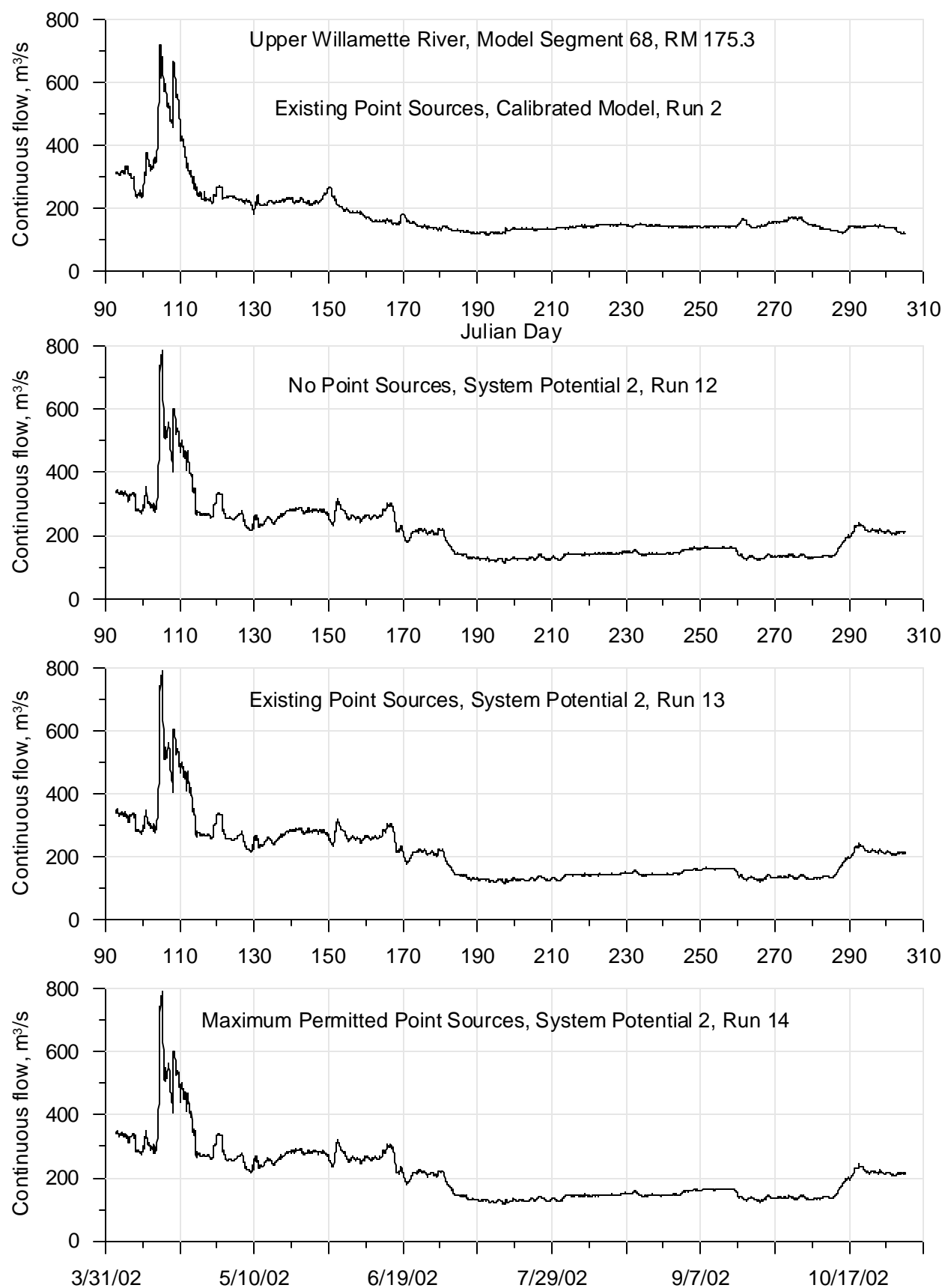


**Figure 351: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the McKenzie River at RM 9.75**

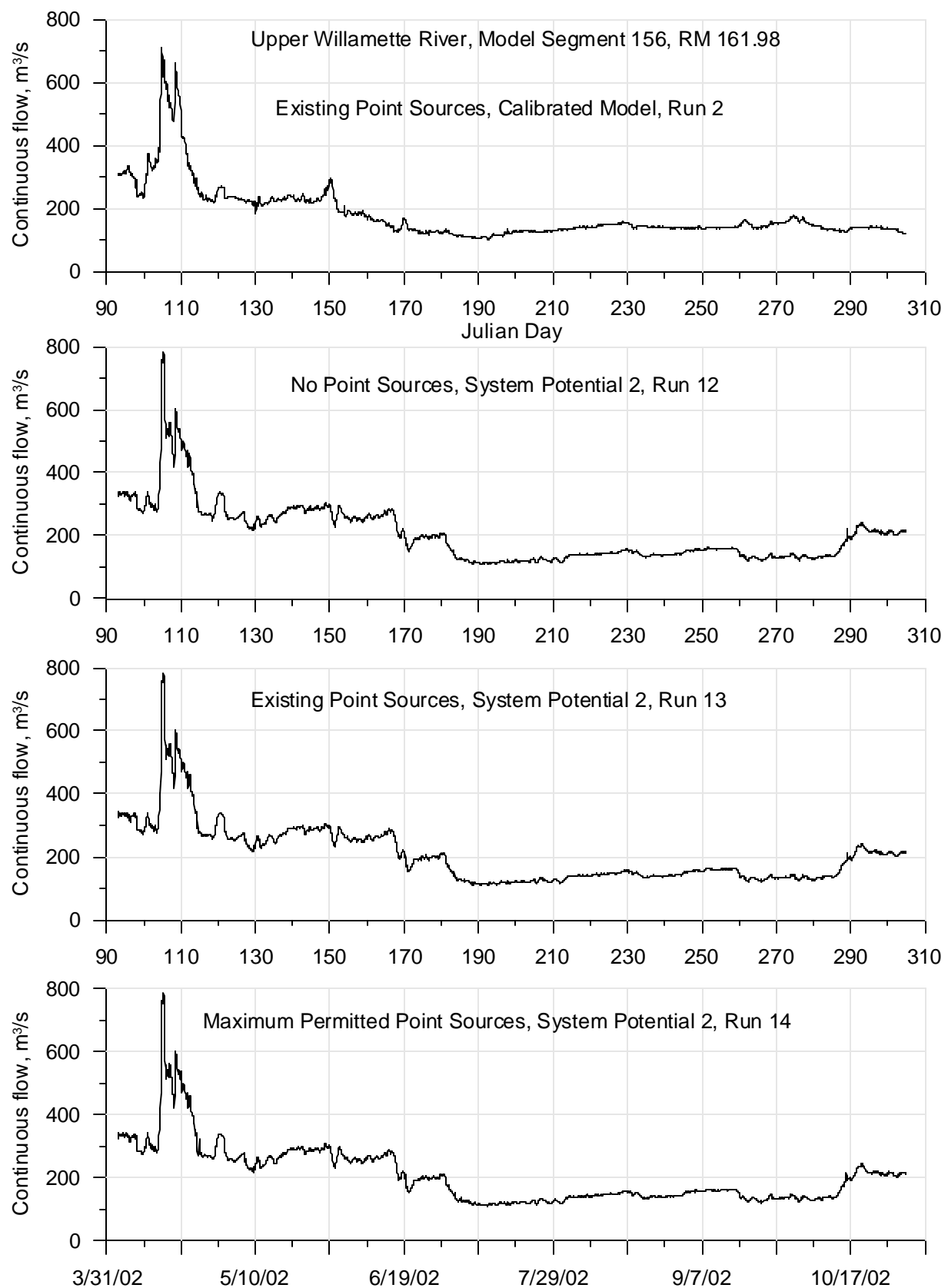


**Figure 352: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Long Tom River at RM 4.64**

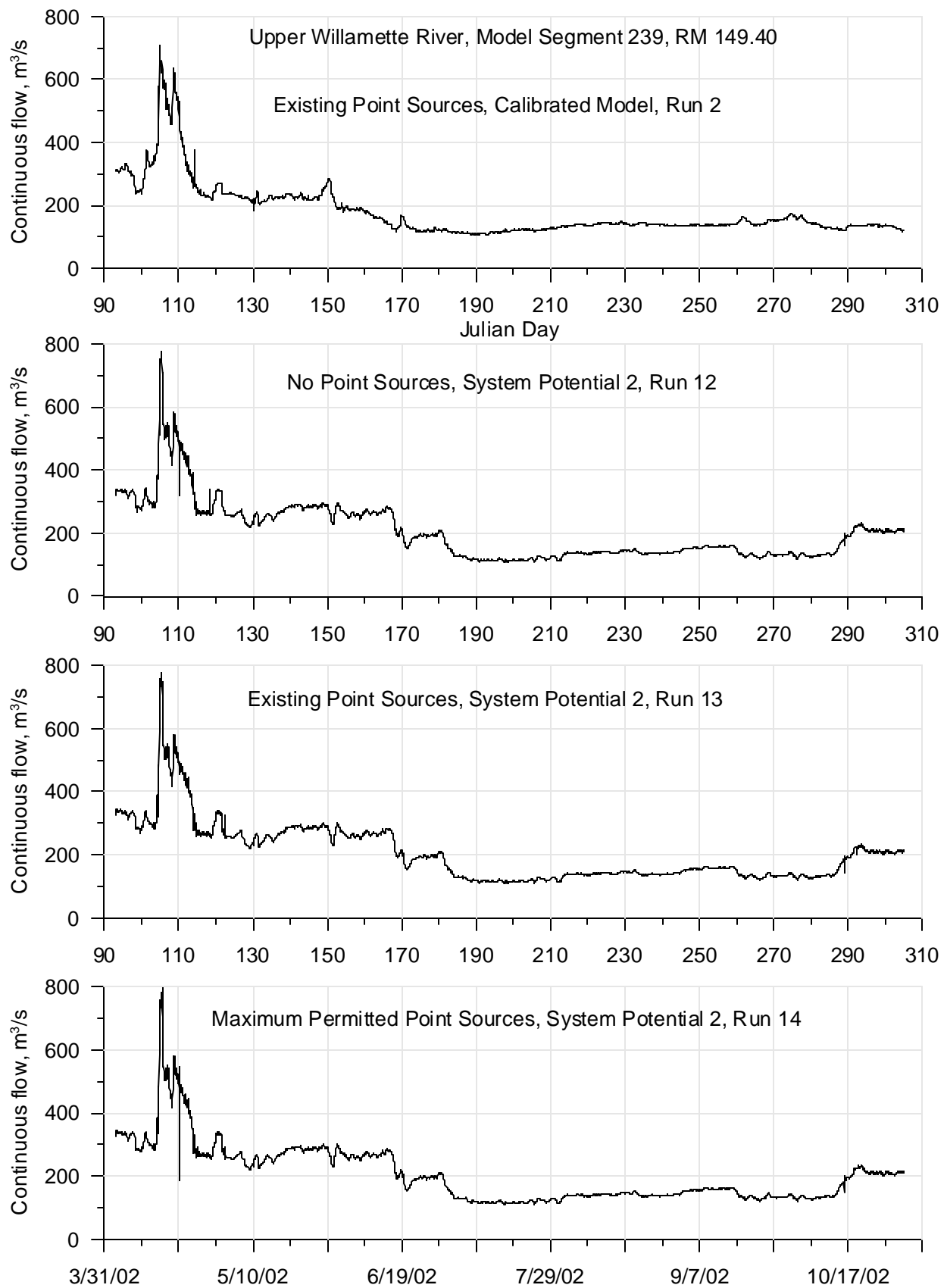




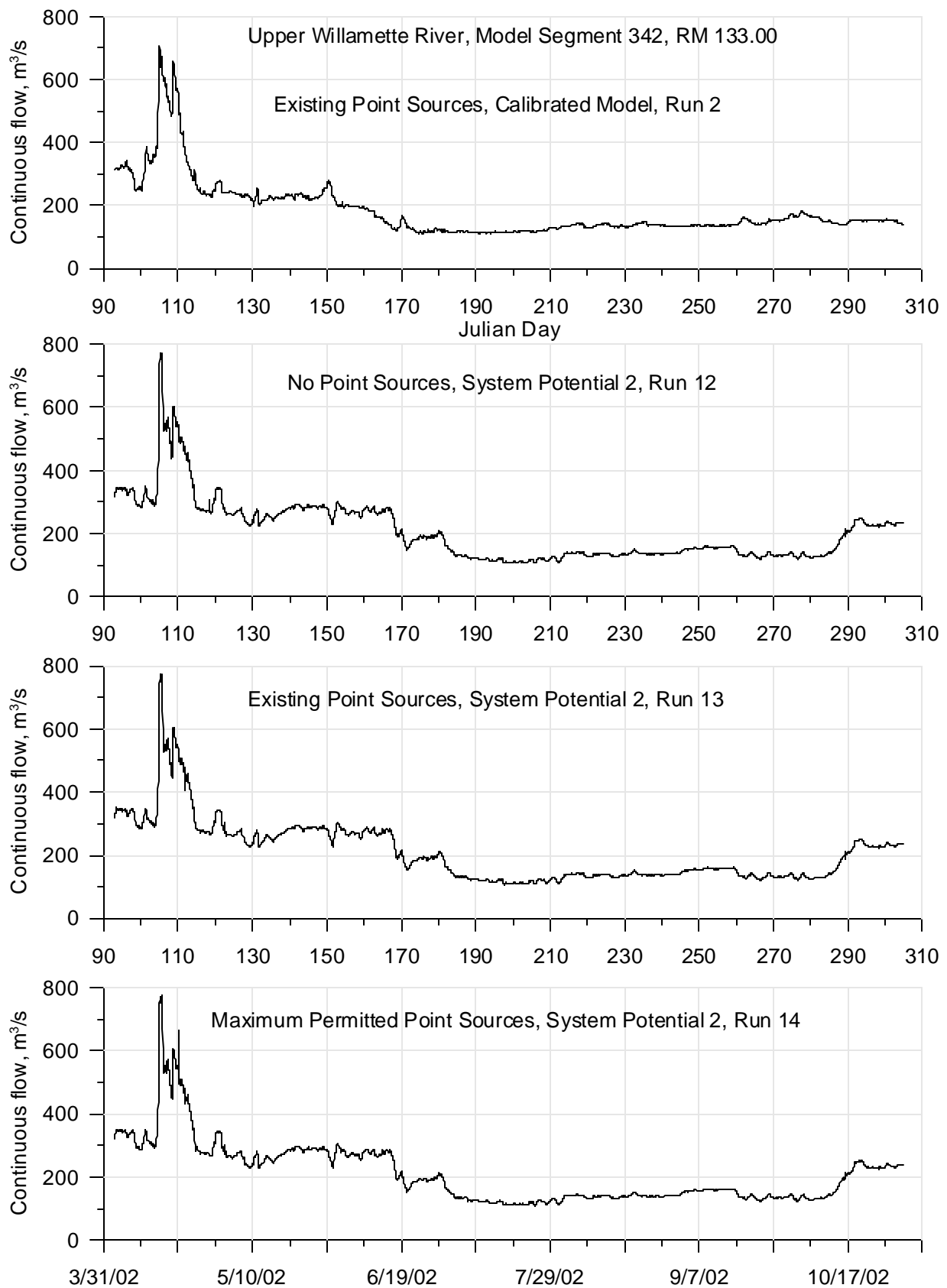
**Figure 353: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 175.3**



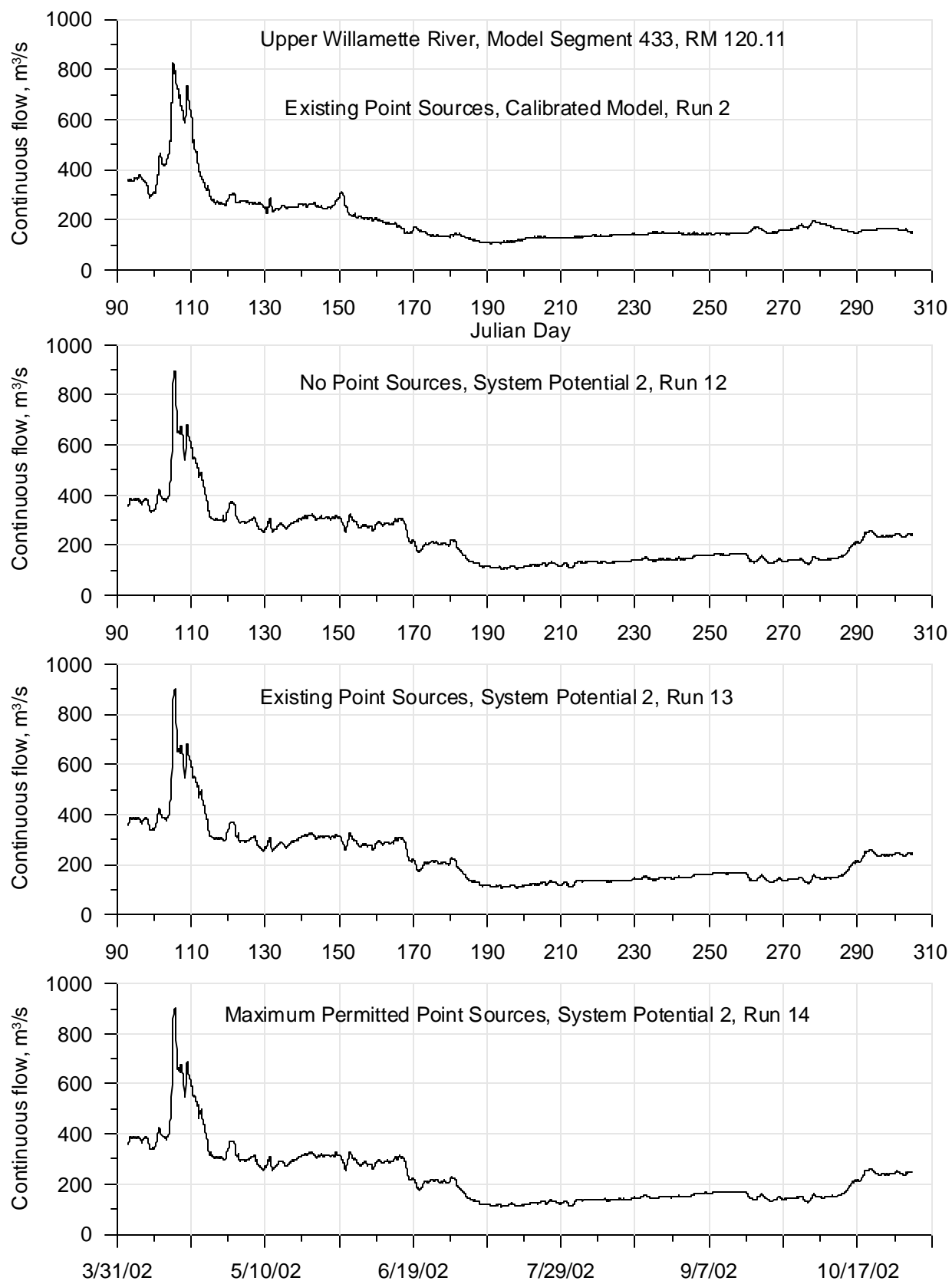
**Figure 354: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 161.98**



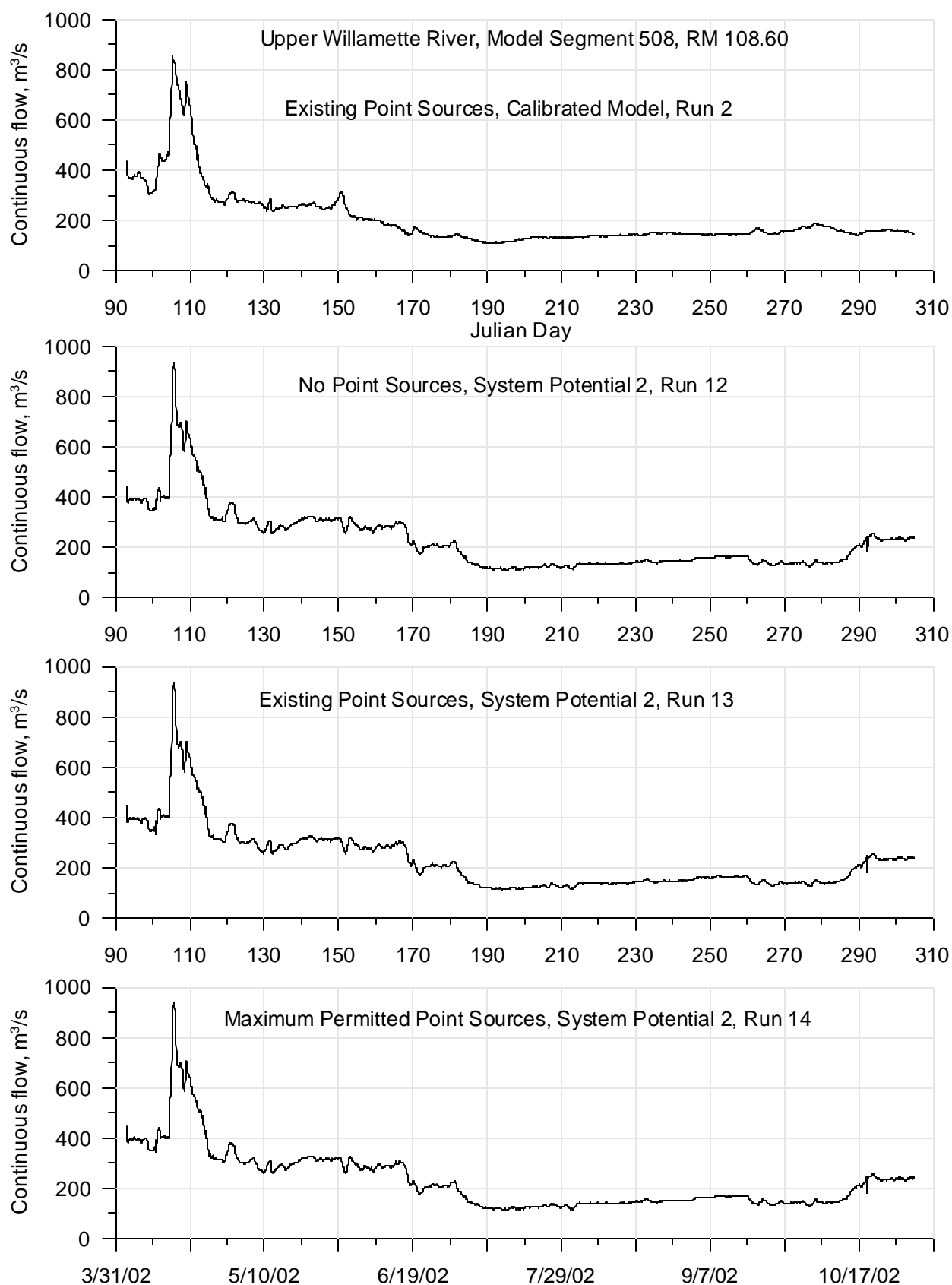
**Figure 355: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 149.4**



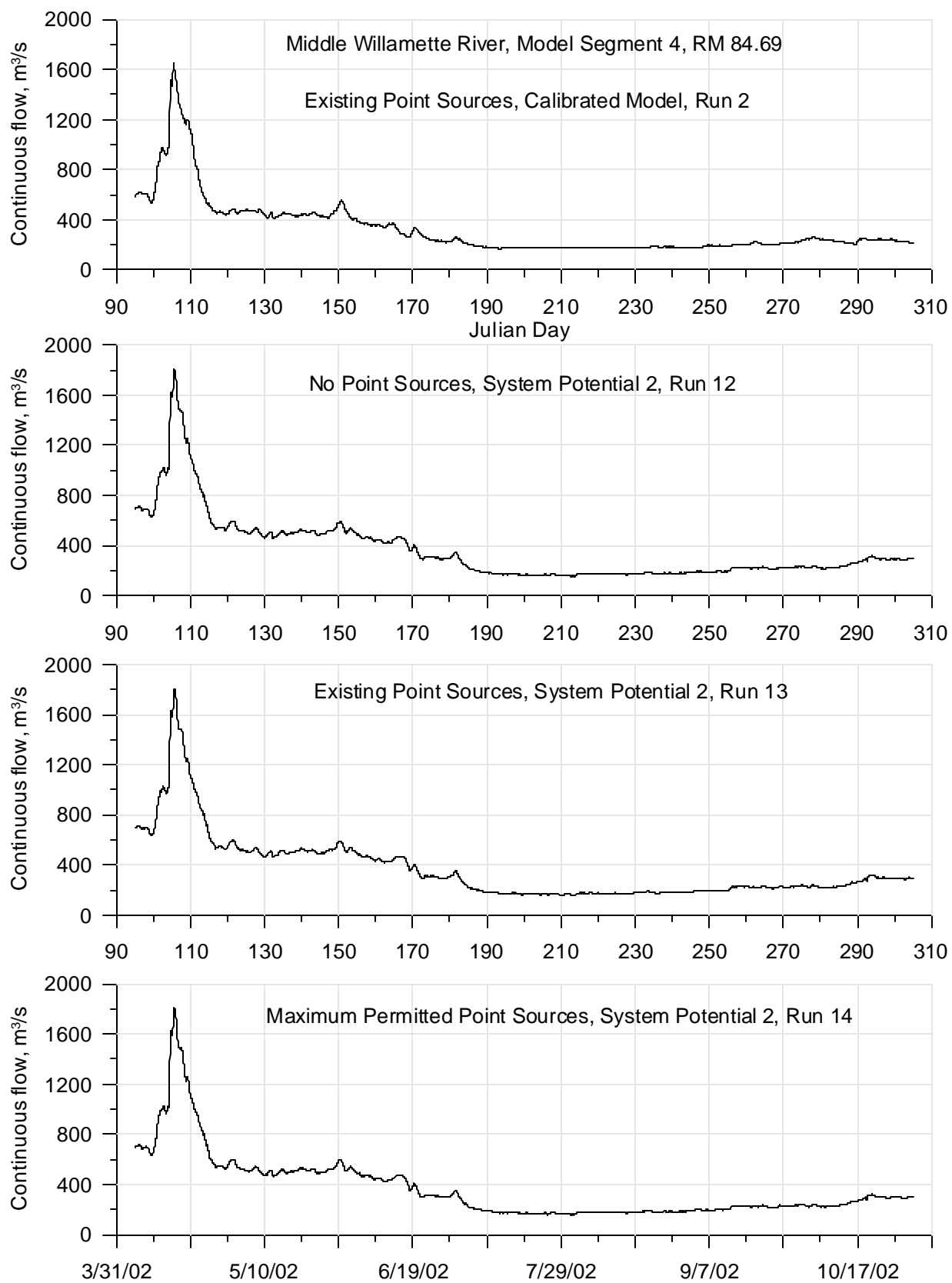
**Figure 356: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 133**



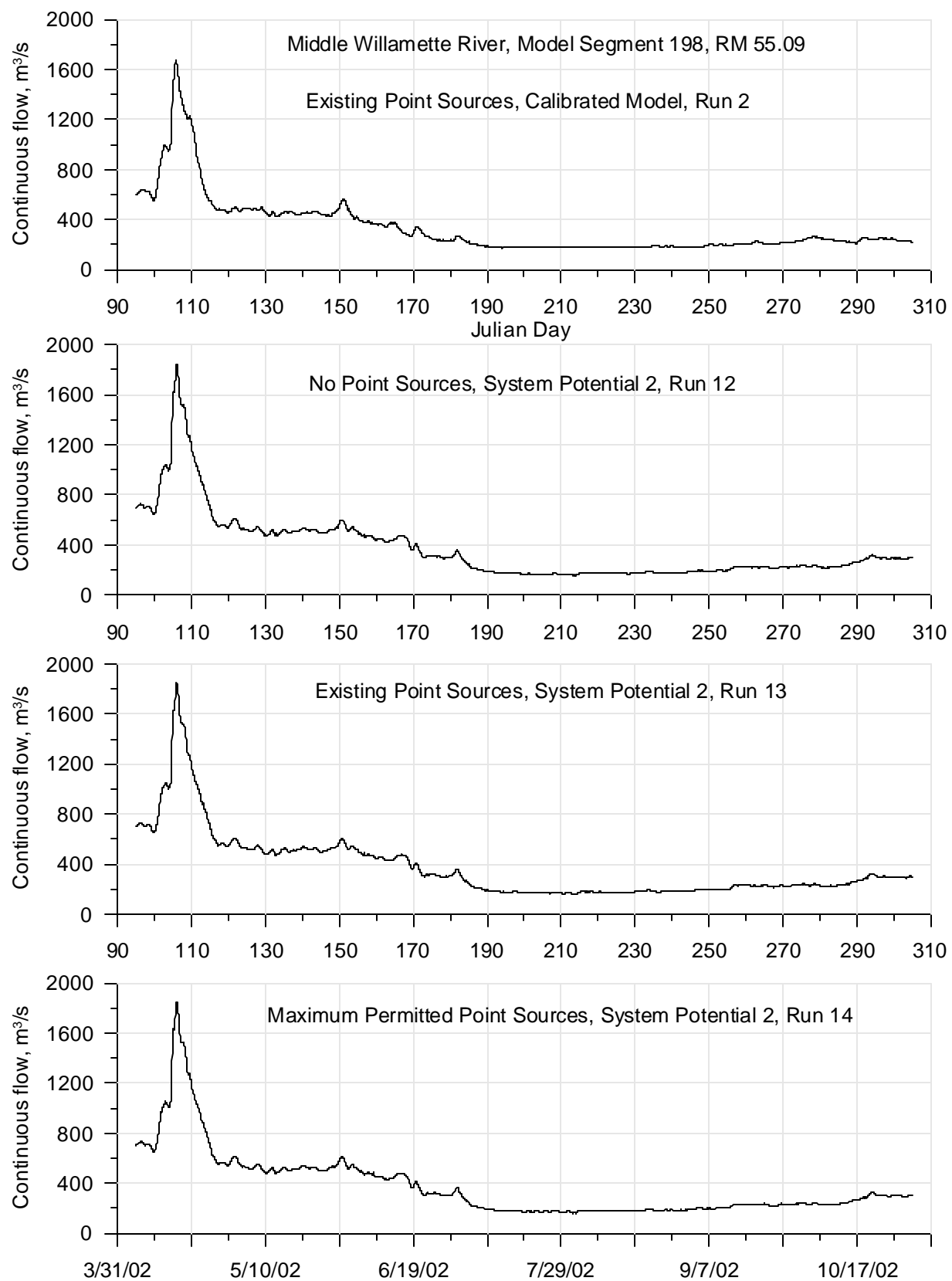
**Figure 357: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 120.11**



**Figure 358: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 108.6**

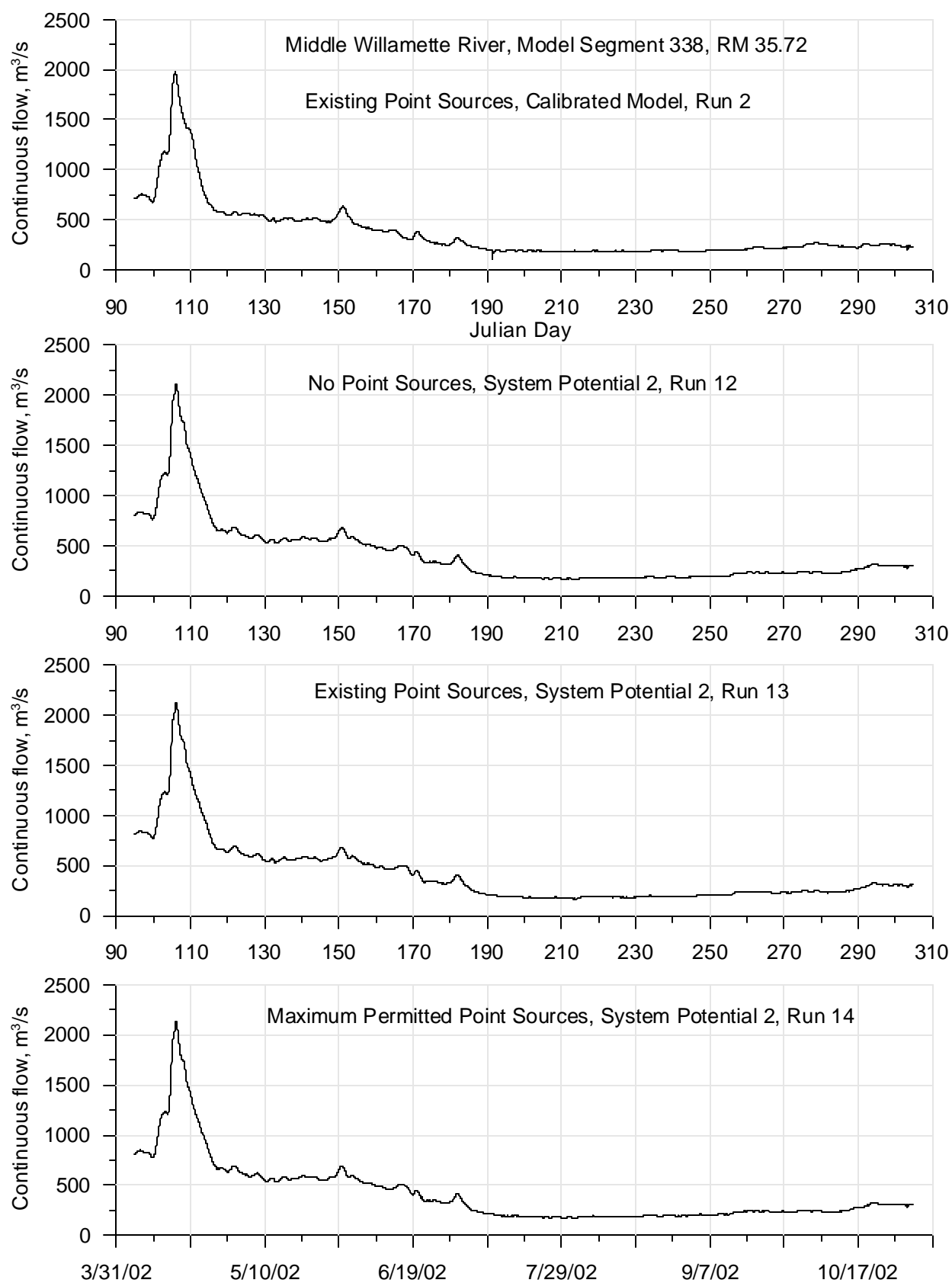


**Figure 359: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 84.69**

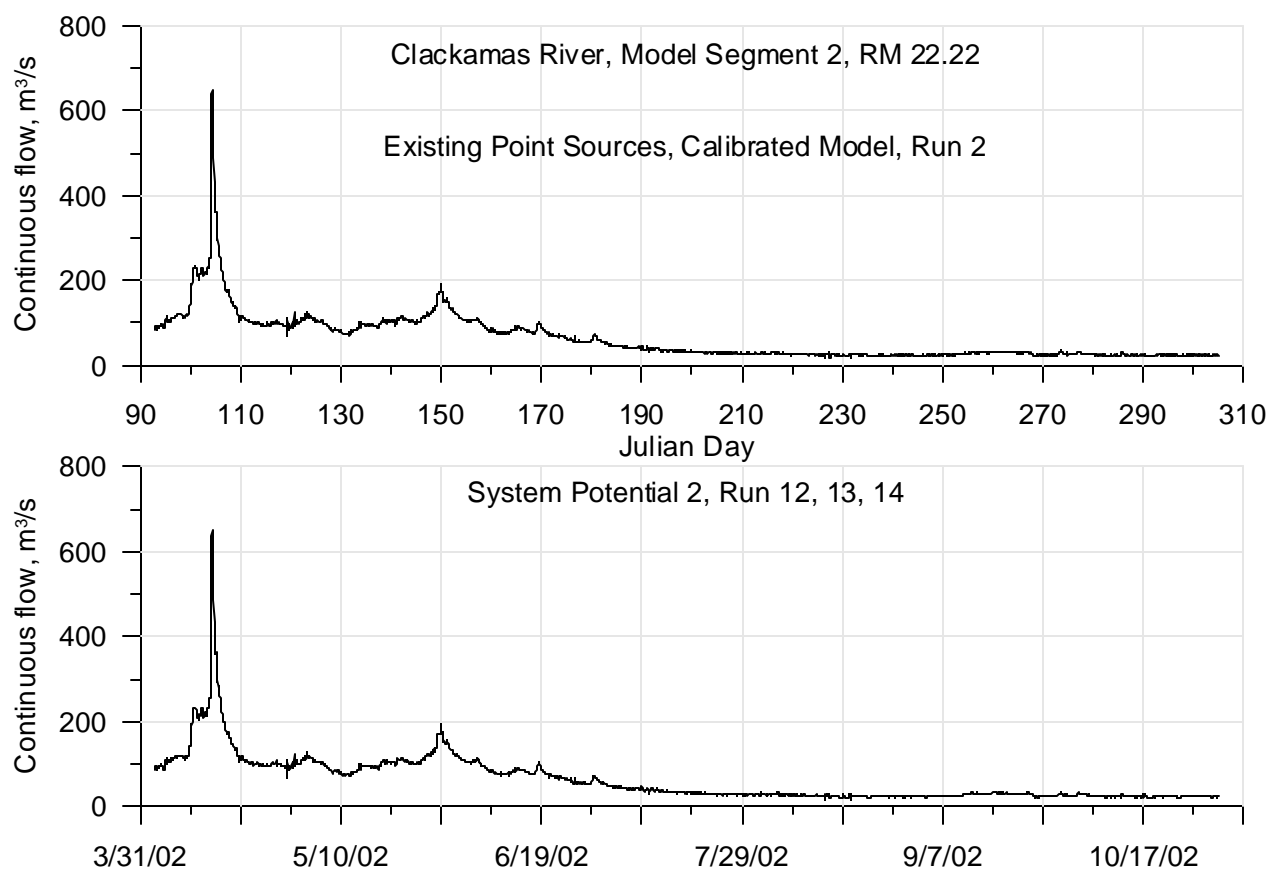


**Figure 360: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 55.09**

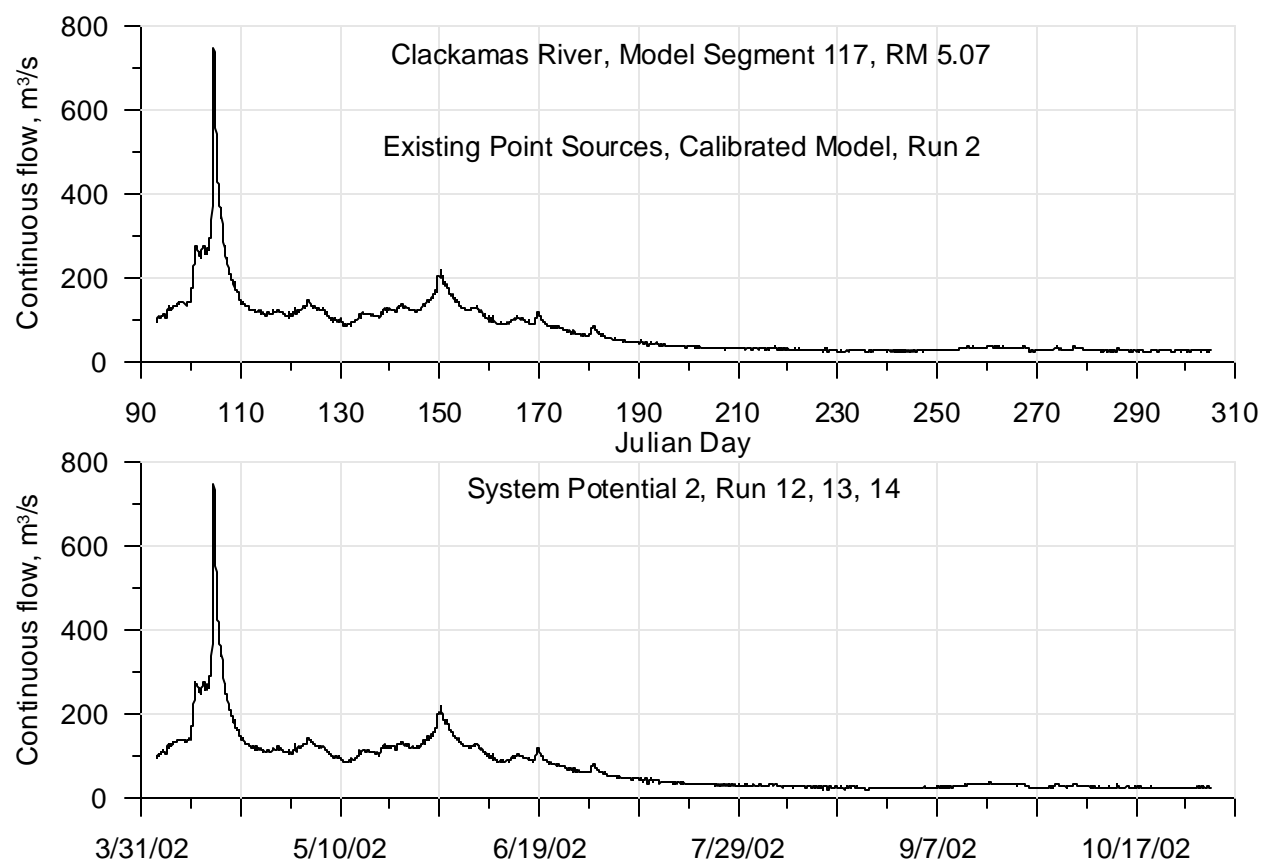




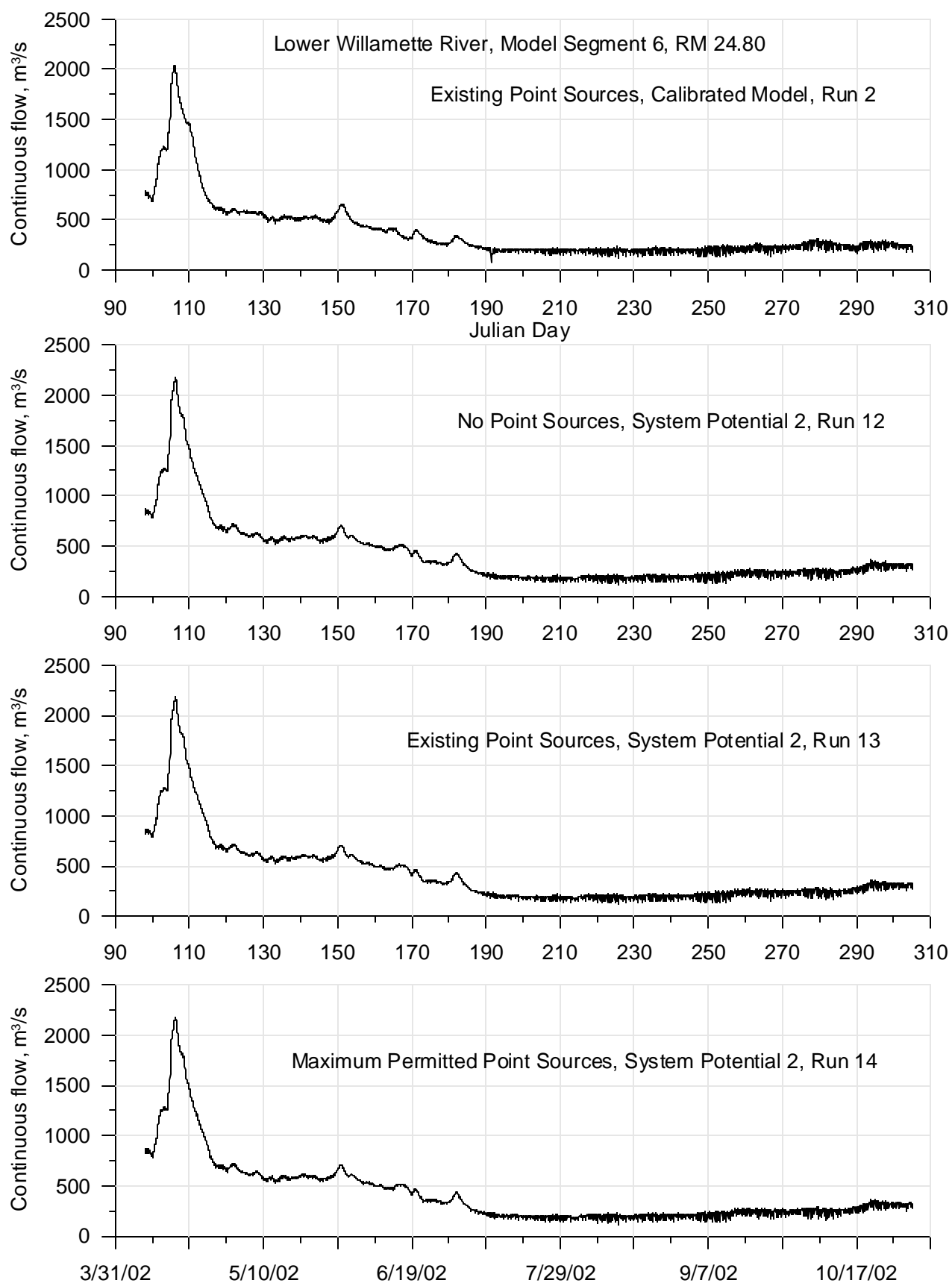
**Figure 361: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 35.72**



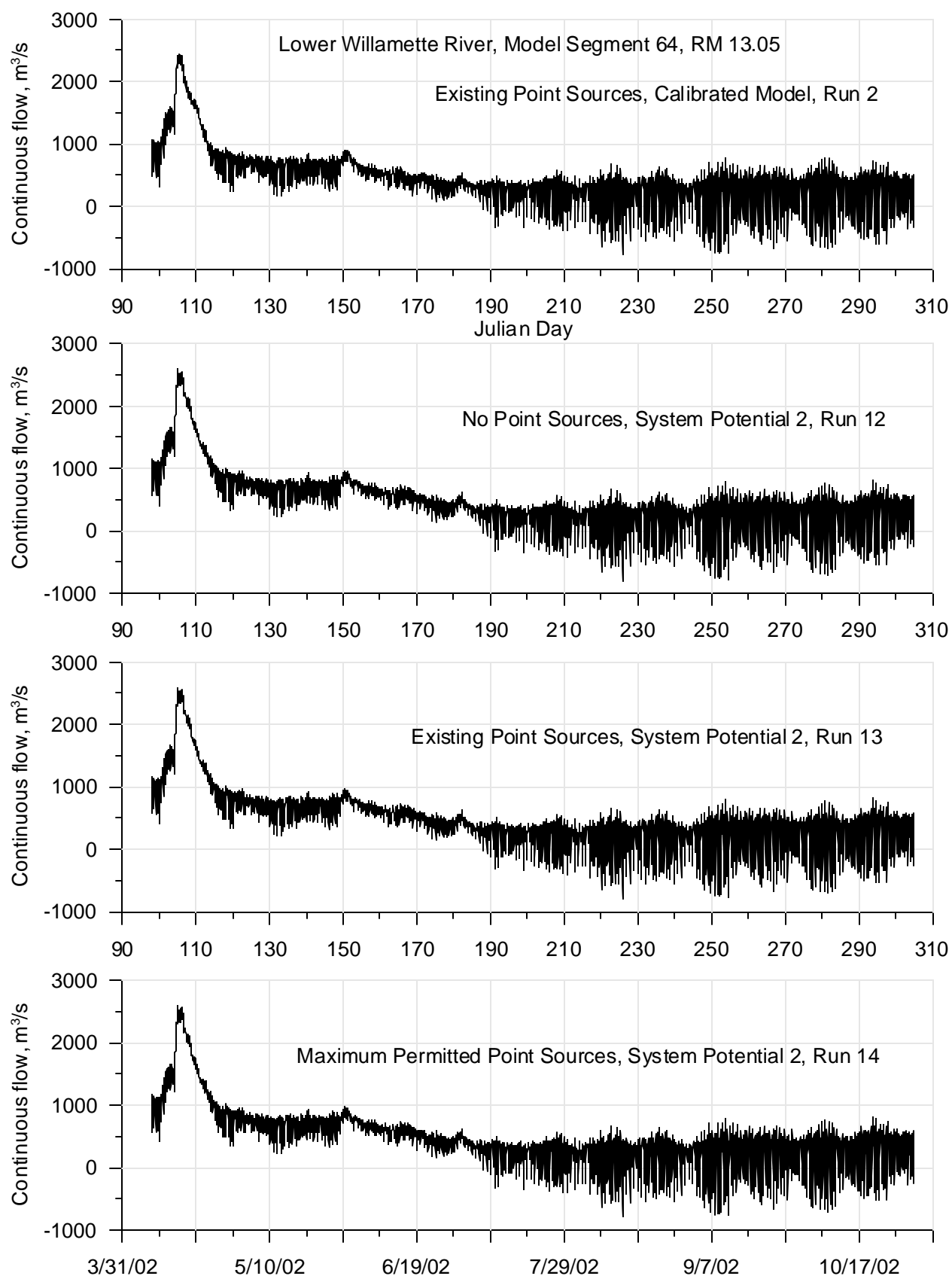
**Figure 362: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Clackamas River at RM 22.22**



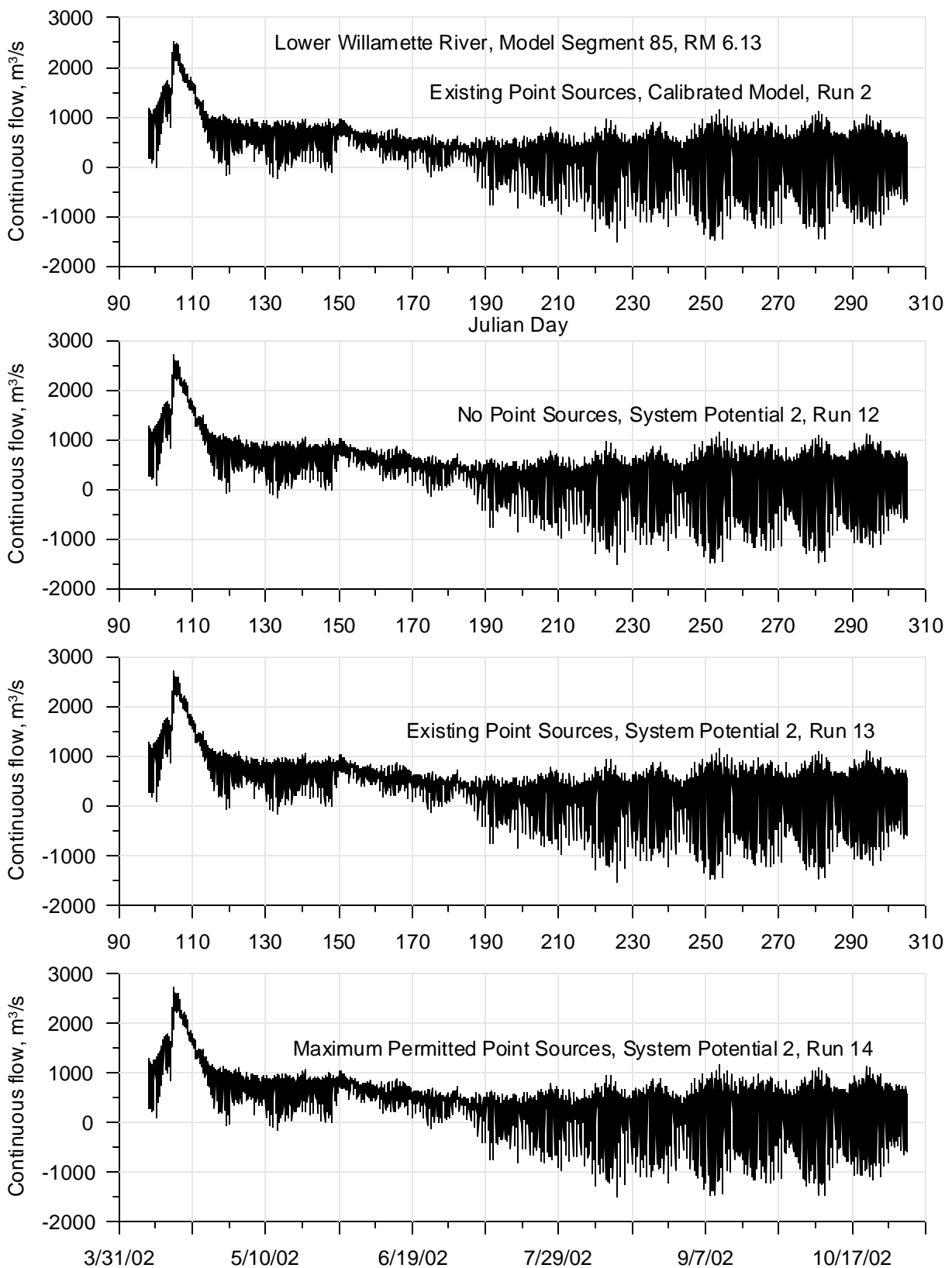
**Figure 363: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Clackamas River at RM 5.07**



**Figure 364: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 24.8**

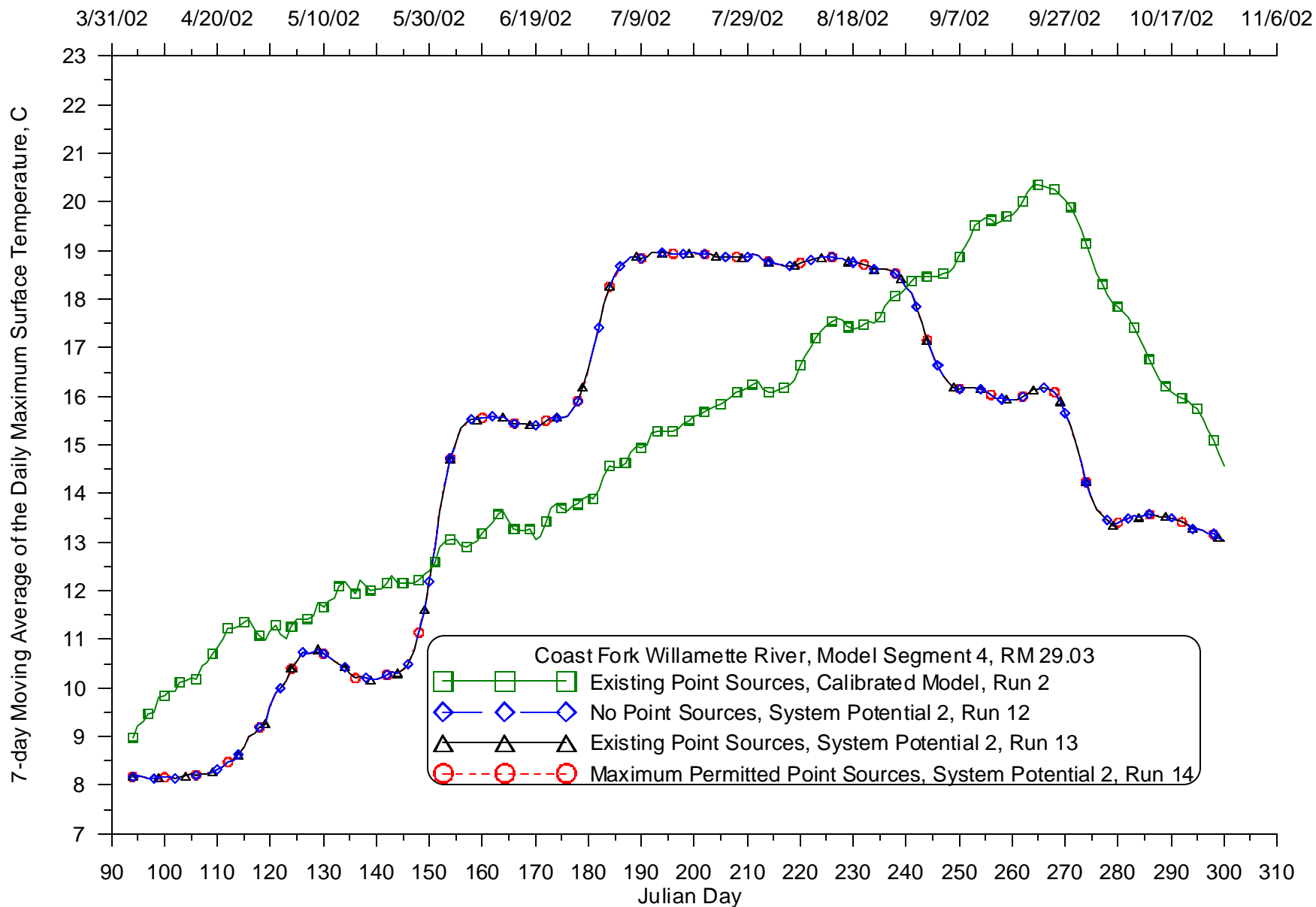


**Figure 365: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 13.05**



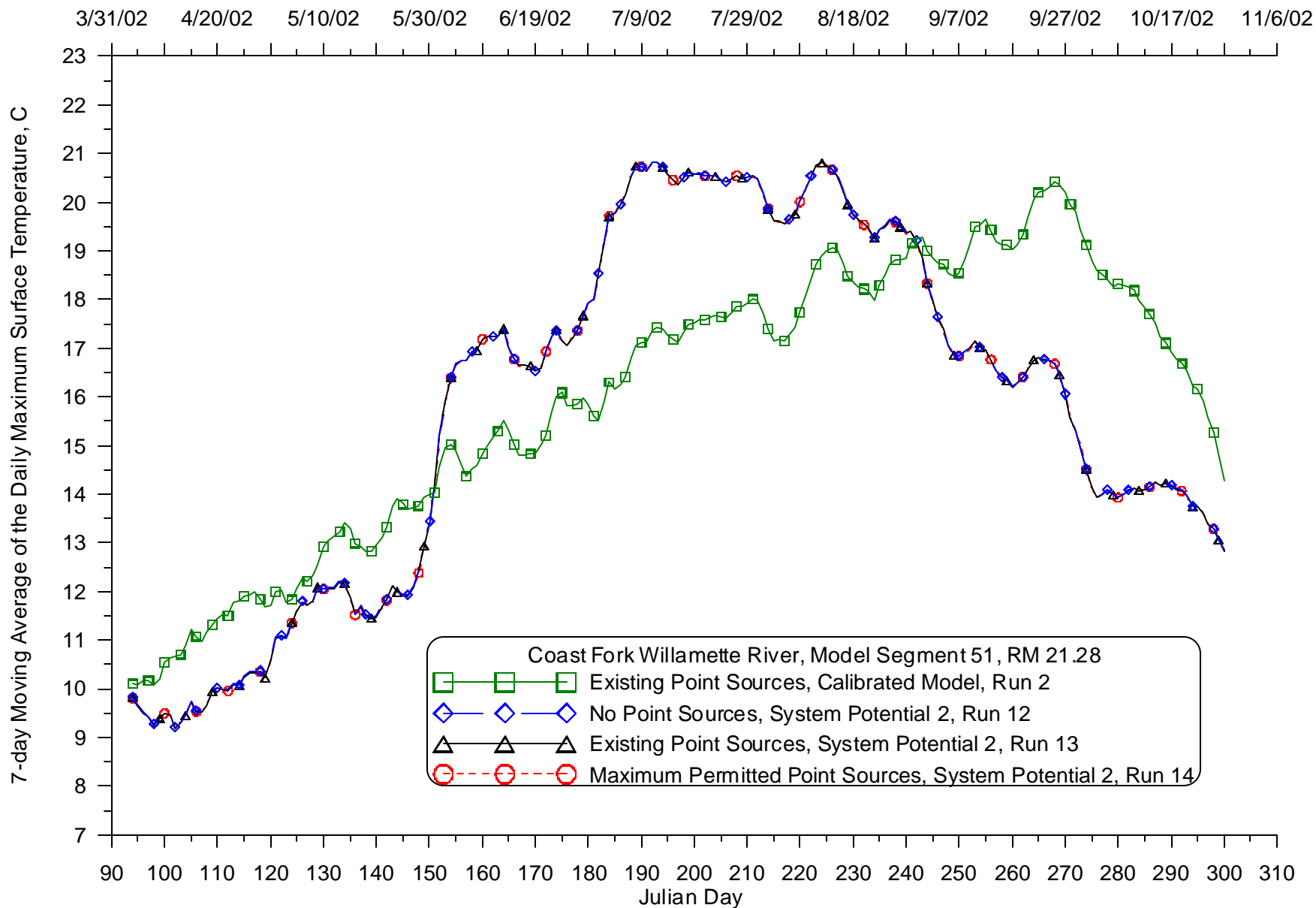
**Figure 366: Calibrated model and System Potential 2 (varying point source discharges) continuous flow comparison for 2002 for the Willamette River at RM 6.13**

**Daily seven day moving average of daily maximum temperature**

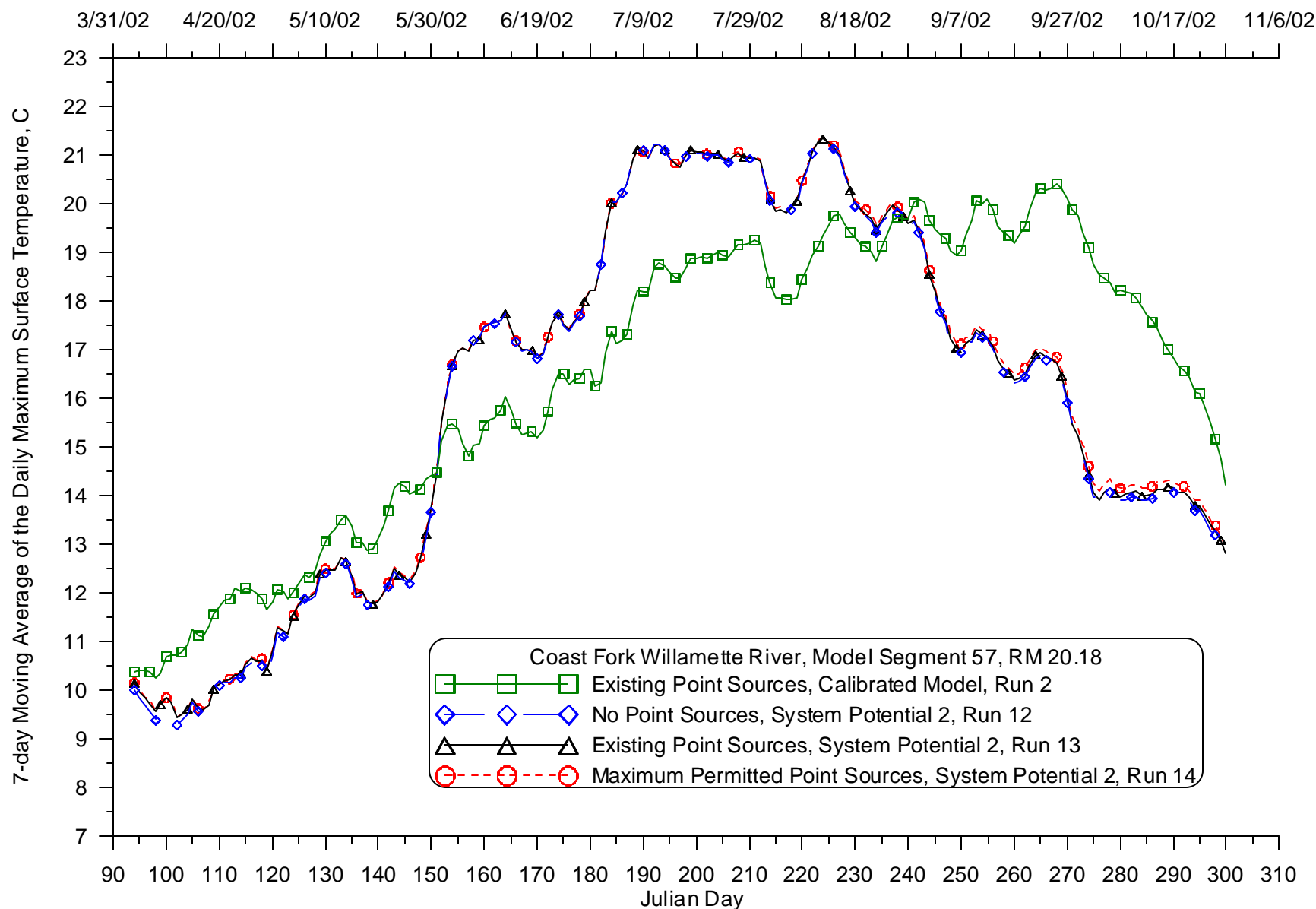


**Figure 367: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Coast Fork Willamette River at RM 29.03**

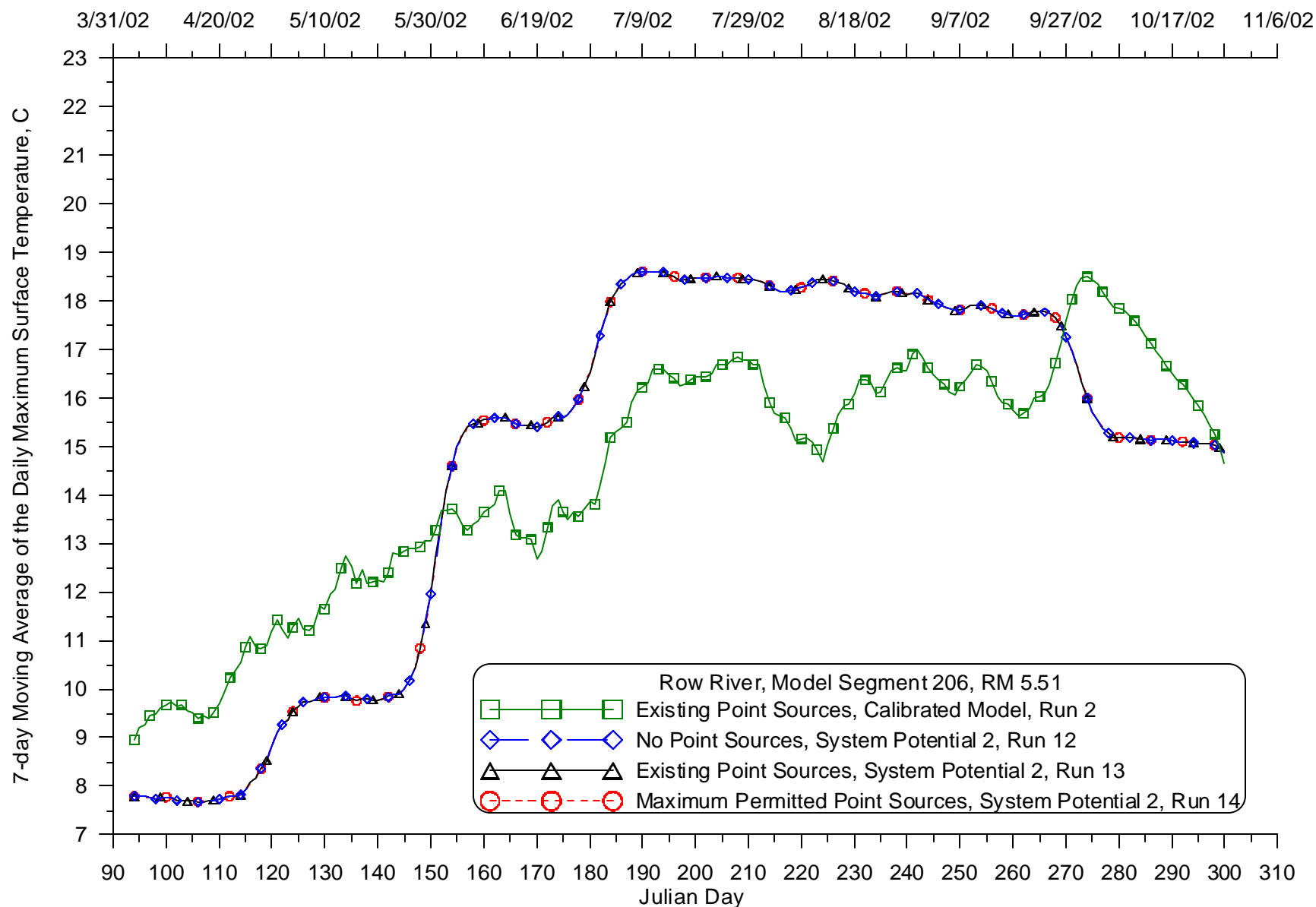




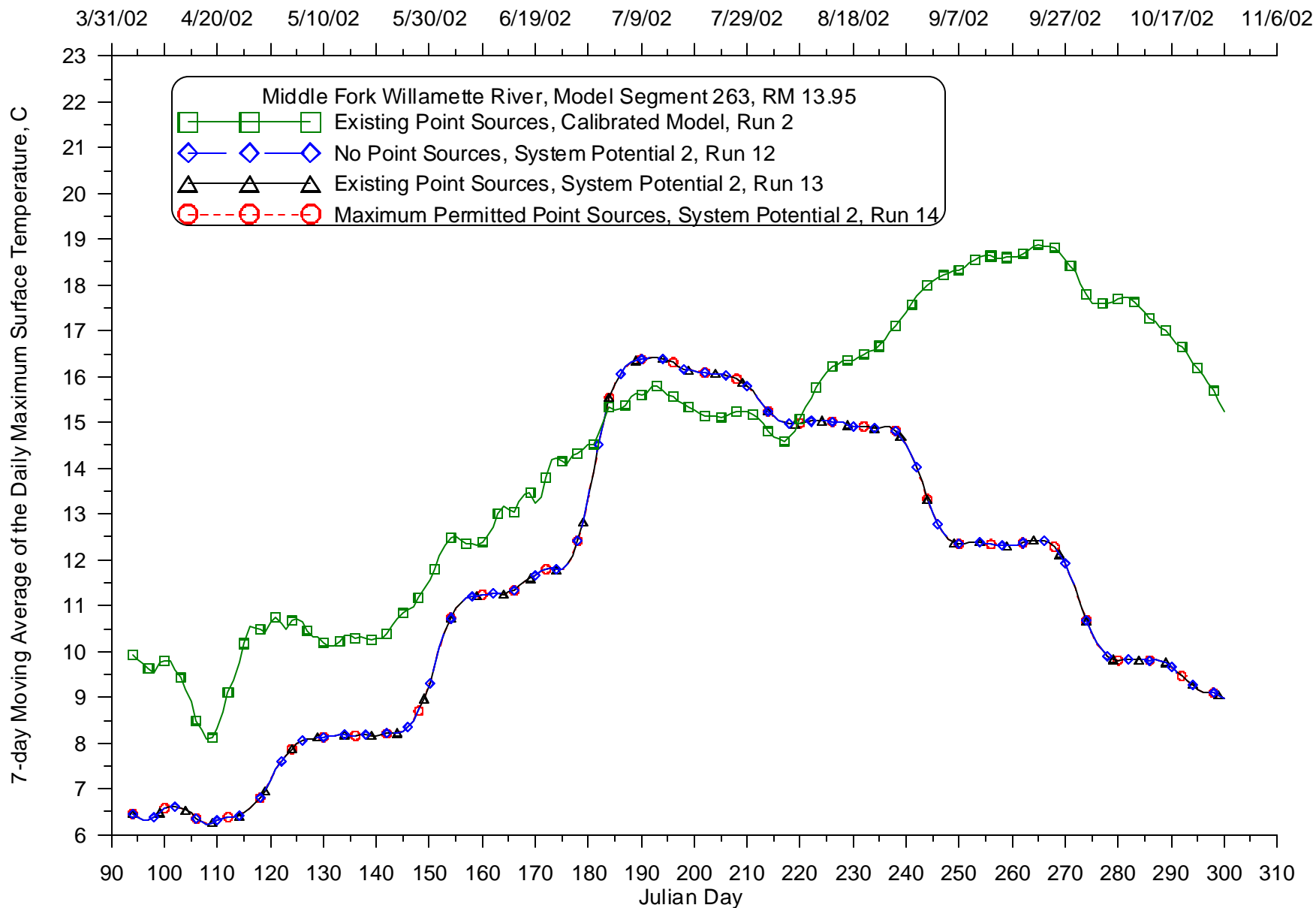
**Figure 368: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Coast Fork Willamette River at RM 21.28**



**Figure 369: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Coast Fork Willamette River at RM 20.18**



**Figure 370: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Row River at RM 5.51**



**Figure 371: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Middle Fork Willamette River at RM 13.95**

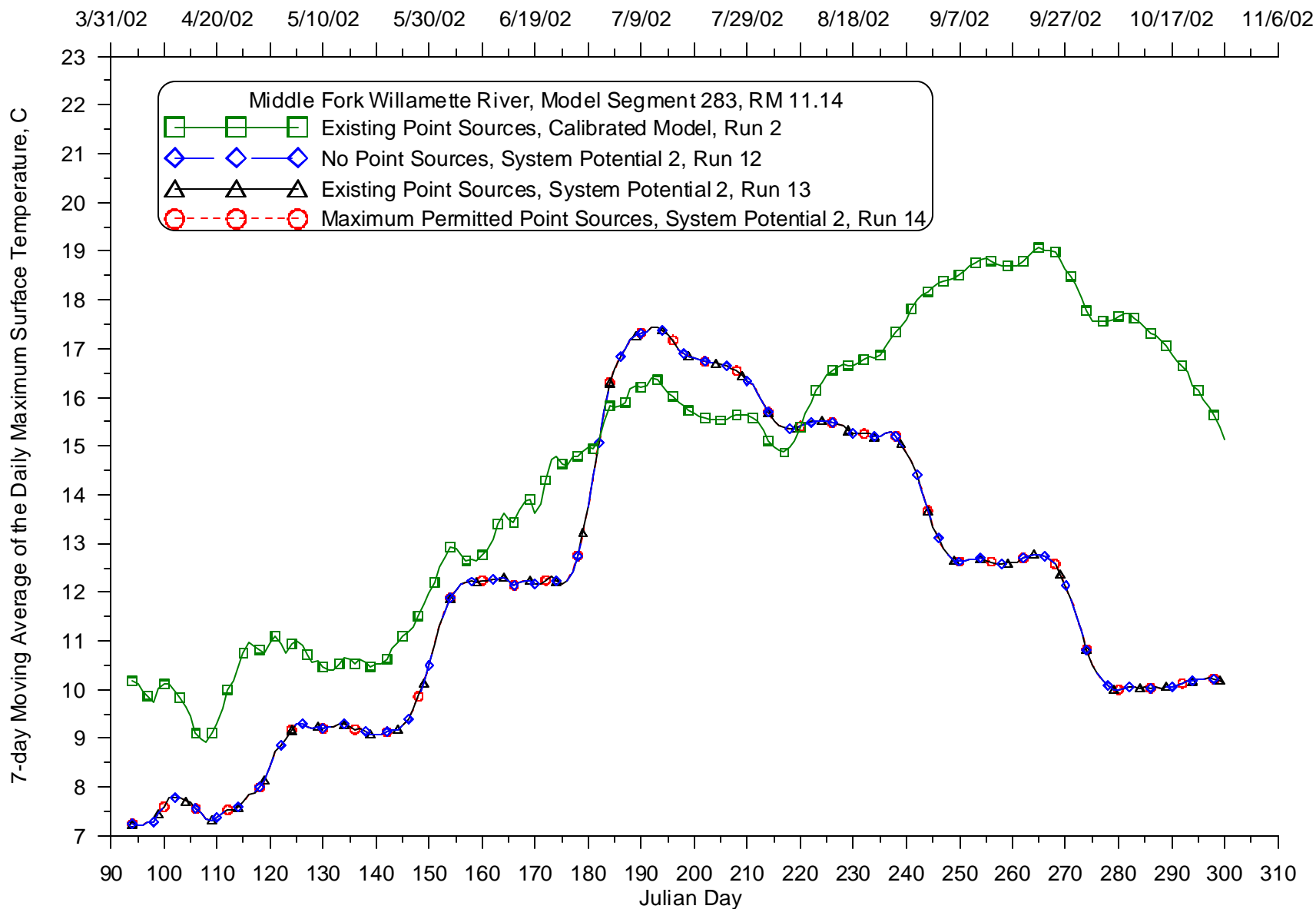
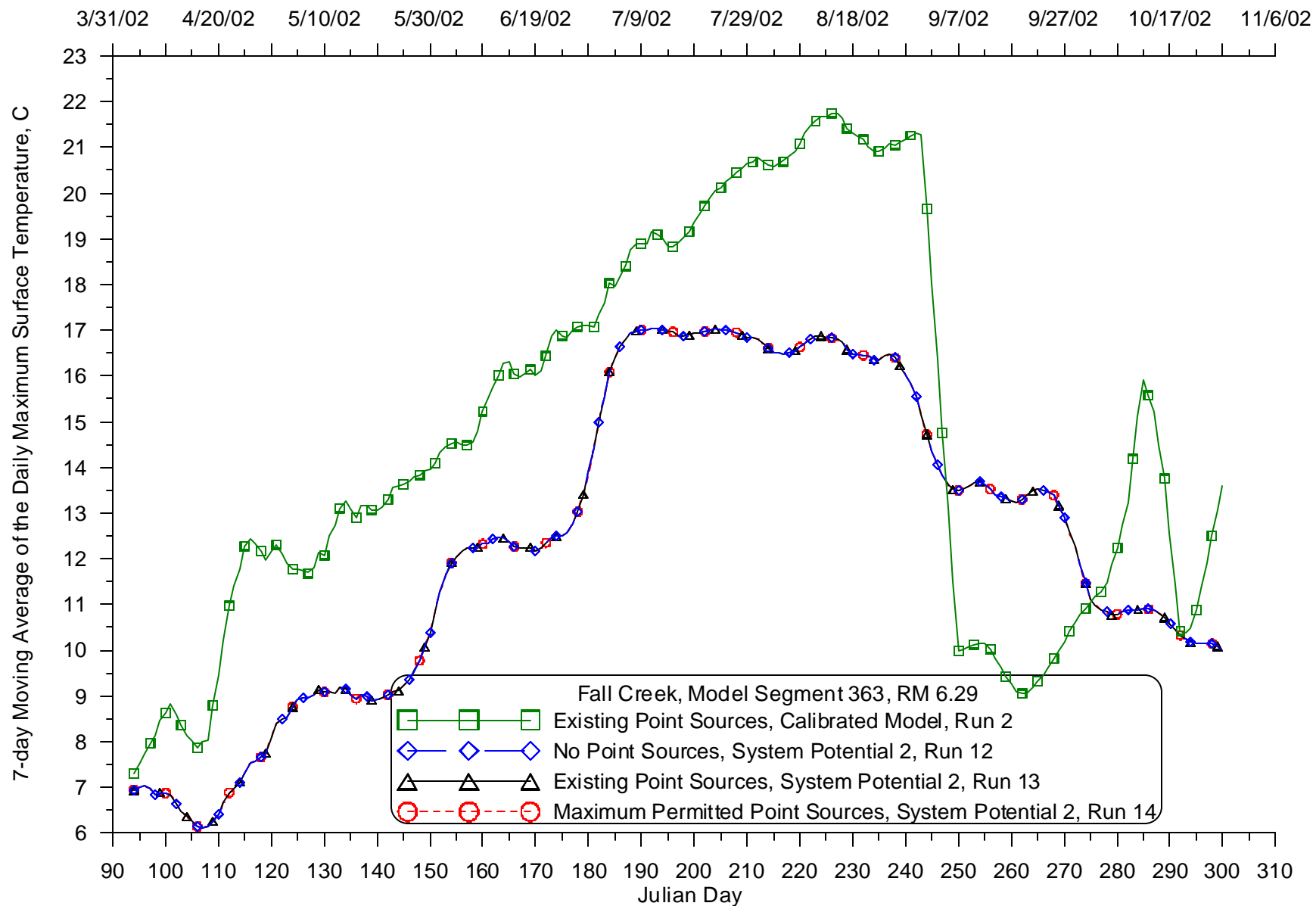
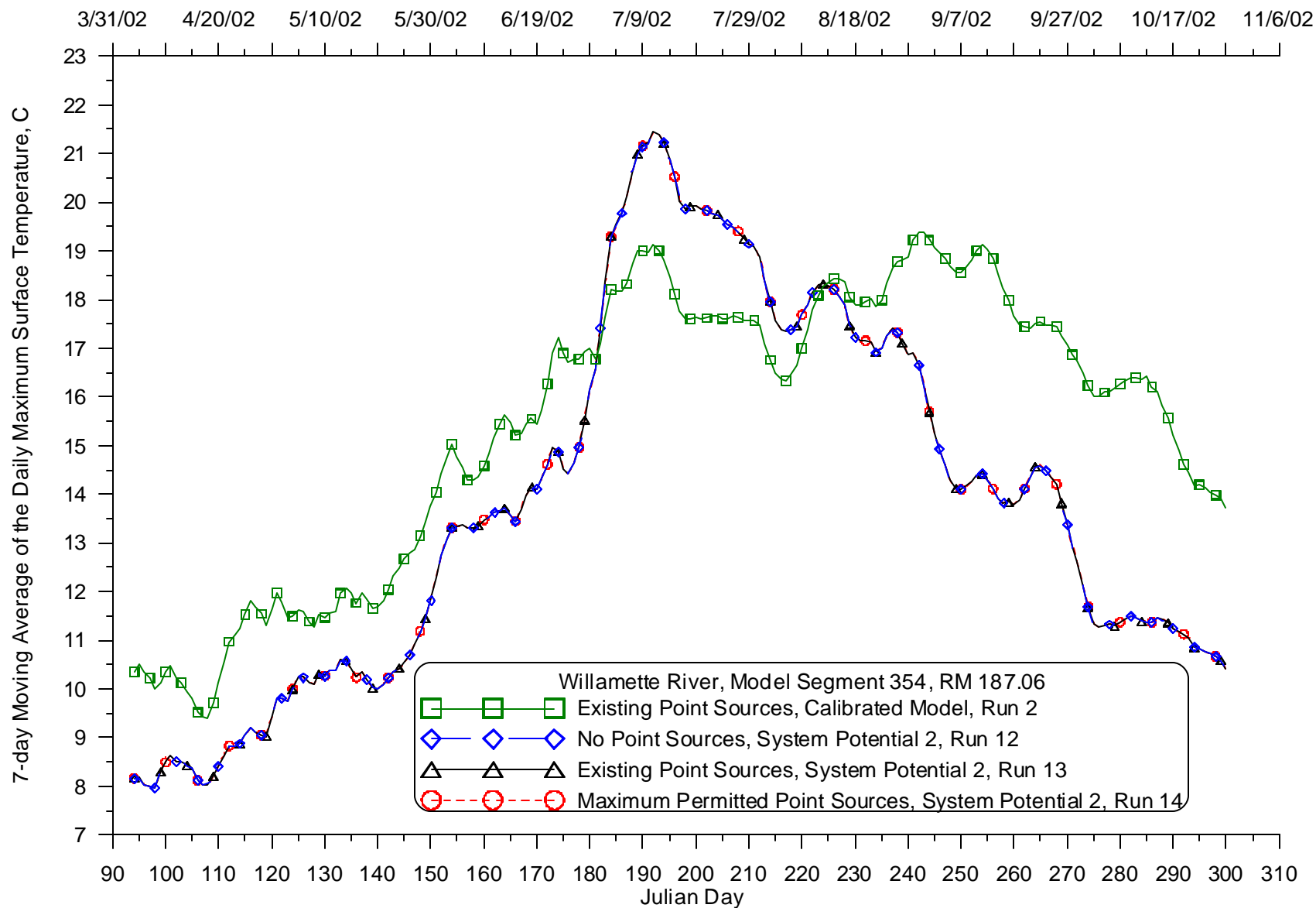


Figure 372: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Middle Fork Willamette River at RM 11.14



**Figure 373: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for Fall Creek at RM 6.29**



**Figure 374: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 187.06**

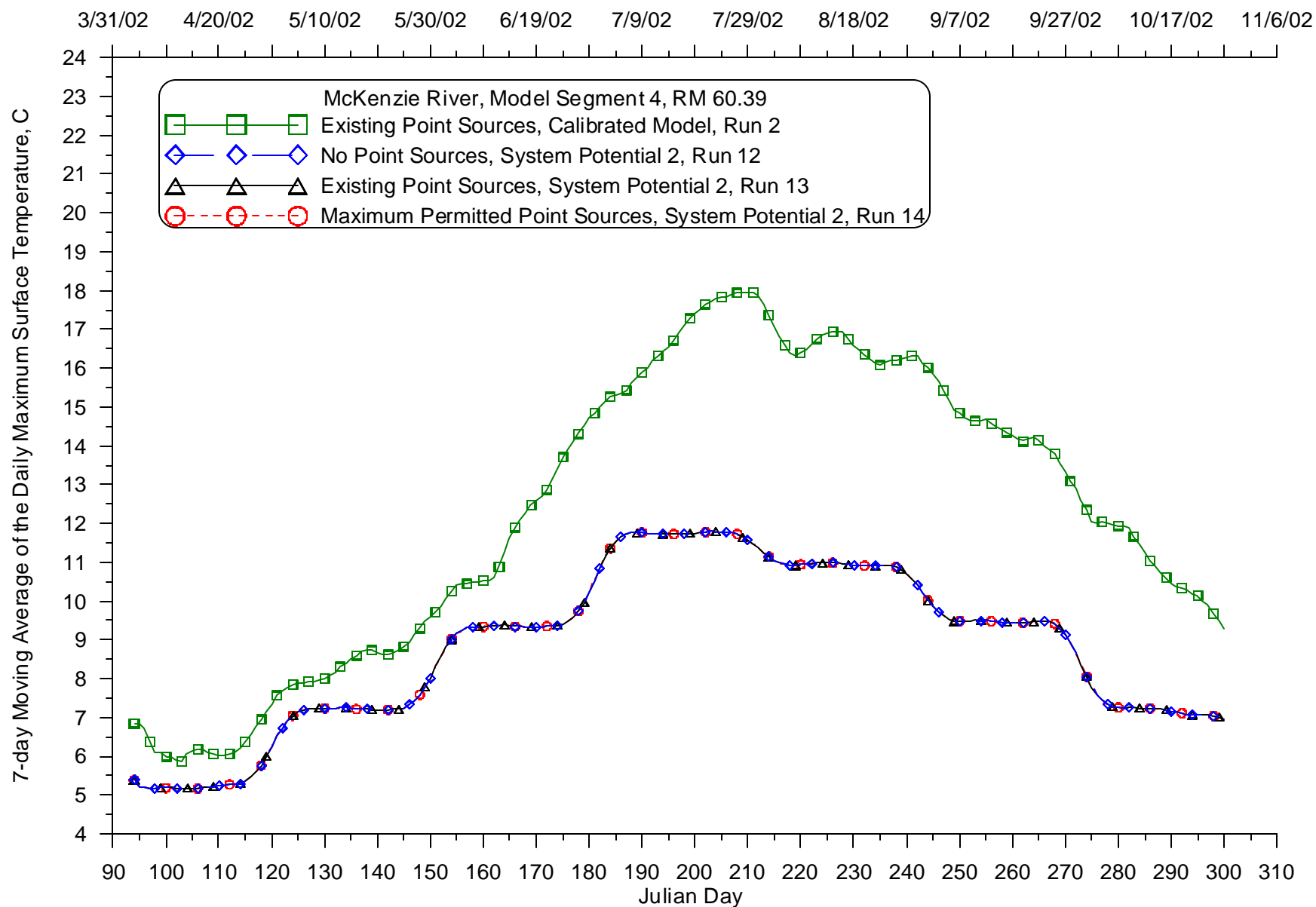
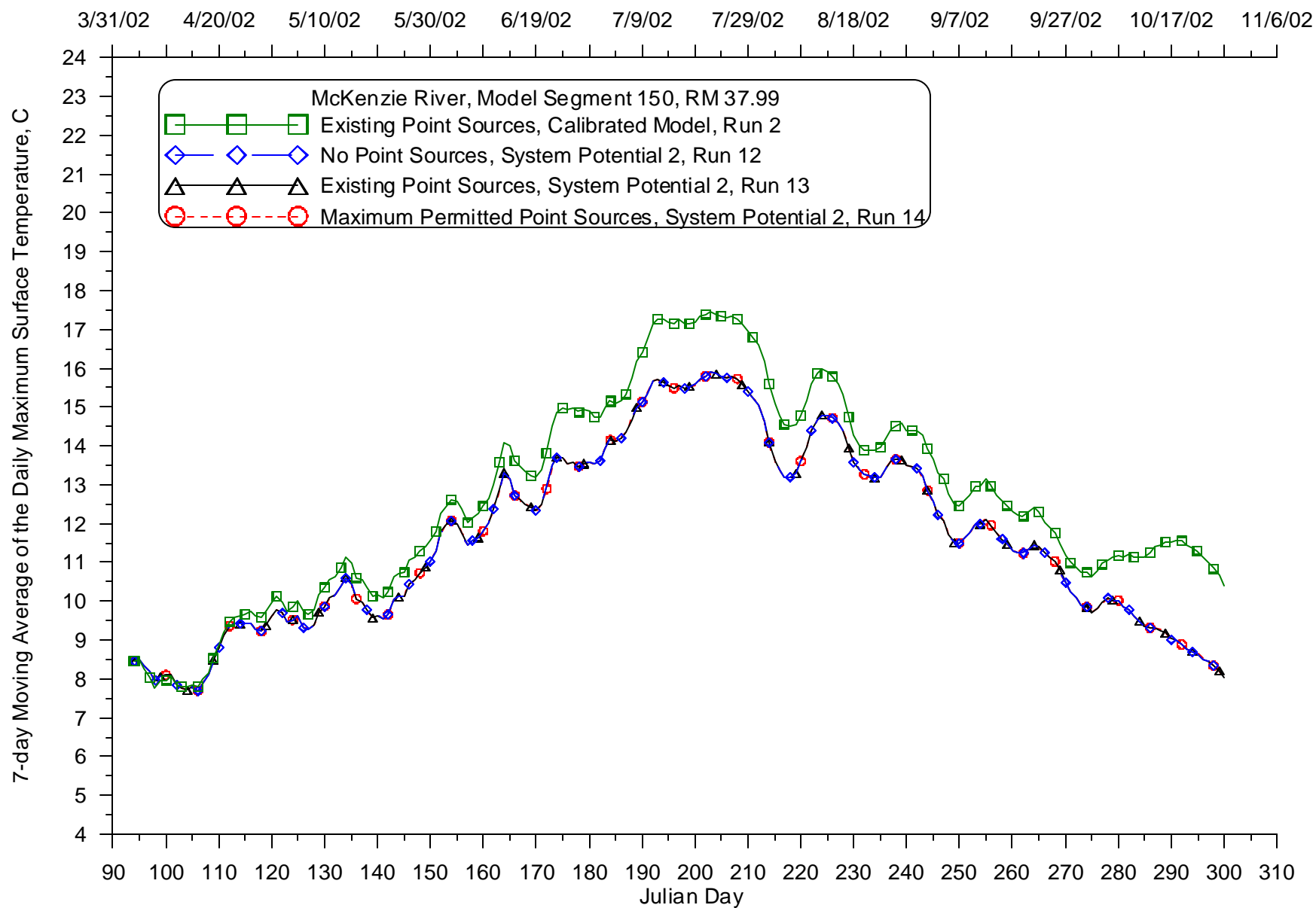
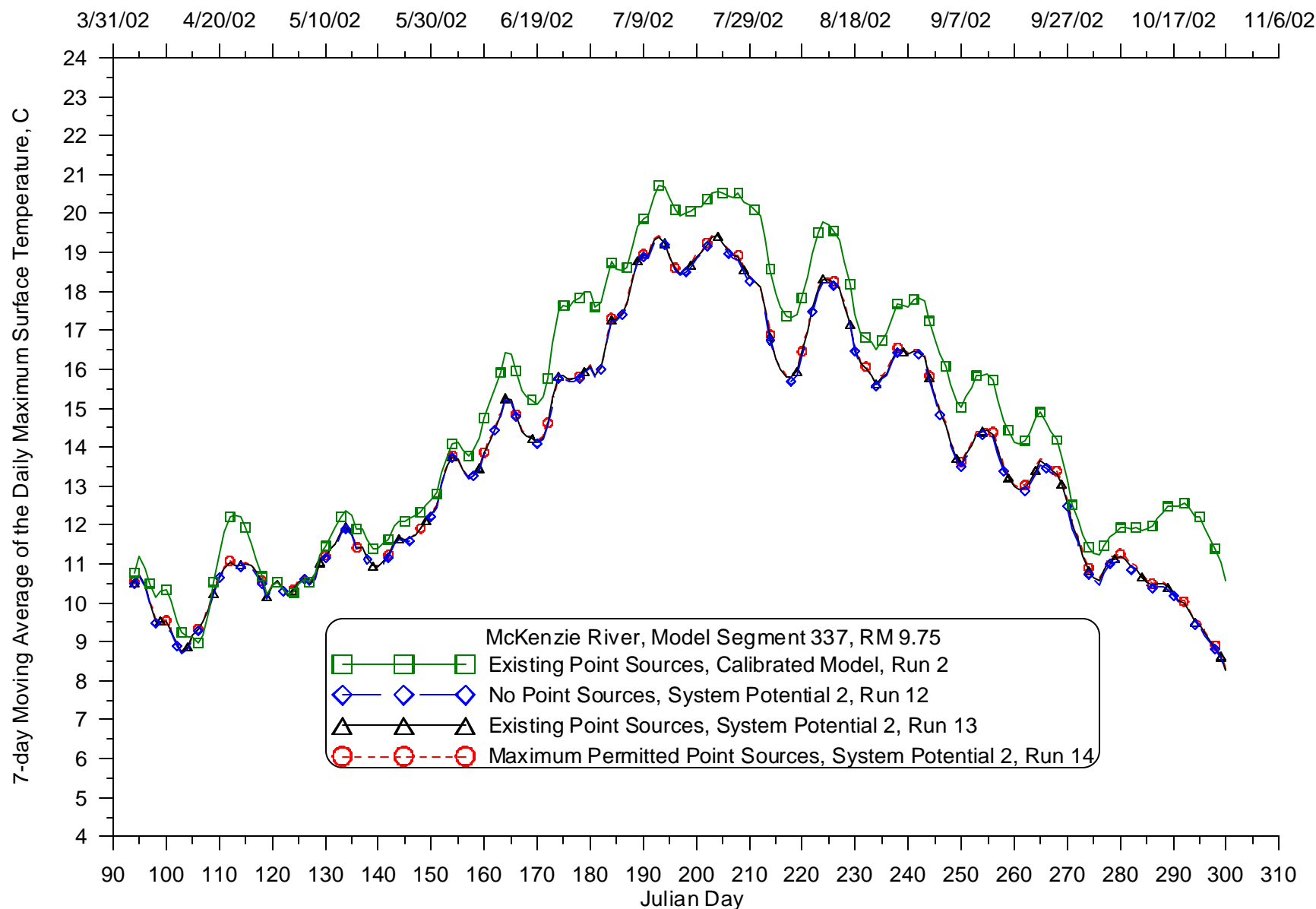


Figure 375: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the McKenzie River at RM 60.39

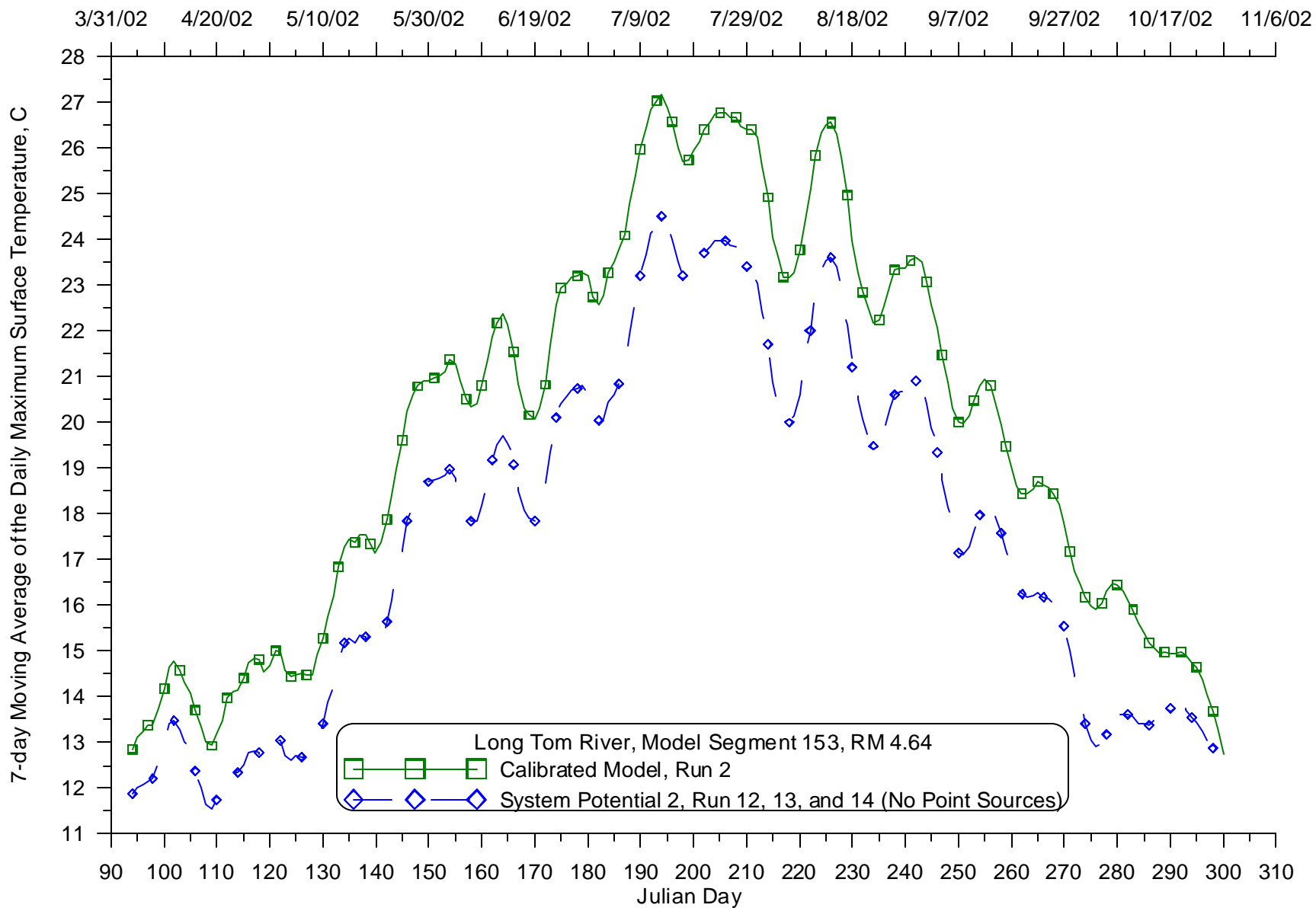




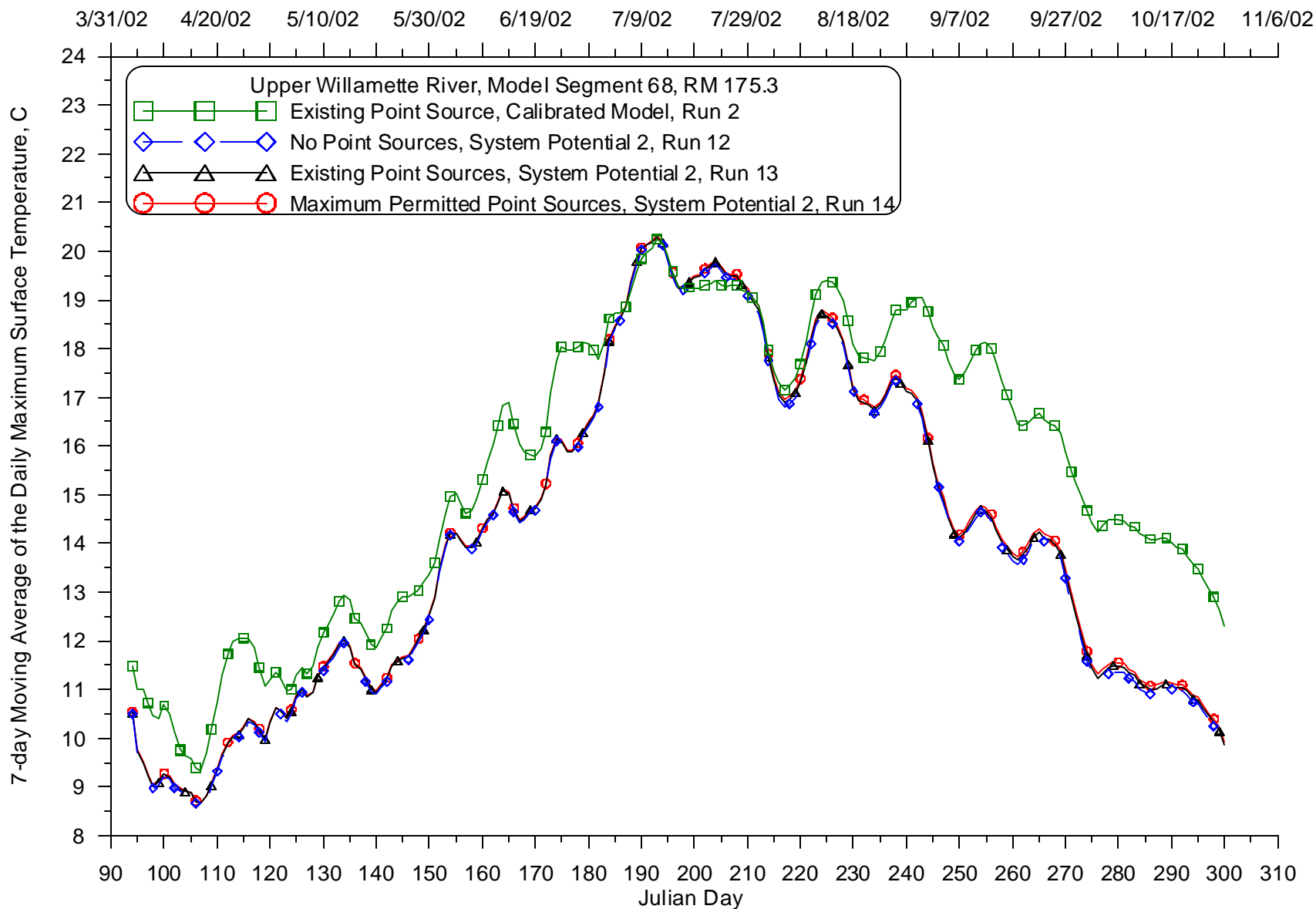
**Figure 376: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the McKenzie River at RM 37.99**



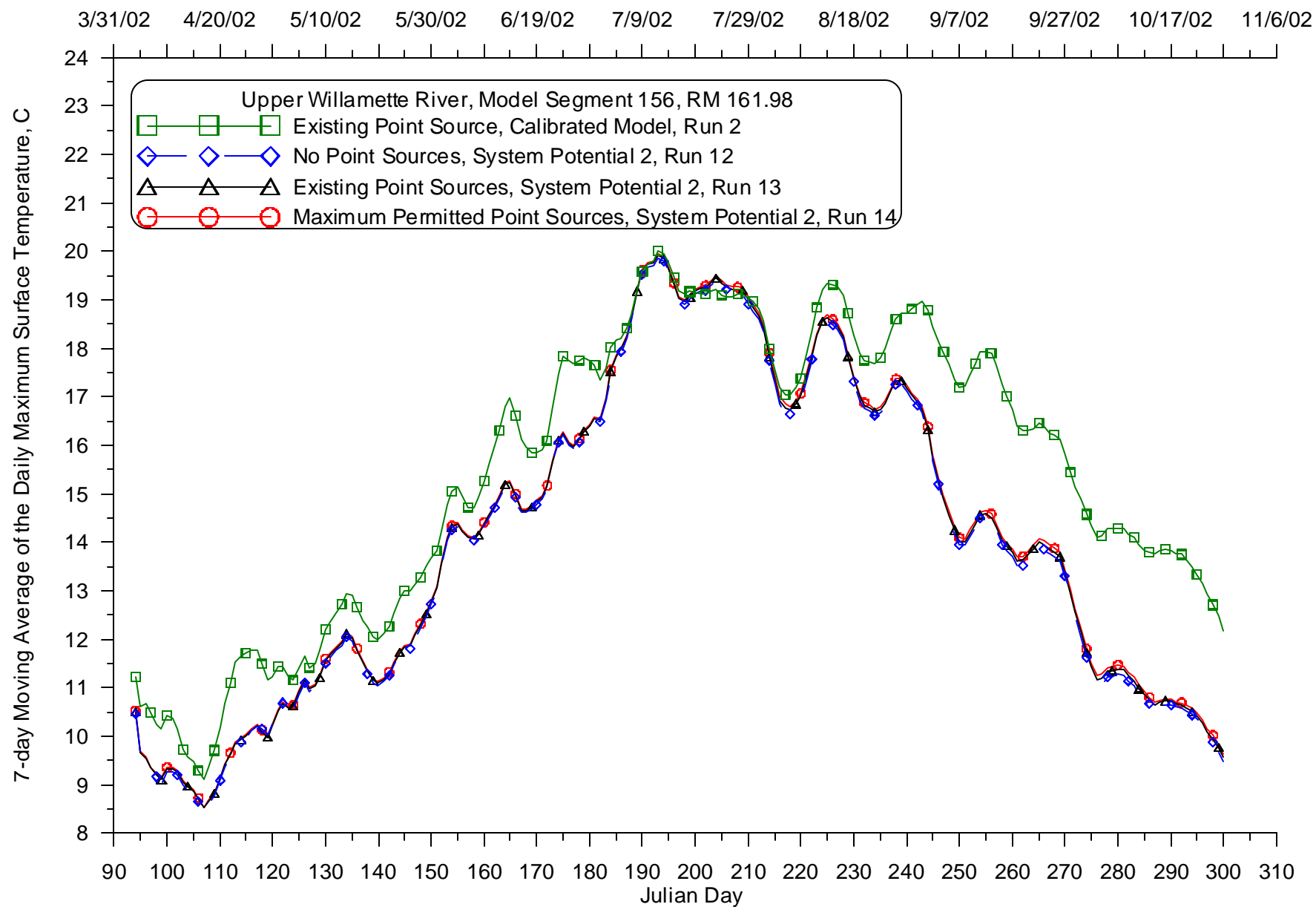
**Figure 377: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the McKenzie River at RM 9.75**



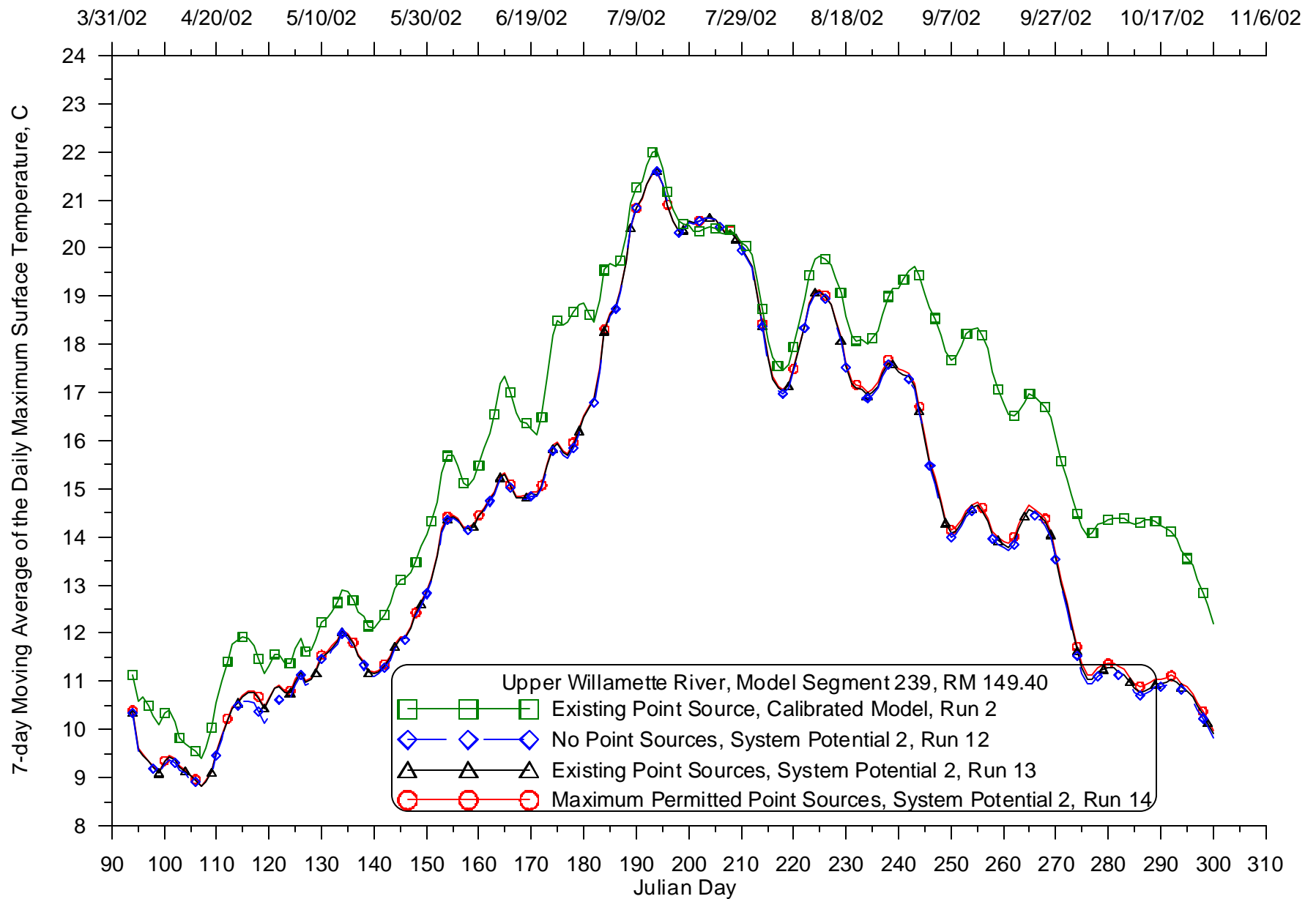
**Figure 378: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Long Tom River at RM 4.64**



**Figure 379: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 175.3**



**Figure 380: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 161.98**



**Figure 381: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 149.4**

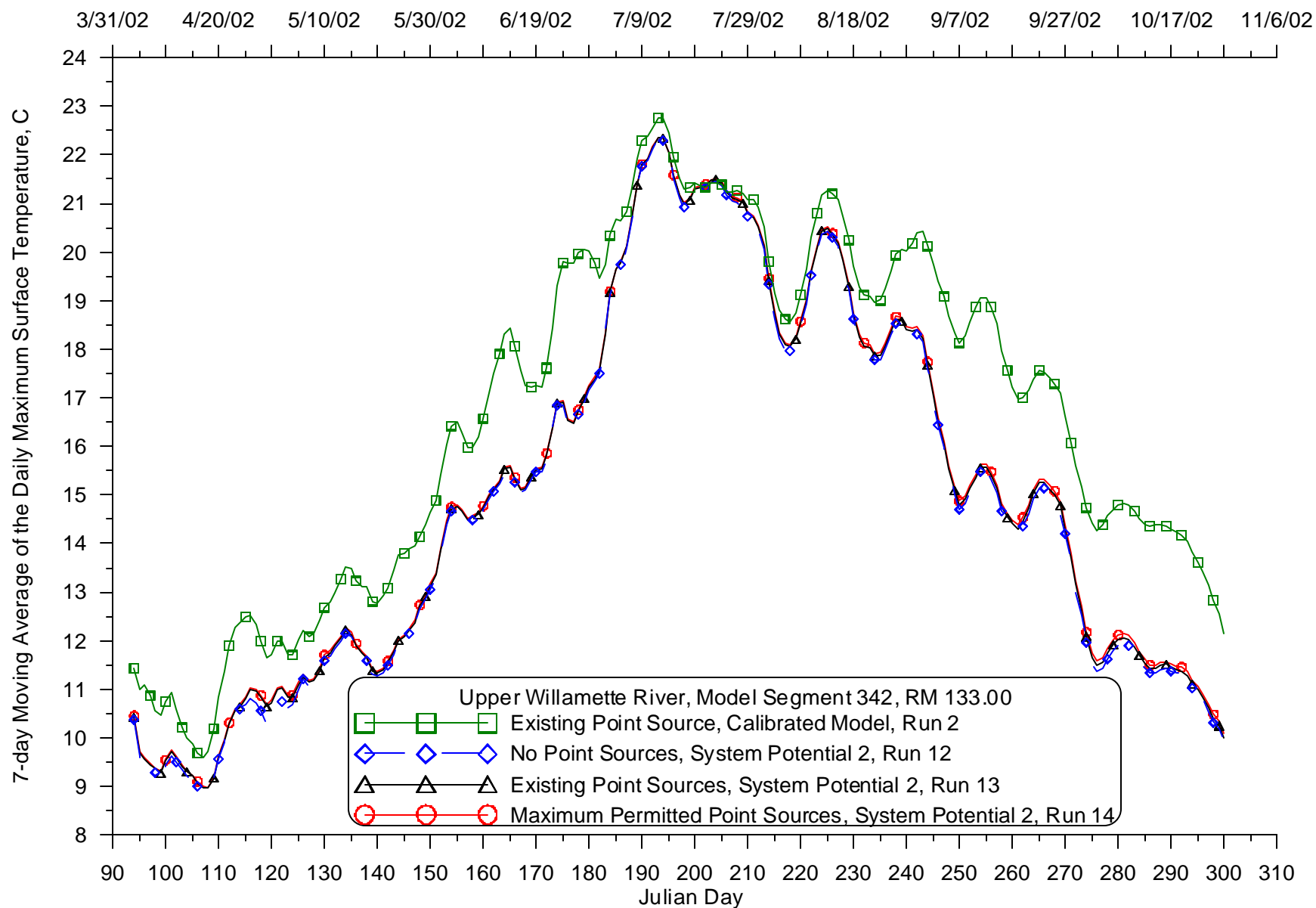
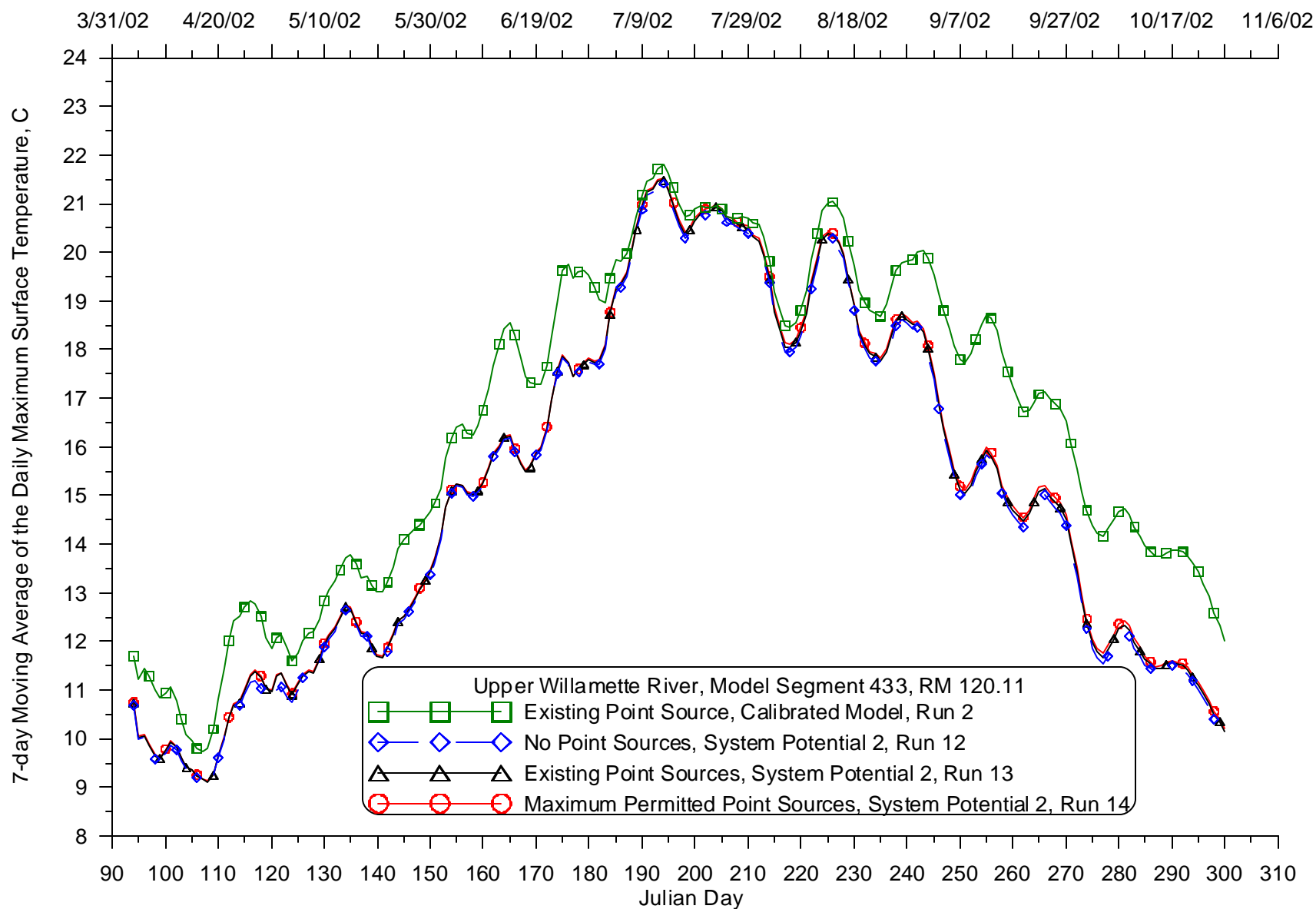
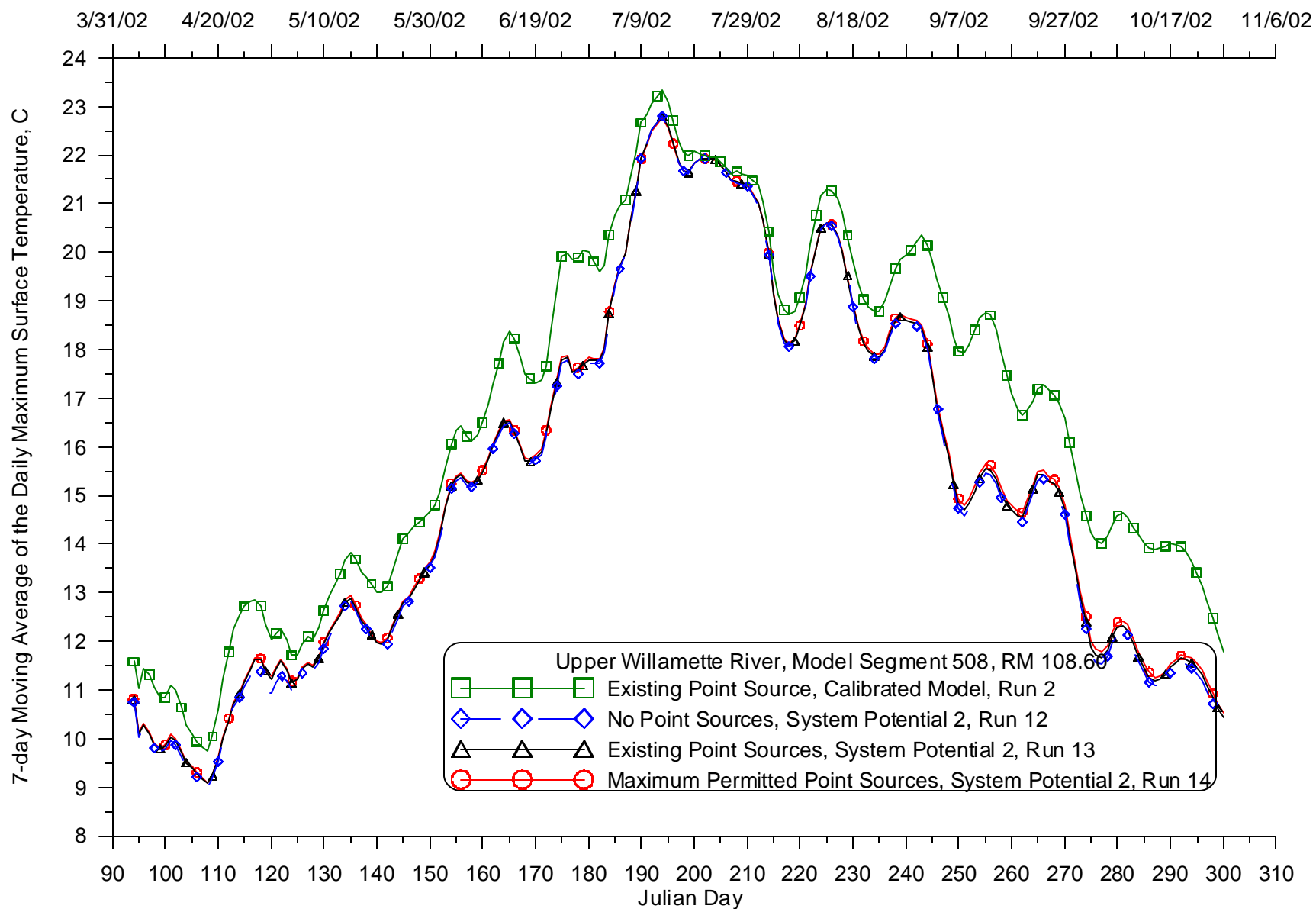


Figure 382: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 133

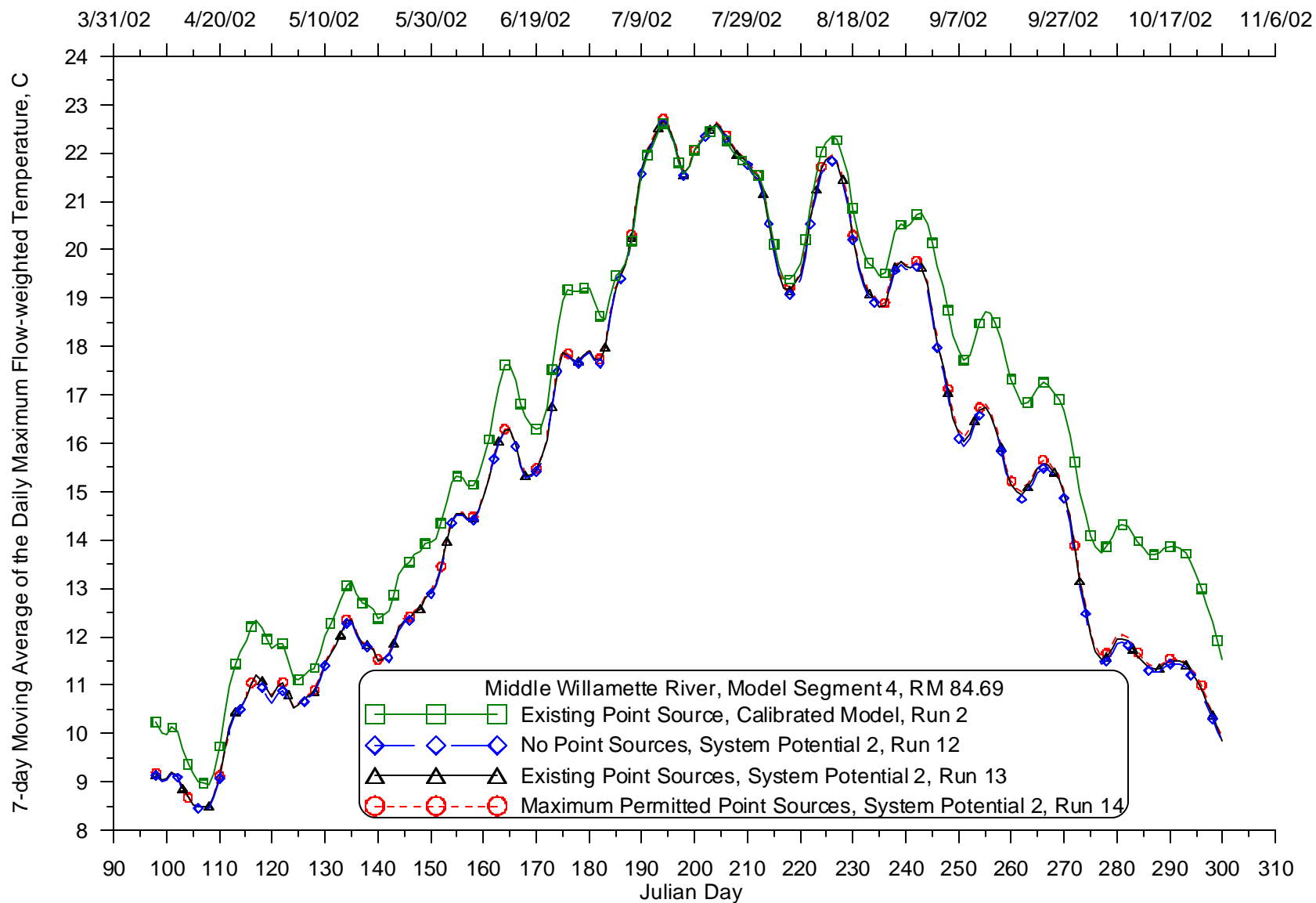


**Figure 383: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 120.11**

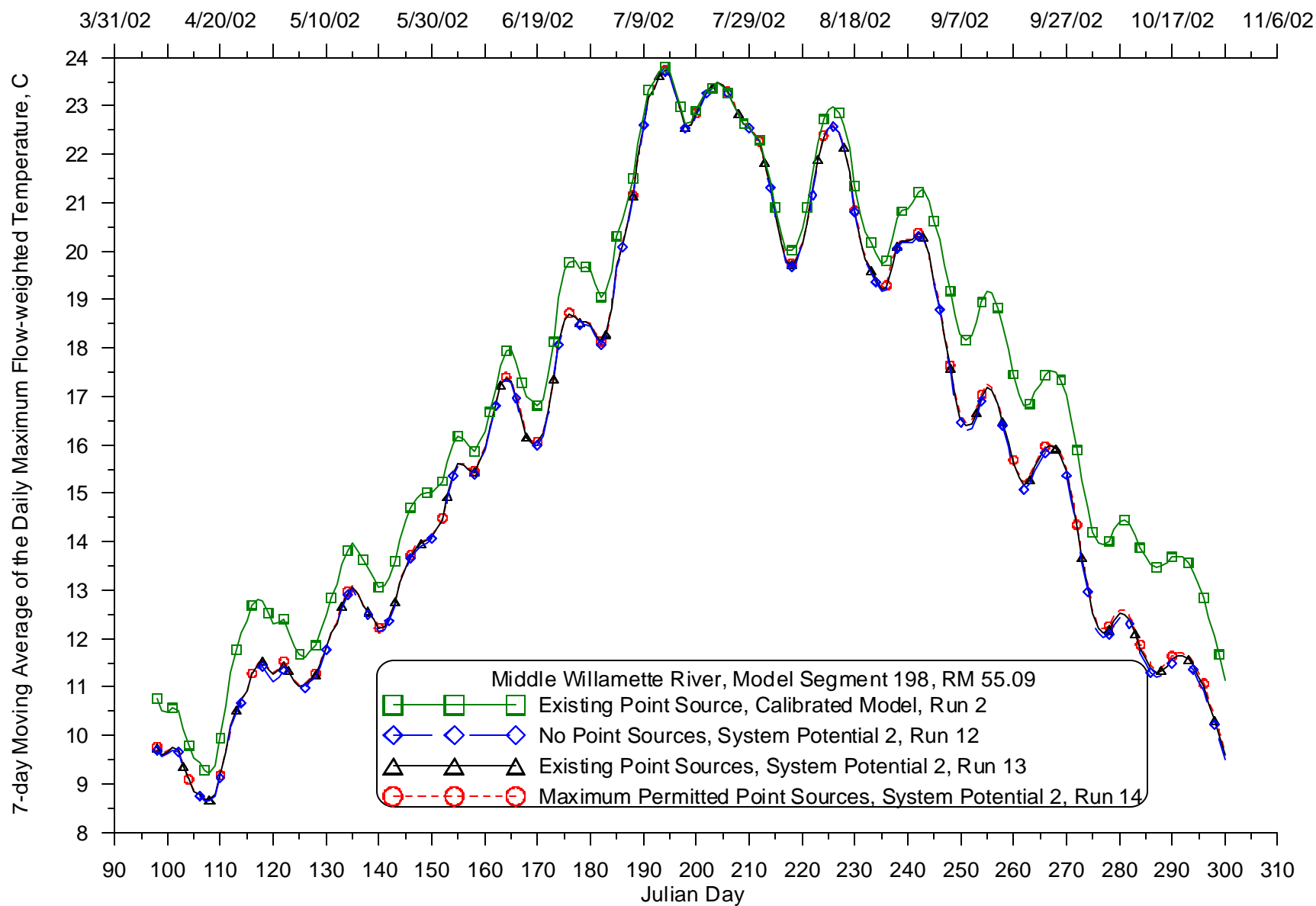




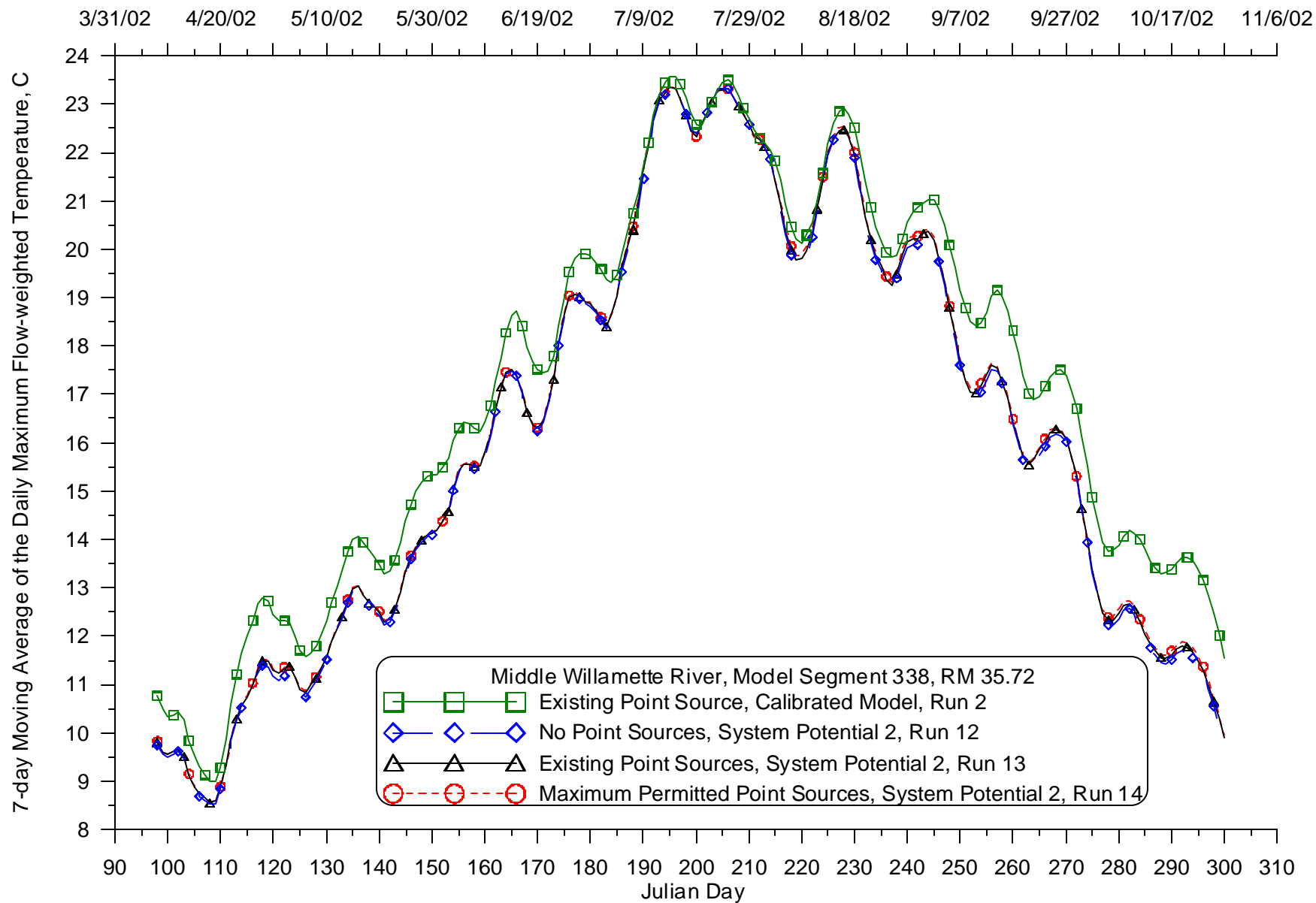
**Figure 384: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 108.6**



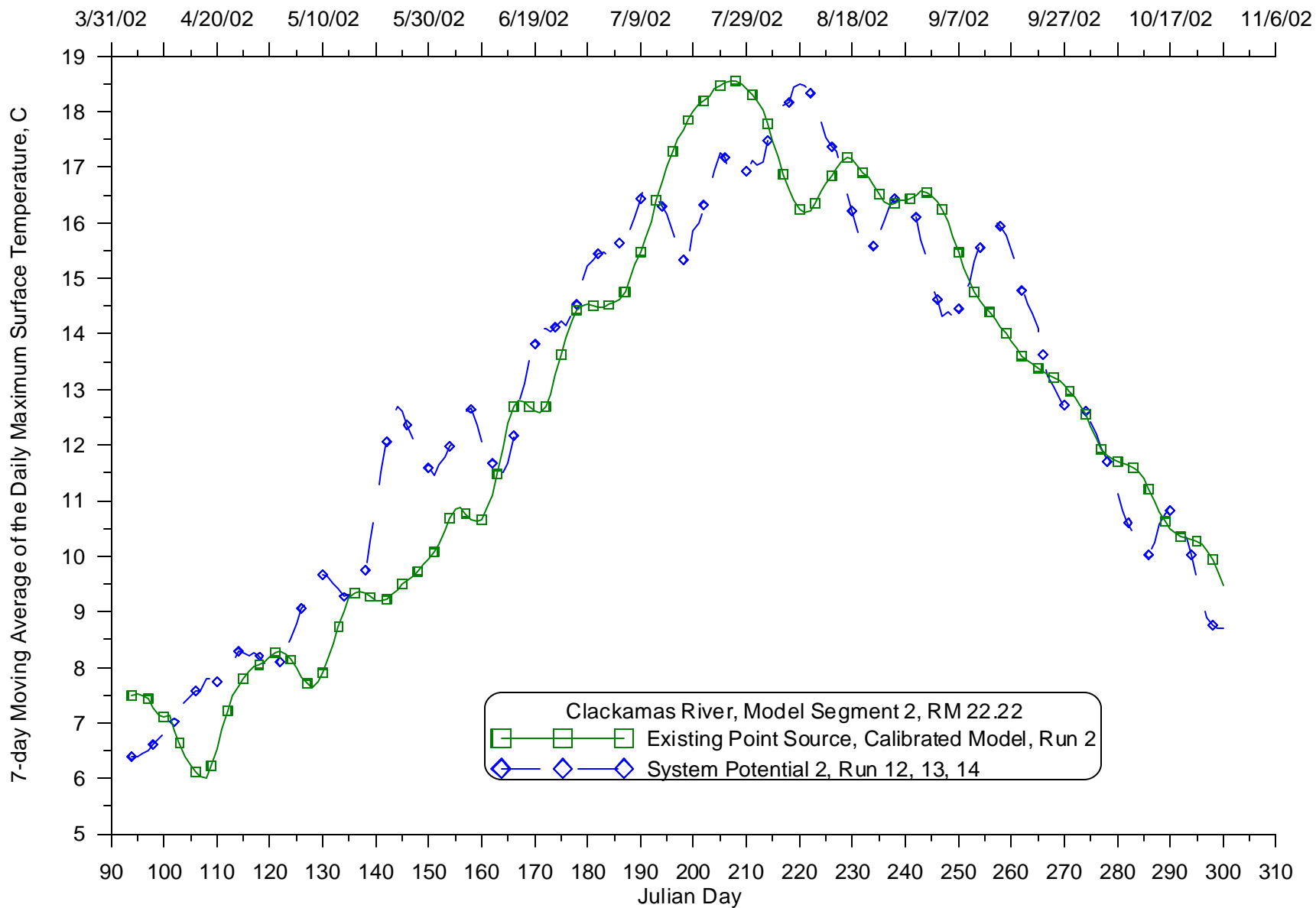
**Figure 385: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 84.69**



**Figure 386: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 55.09**



**Figure 387: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 35.72**



**Figure 388: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Clackamas River at RM 22.22**

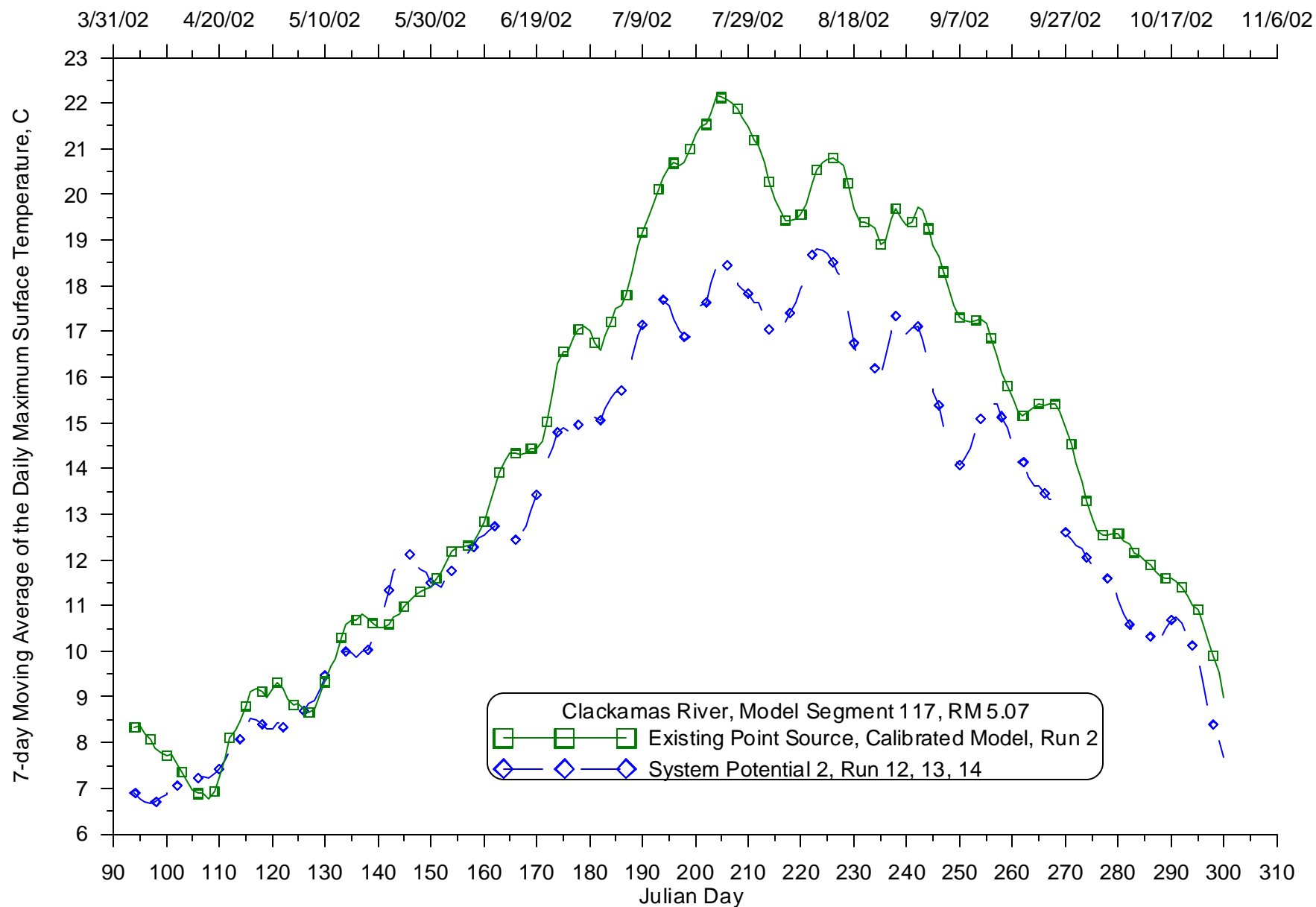
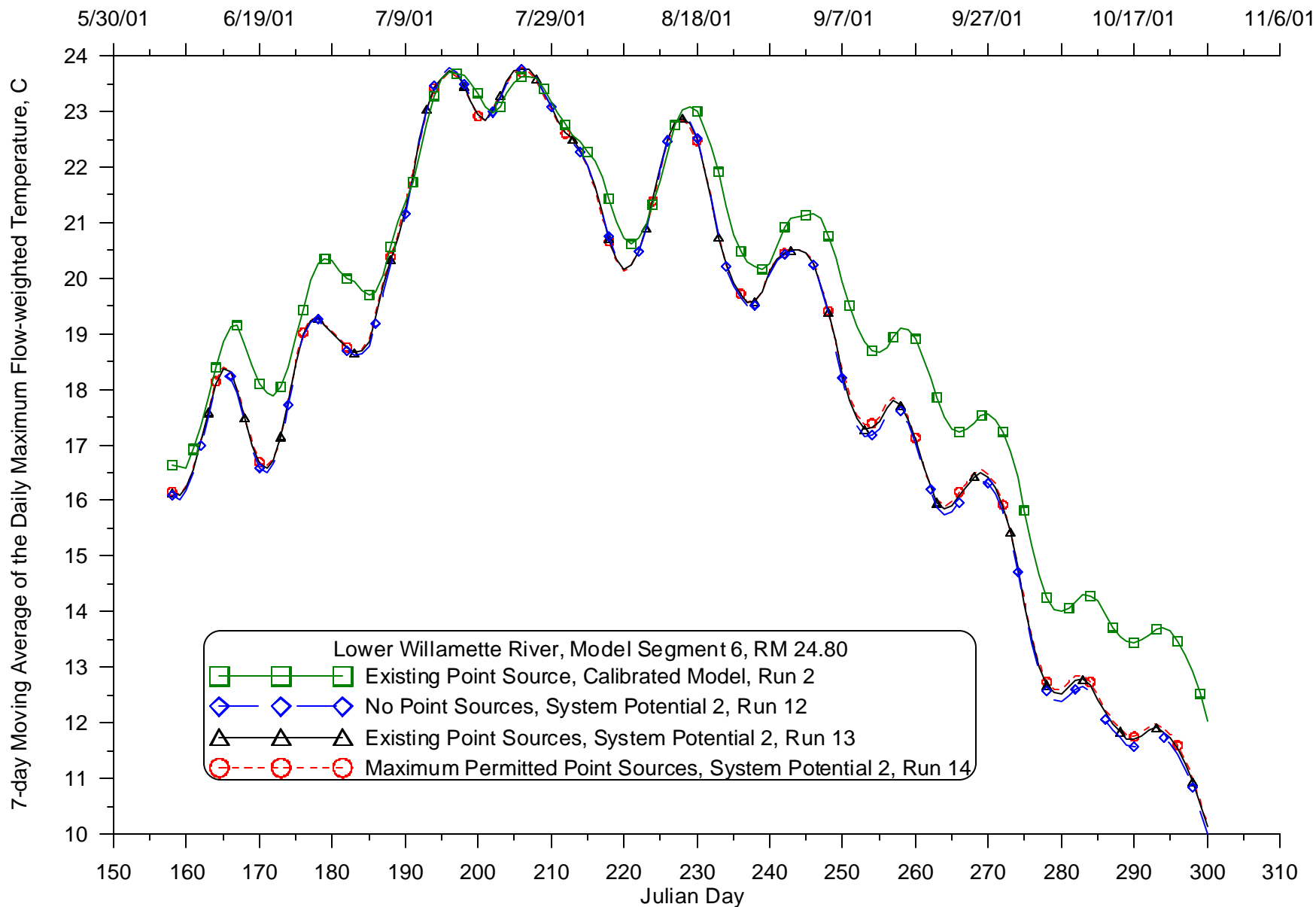


Figure 389: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Clackamas River at RM 5.07



**Figure 390: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 24.8**

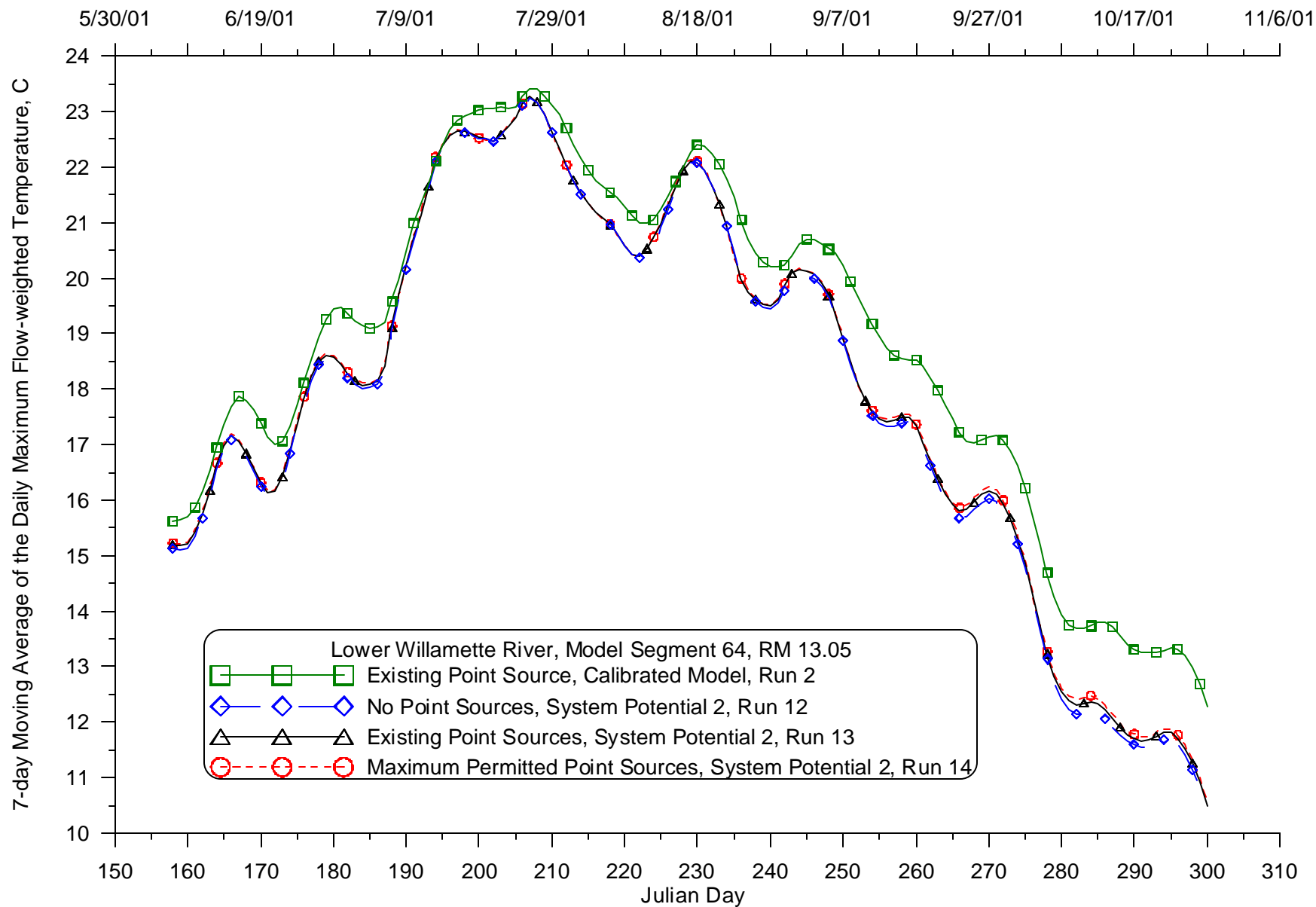


Figure 391: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 13.05



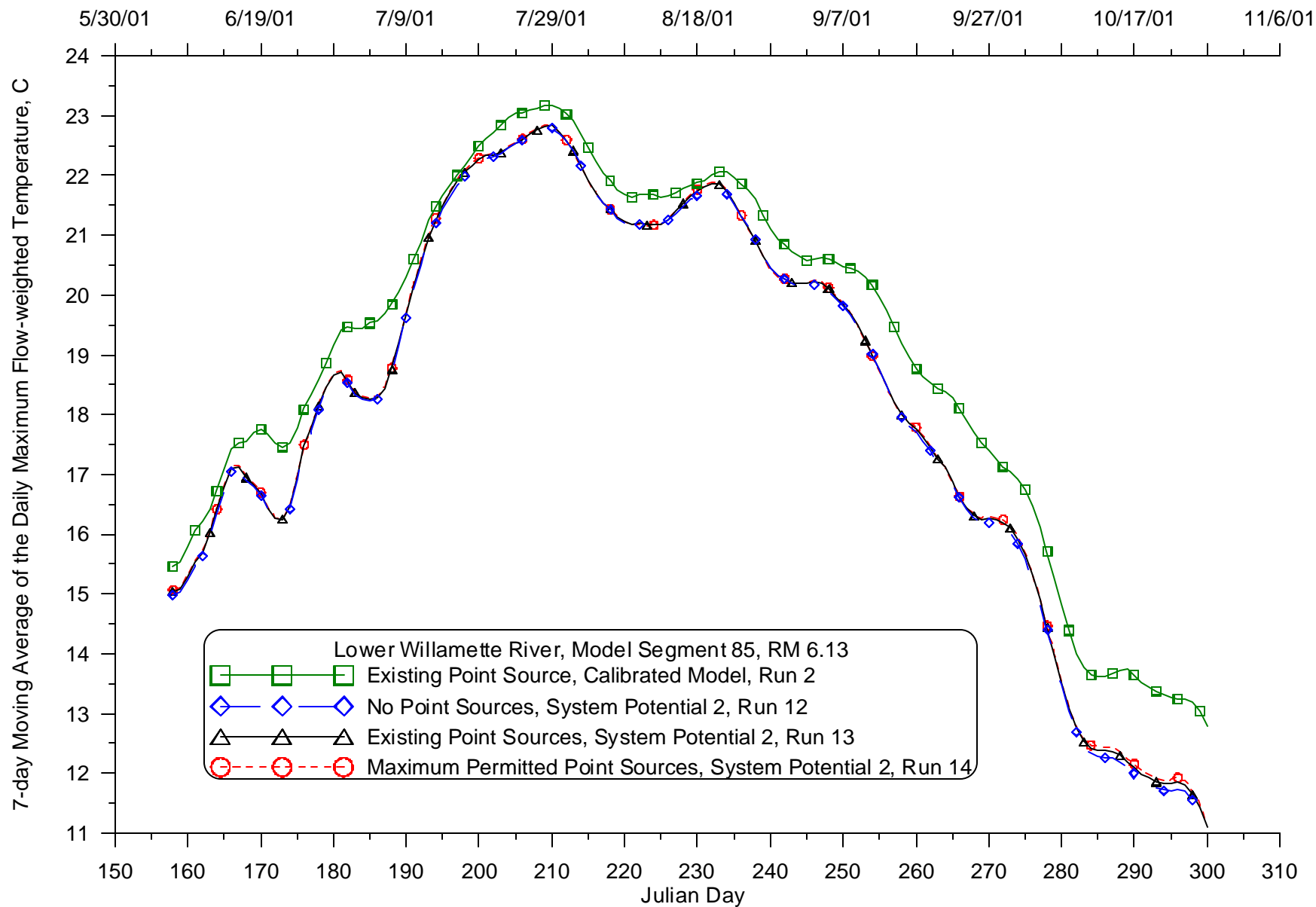


Figure 392: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily maximum temperature comparison for 2002 for the Willamette River at RM 6.13

**Daily seven day average flow**

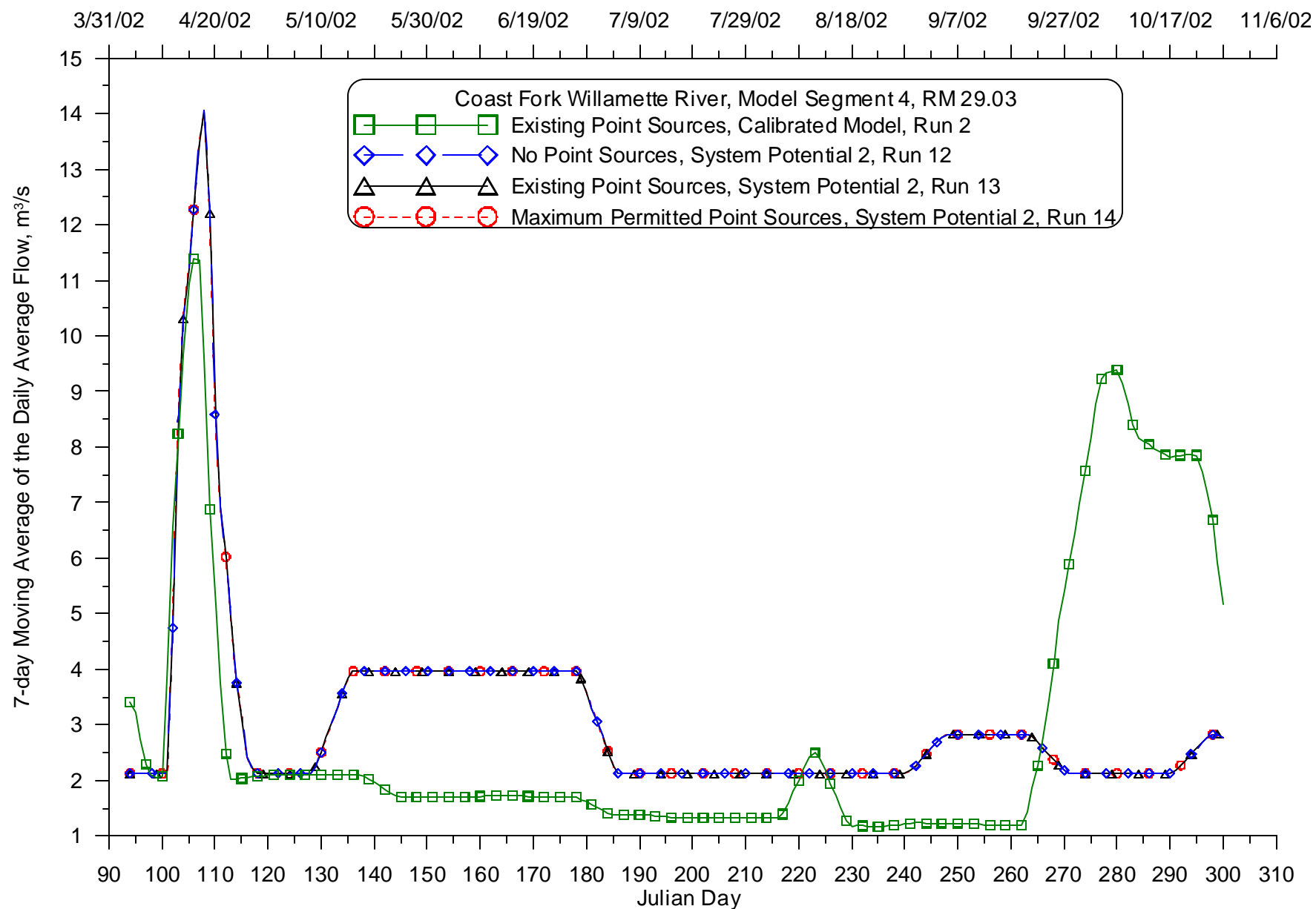
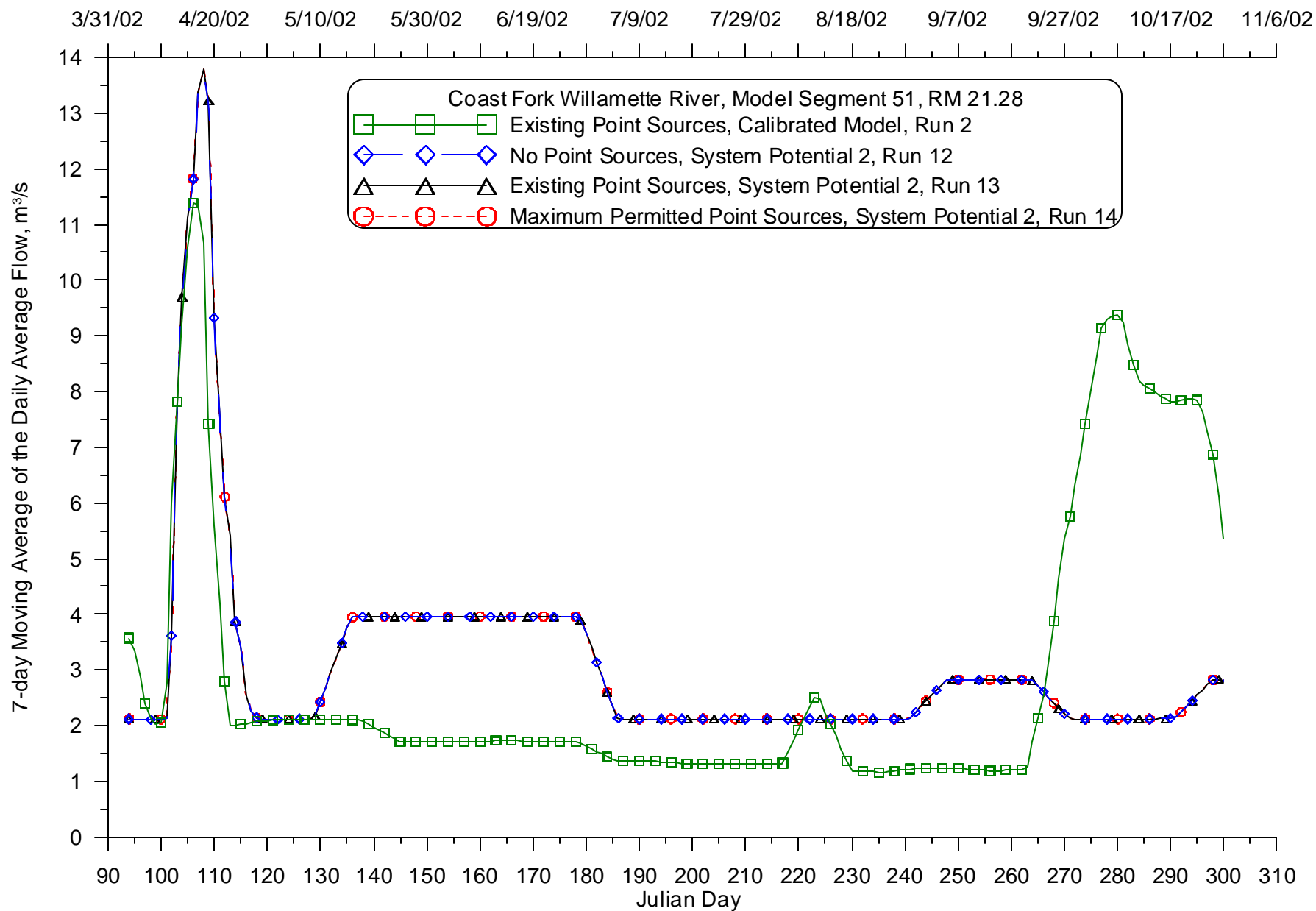


Figure 393: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Coast Fork Willamette River at RM 29.03



**Figure 394: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Coast Fork Willamette River at RM 21.28**

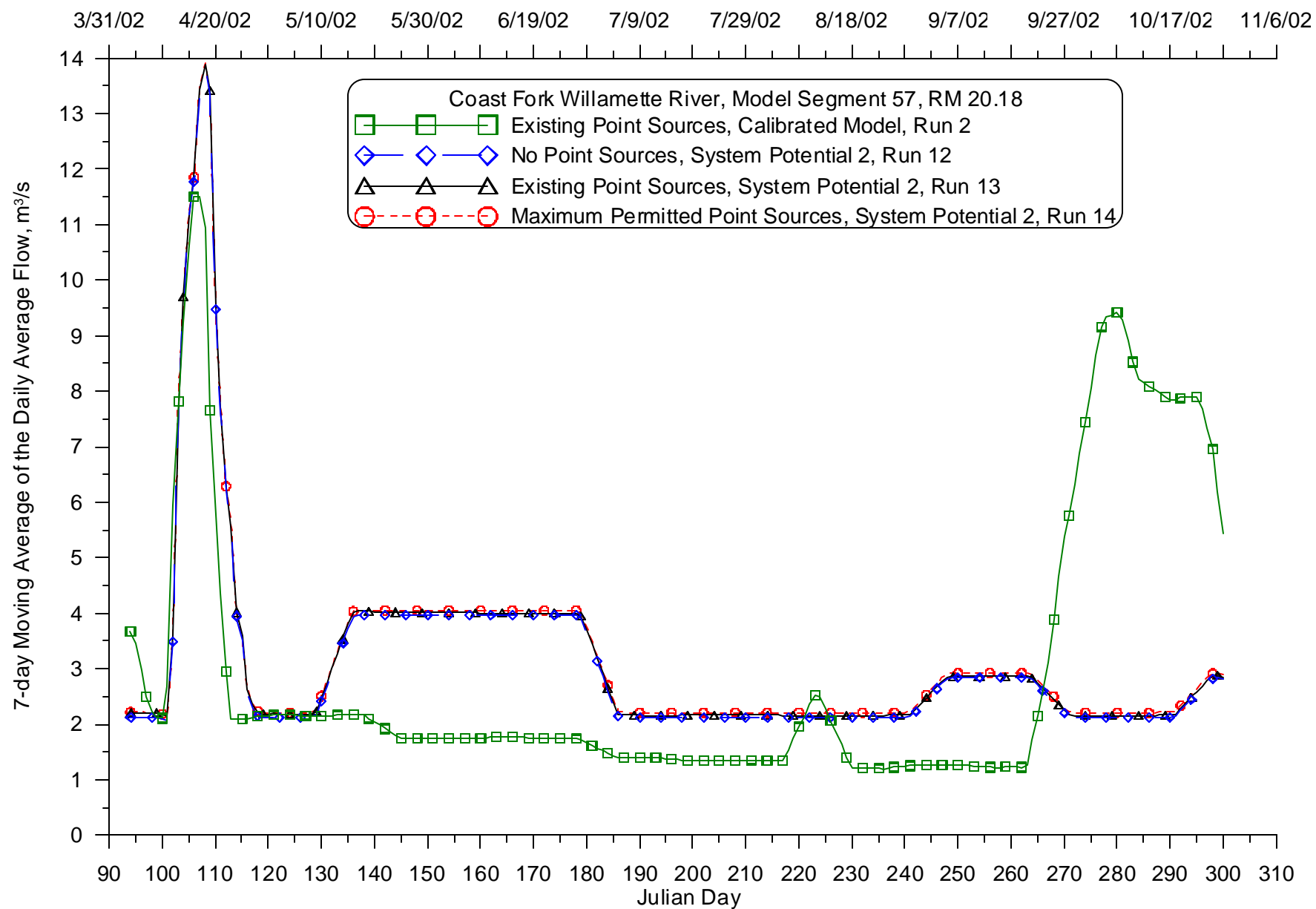
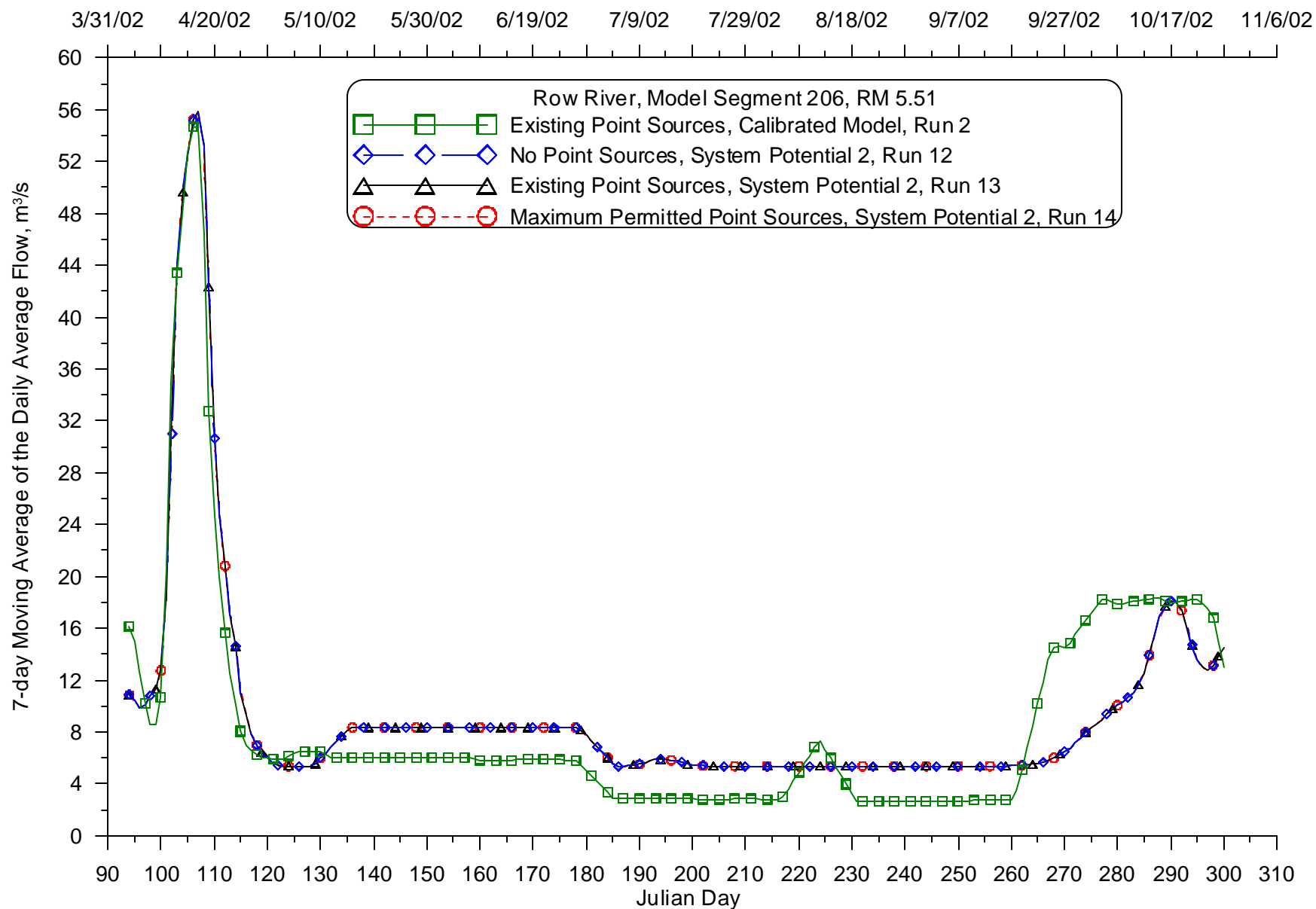
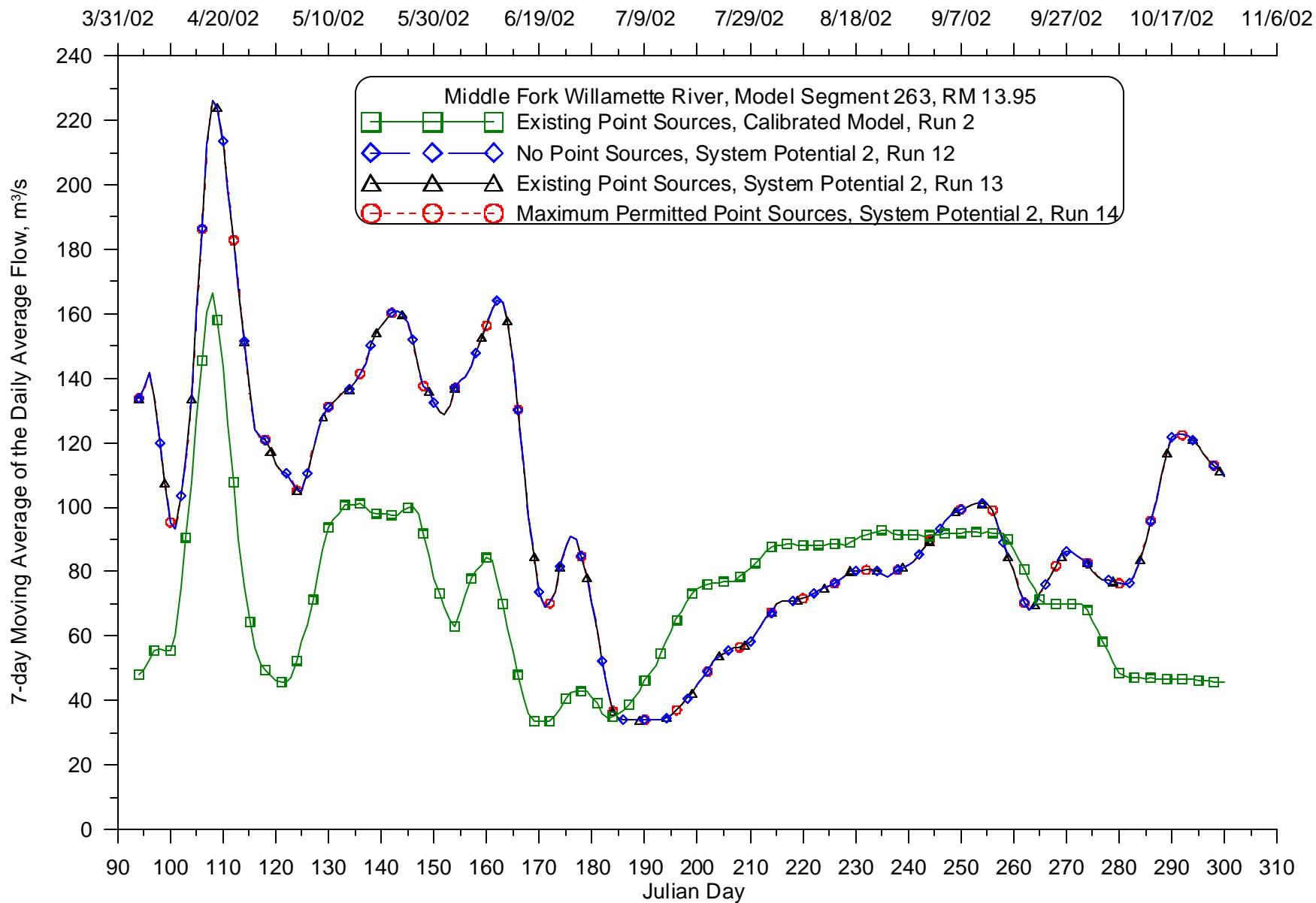


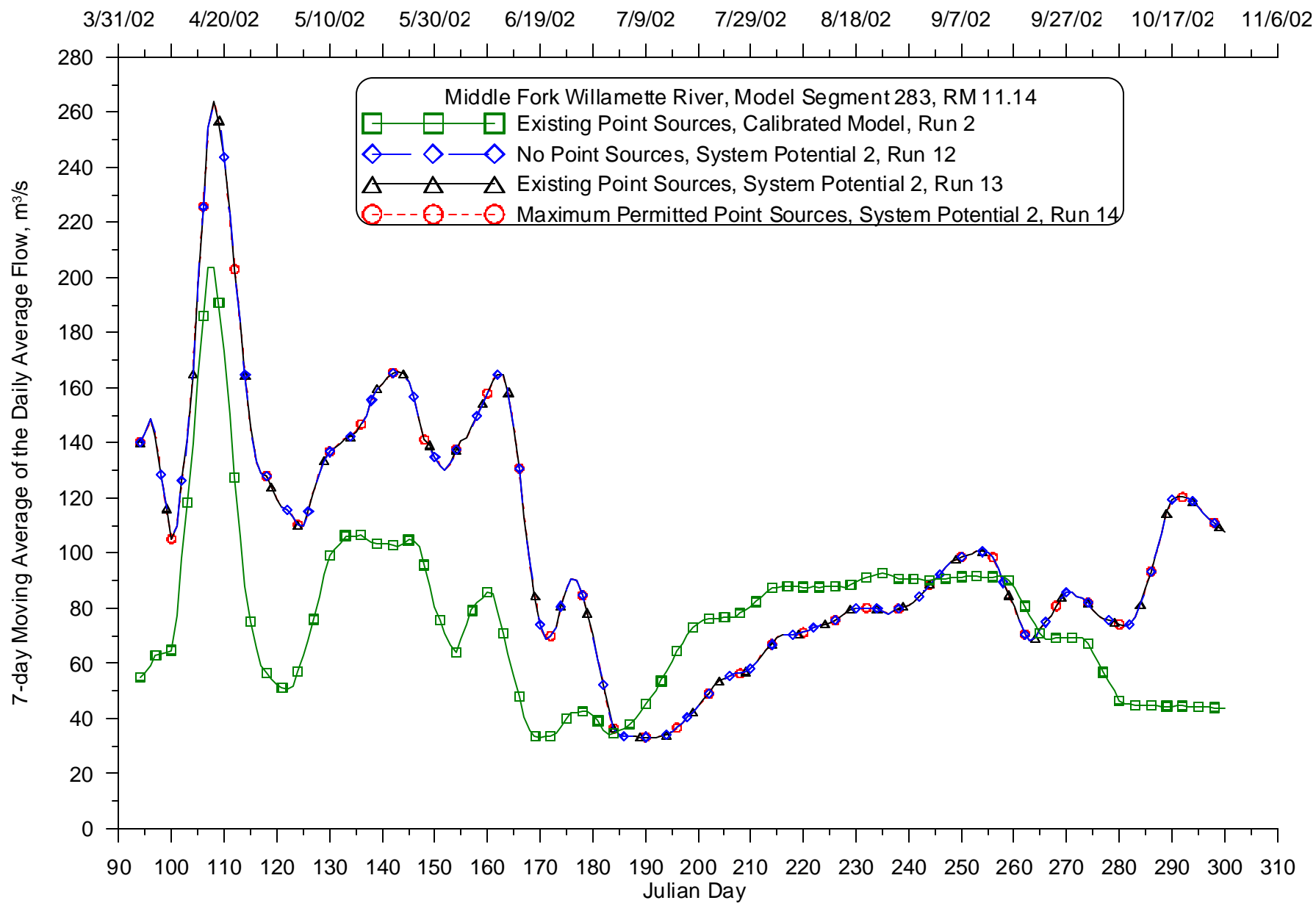
Figure 395: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Coast Fork Willamette River at RM 20.18



**Figure 396: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Row River at RM 5.51**



**Figure 397: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Middle Fork Willamette River at RM 13.95**



**Figure 398: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Middle Fork Willamette River at RM 11.14**



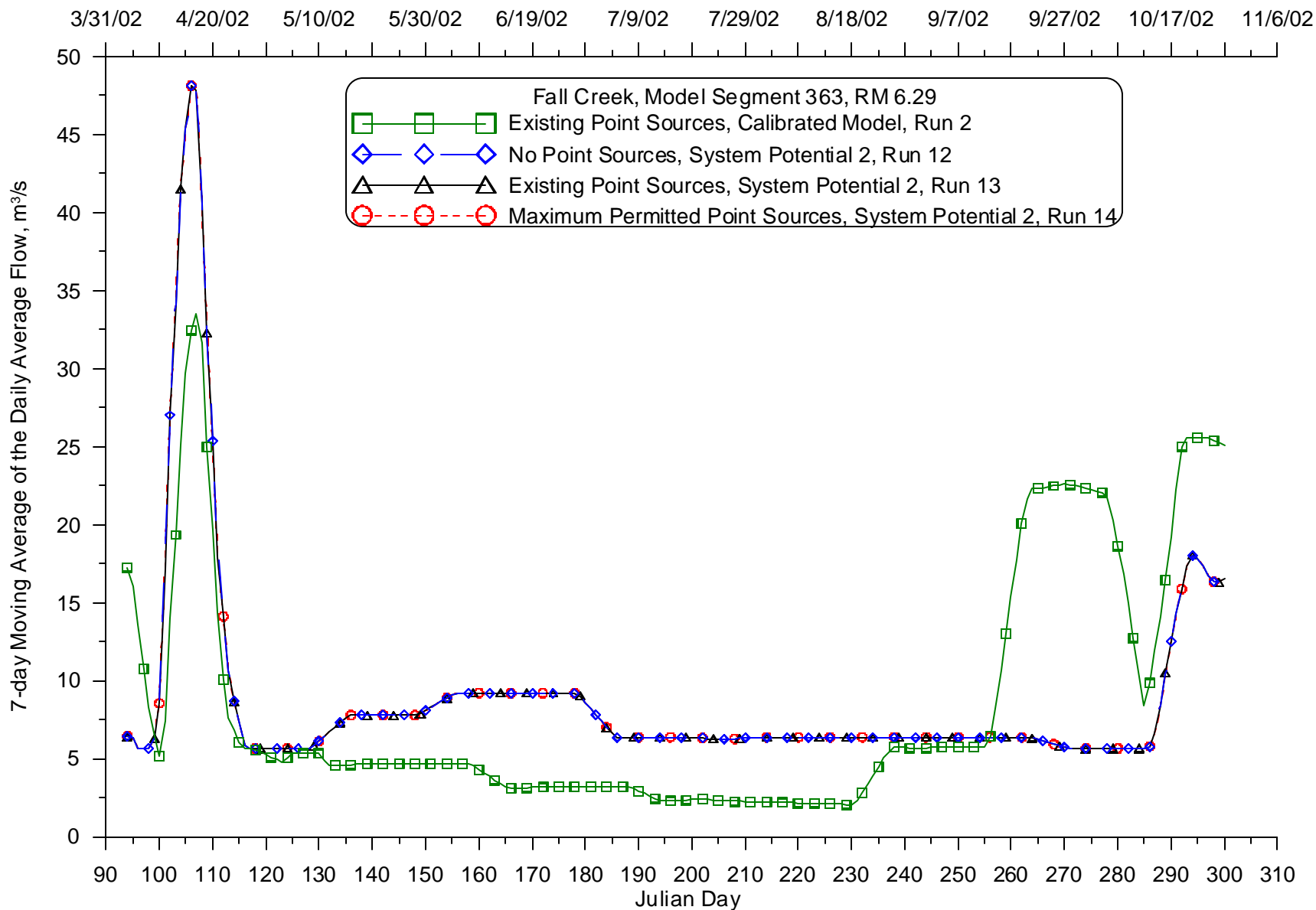
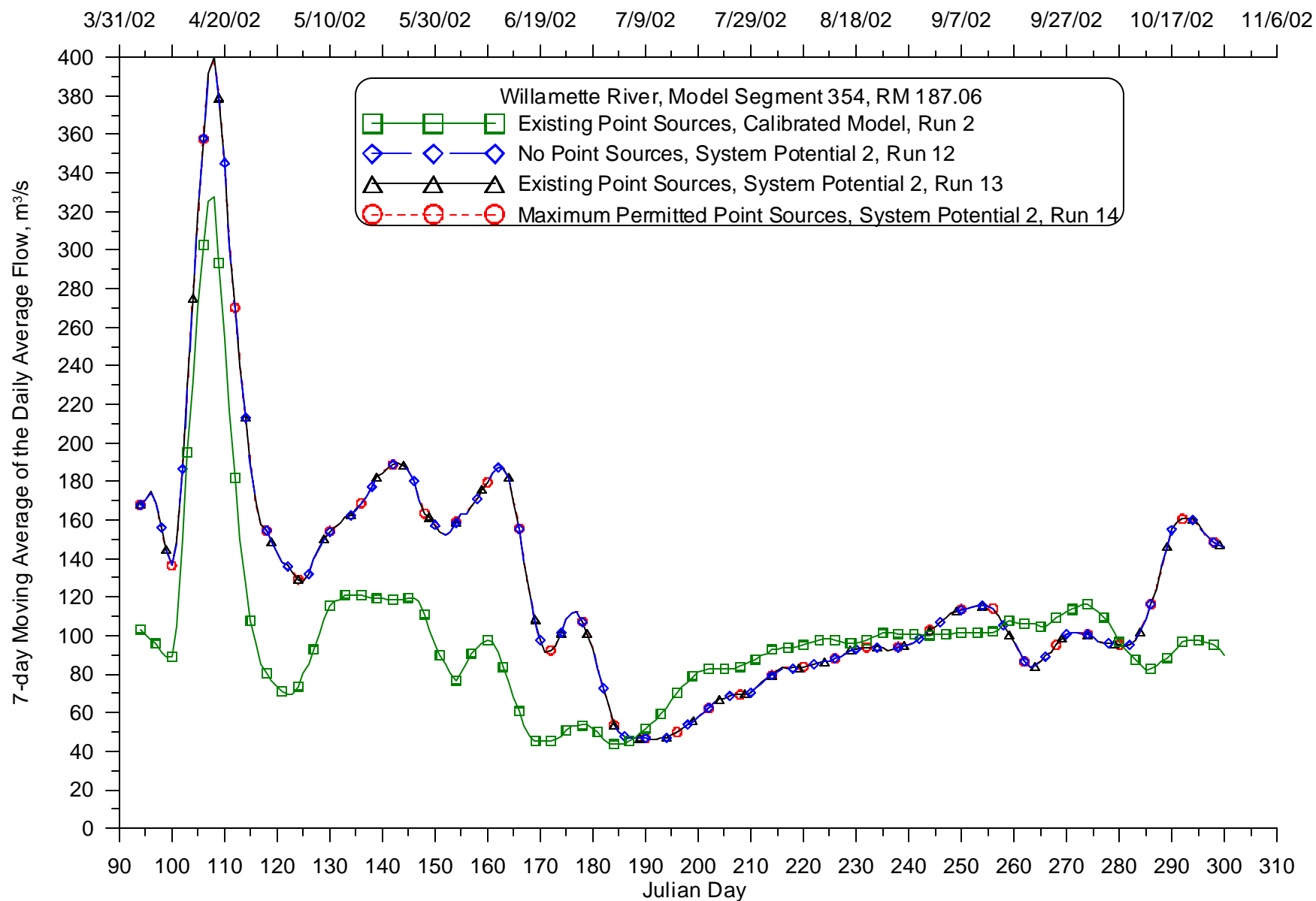
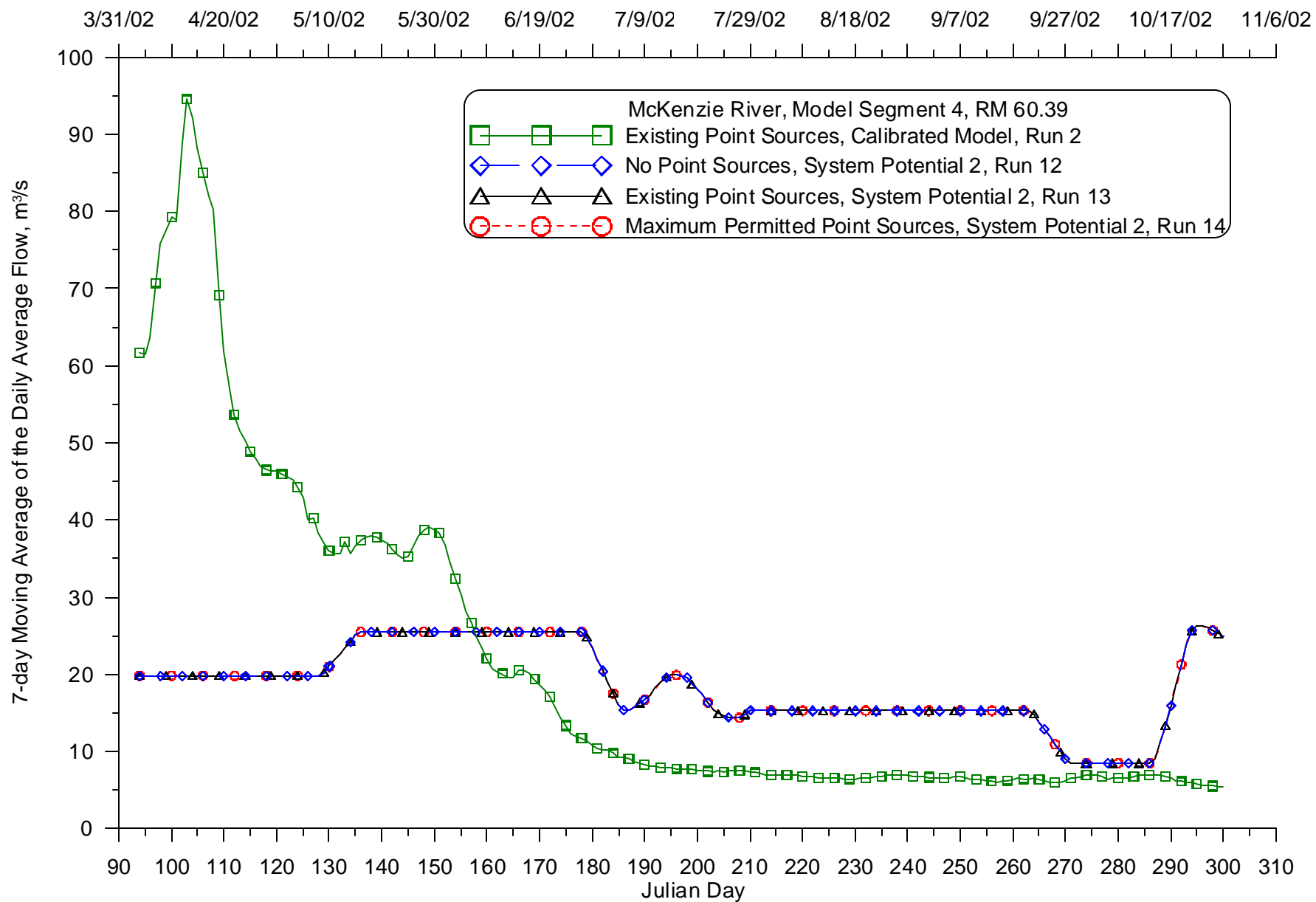


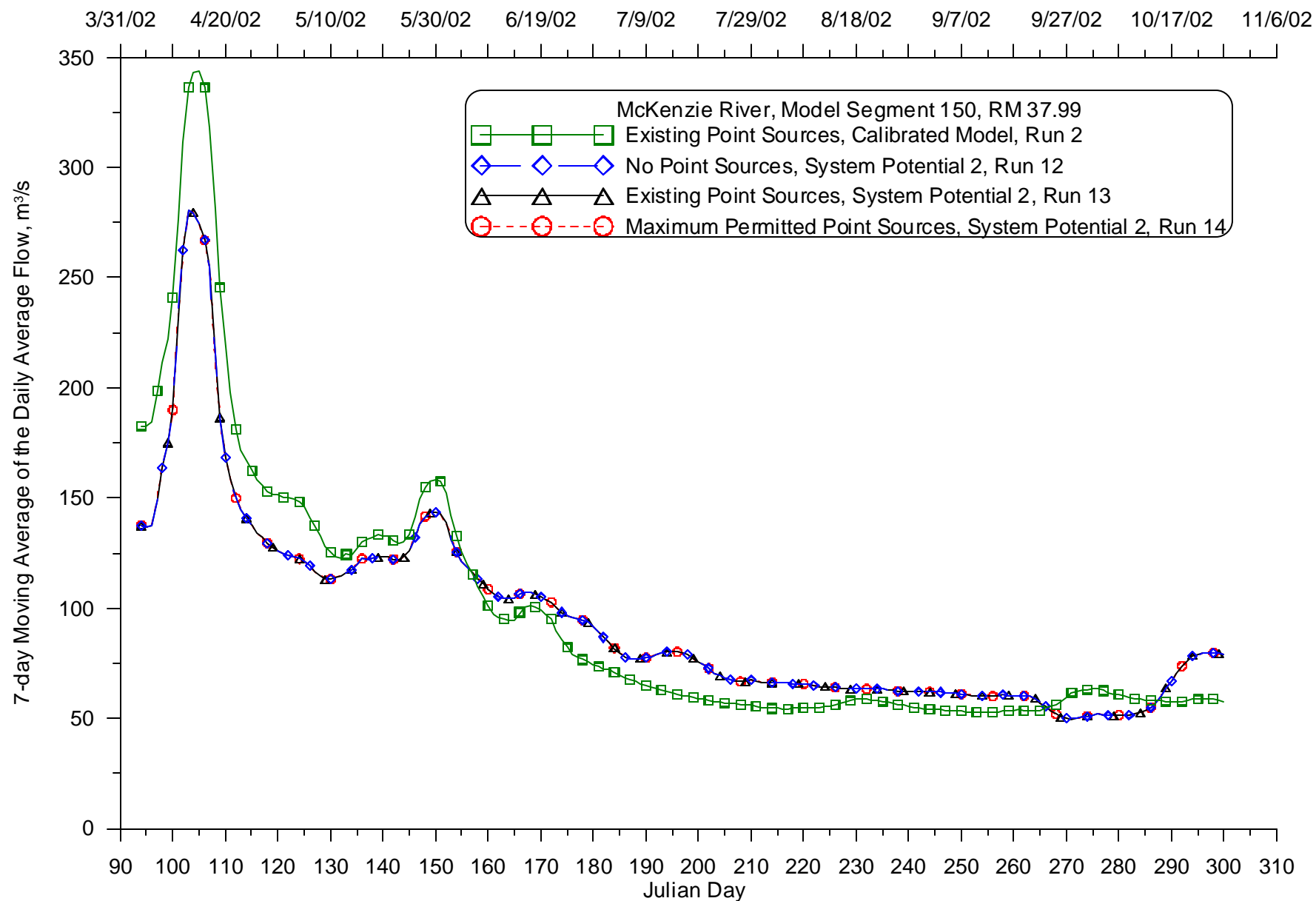
Figure 399: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for Fall Creek at RM 6.29



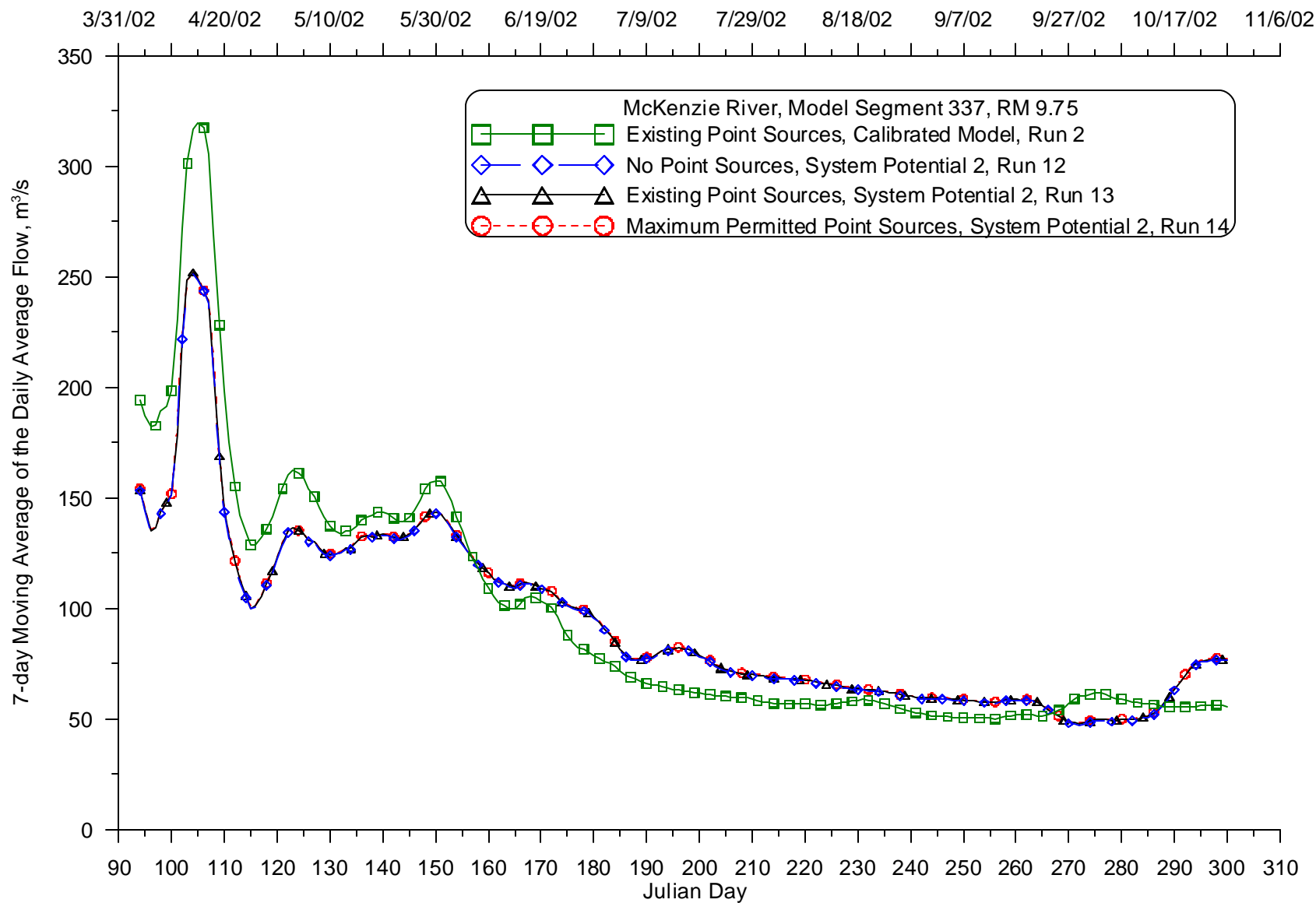
**Figure 400: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 187.06**



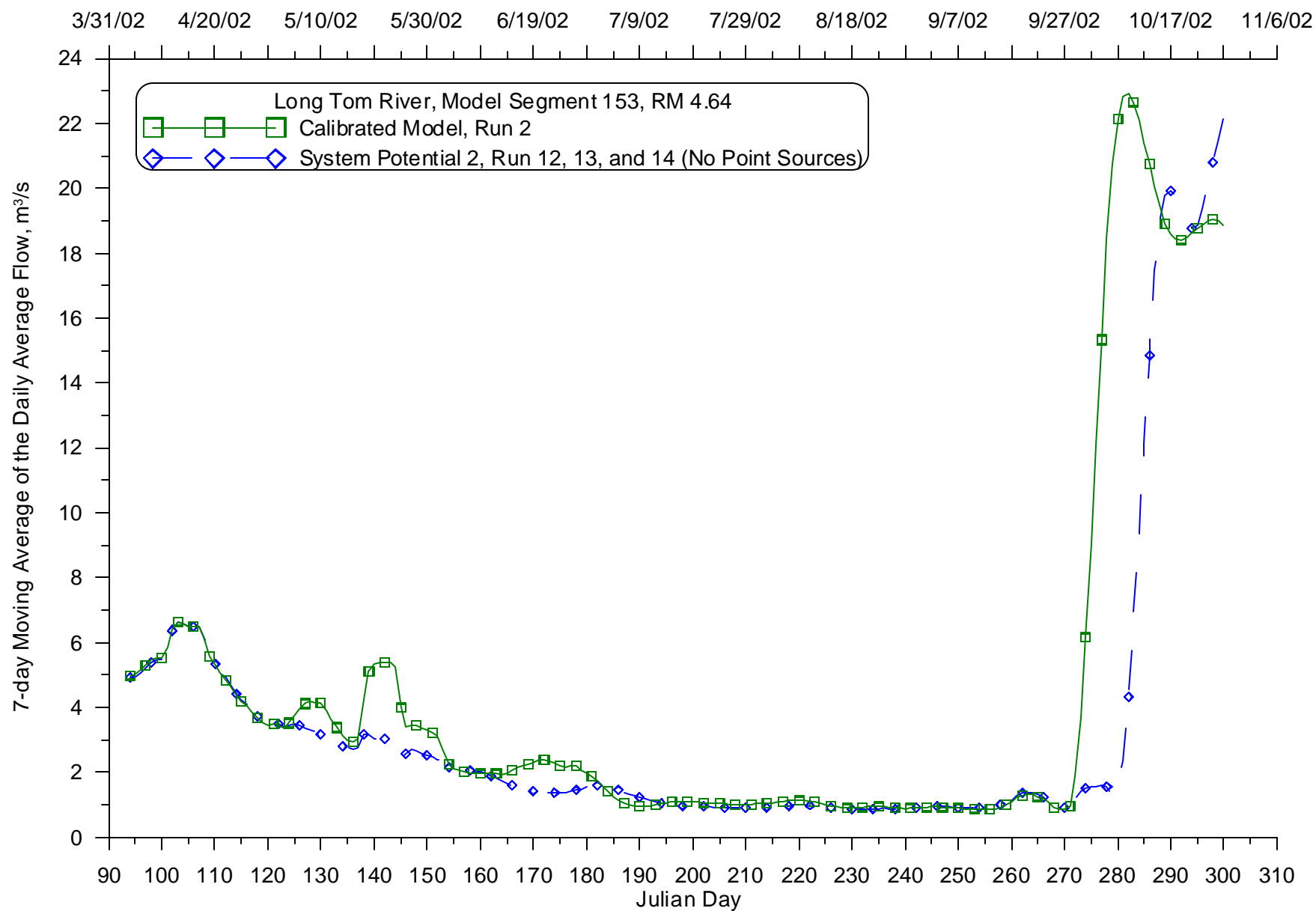
**Figure 401: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the McKenzie River at RM 60.39**



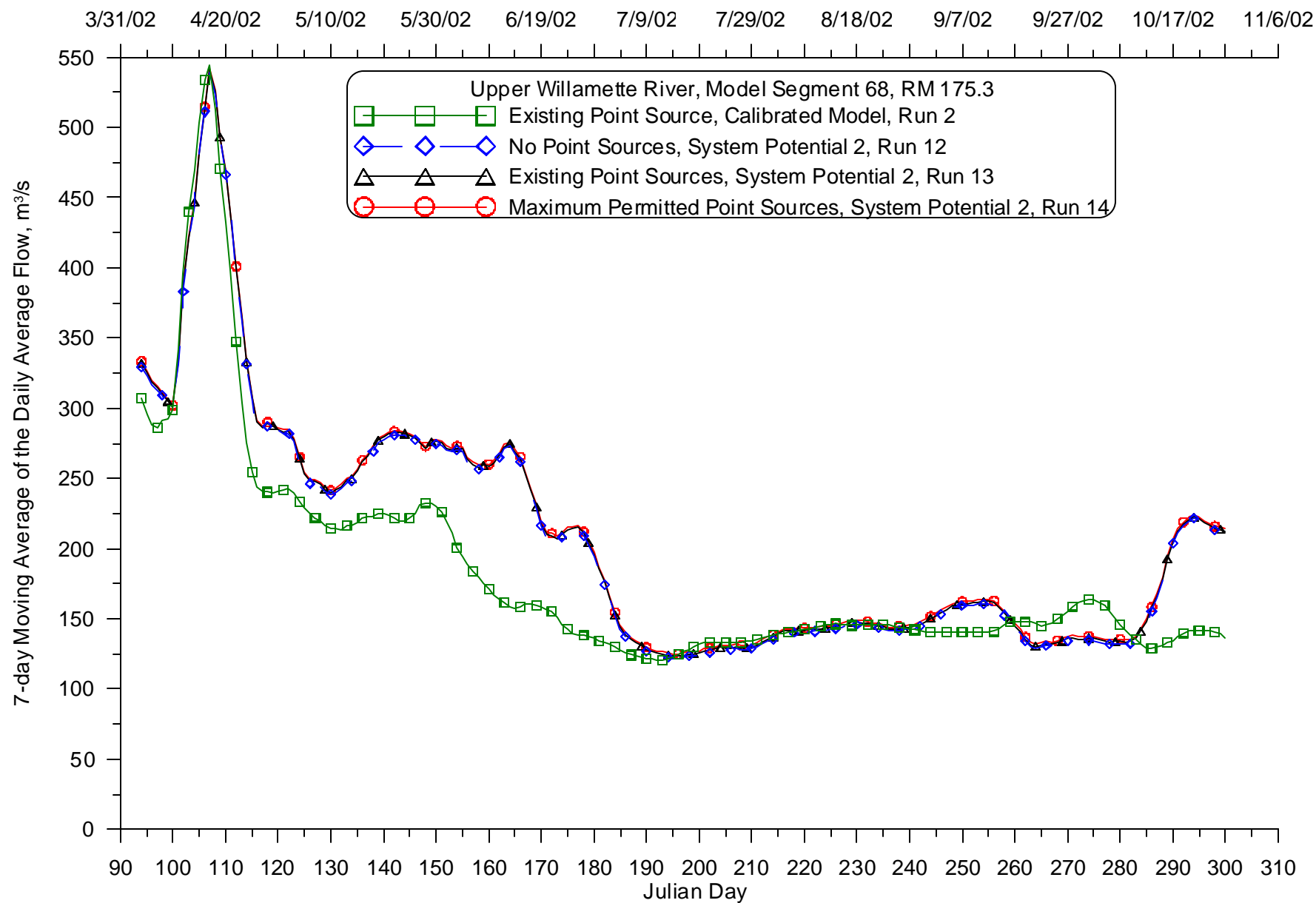
**Figure 402: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the McKenzie River at RM 37.99**



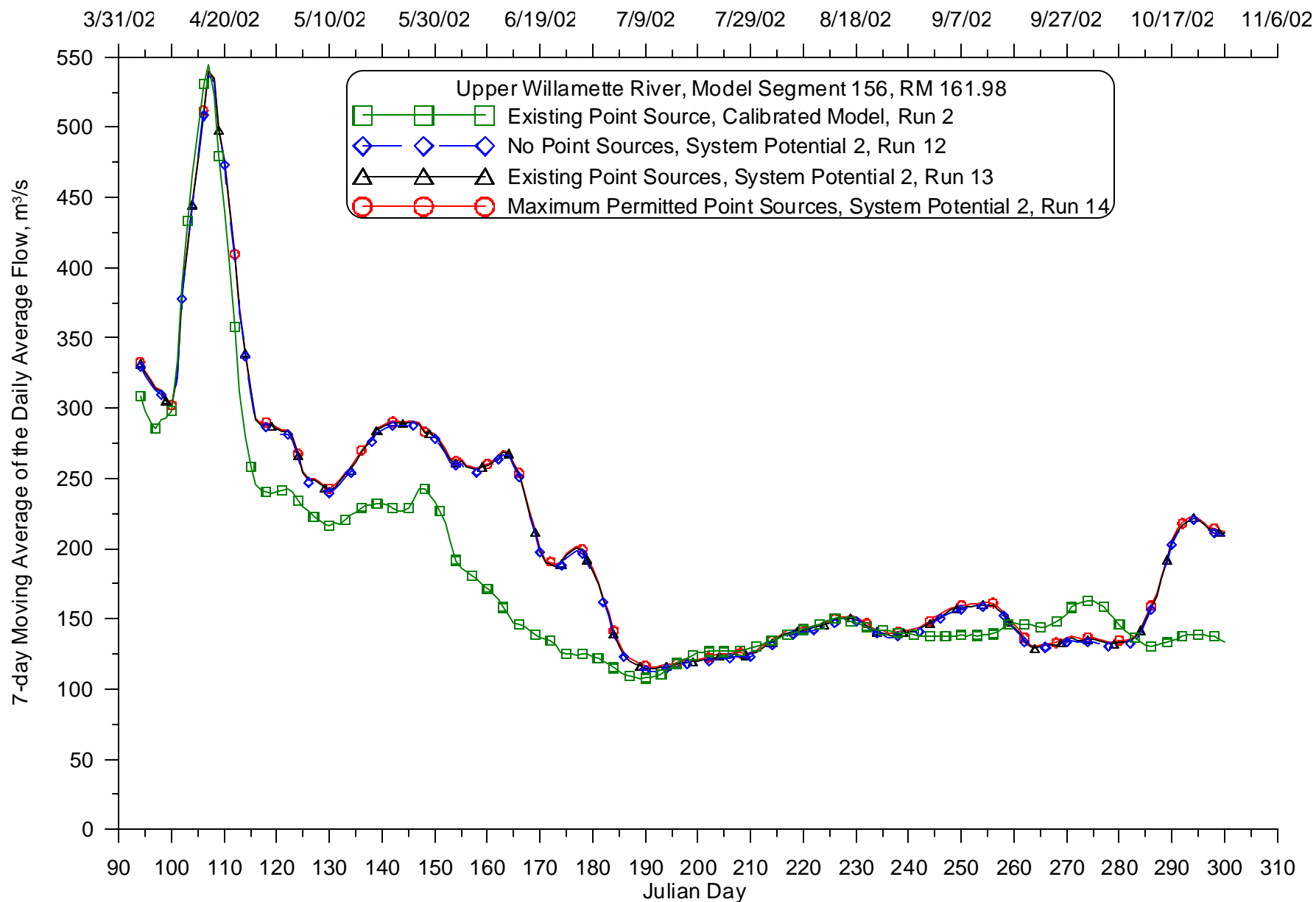
**Figure 403: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the McKenzie River at RM 9.75**



**Figure 404: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Long Tom River at RM 4.64**

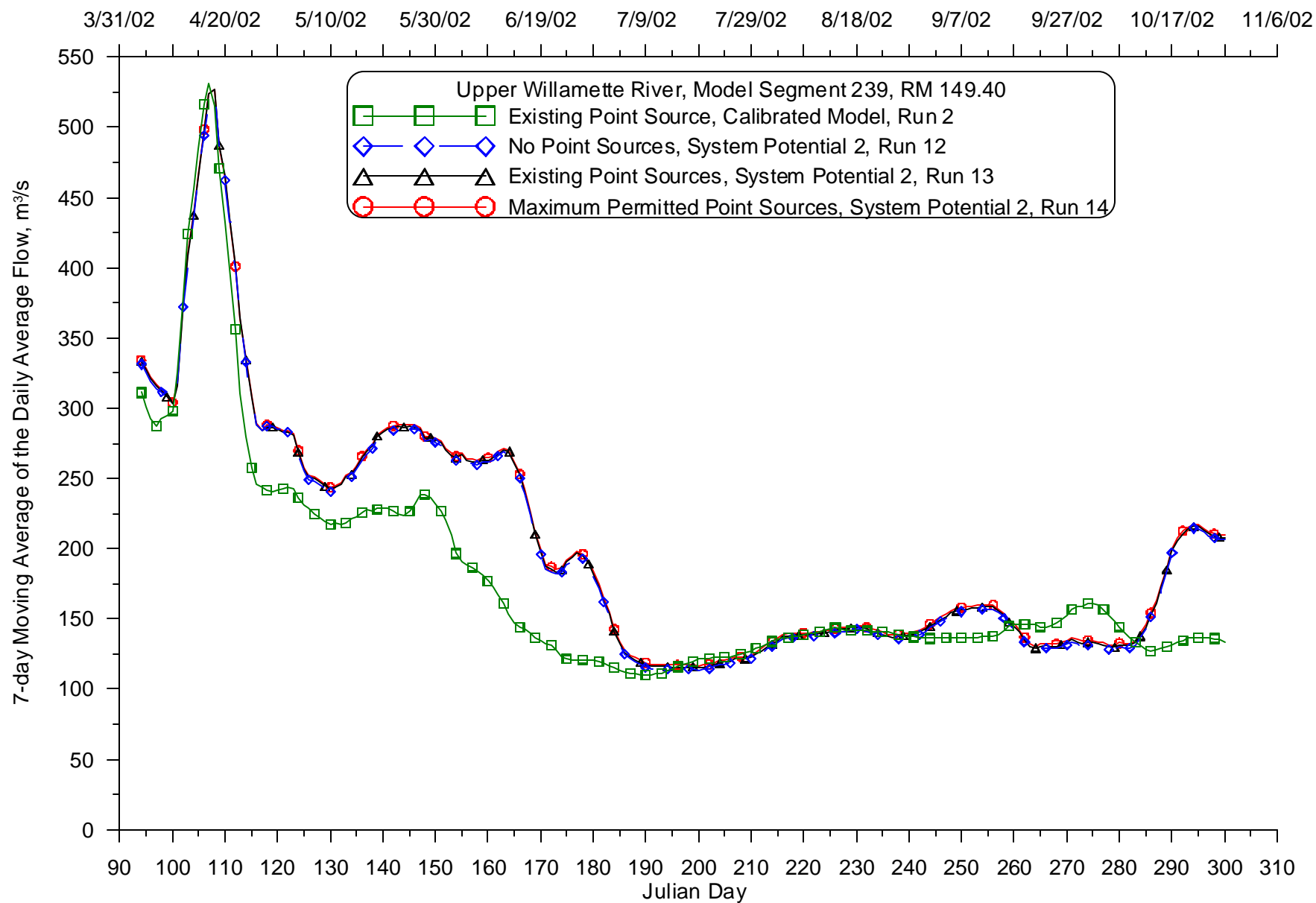


**Figure 405: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 175.3**

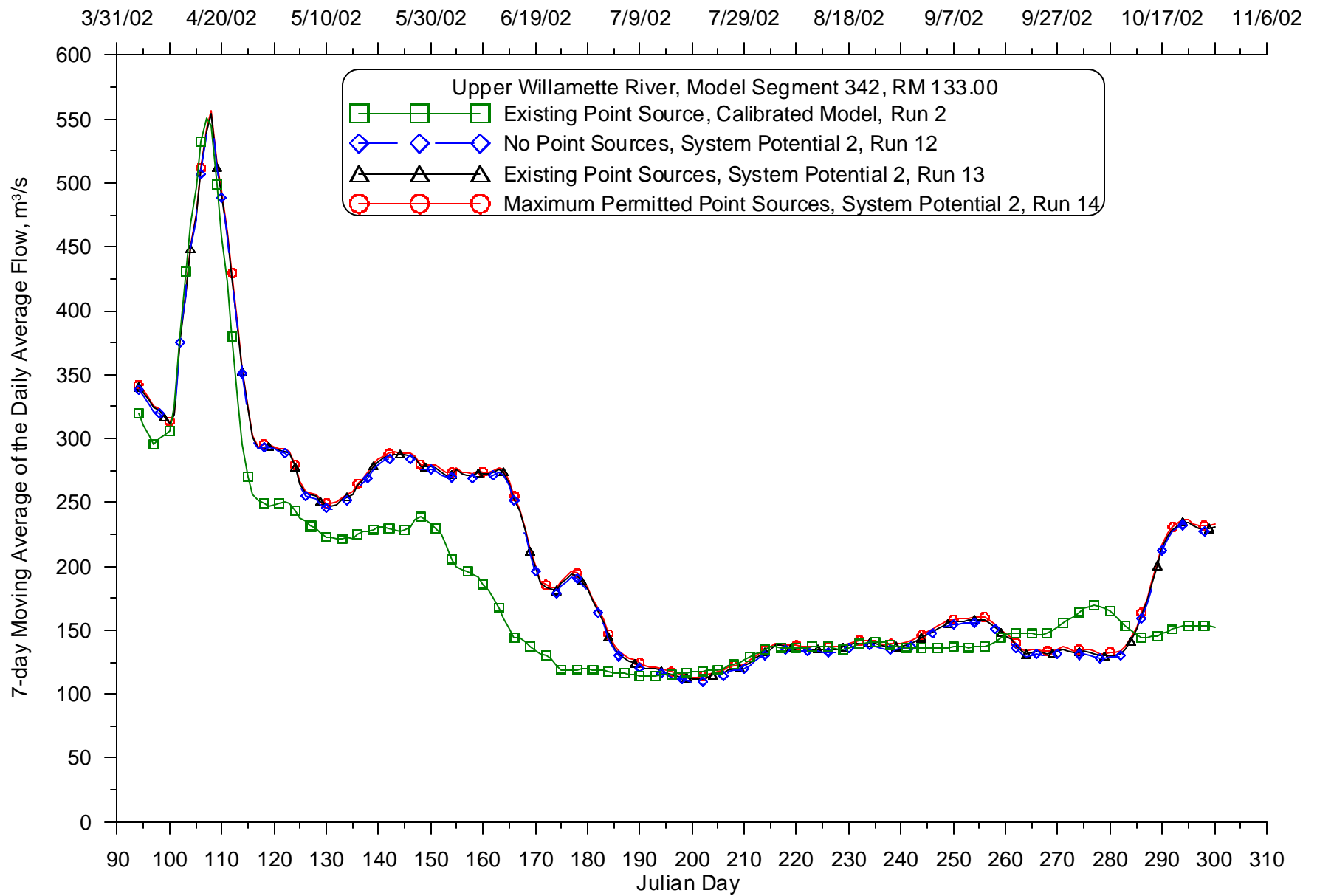


**Figure 406: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 161.98**

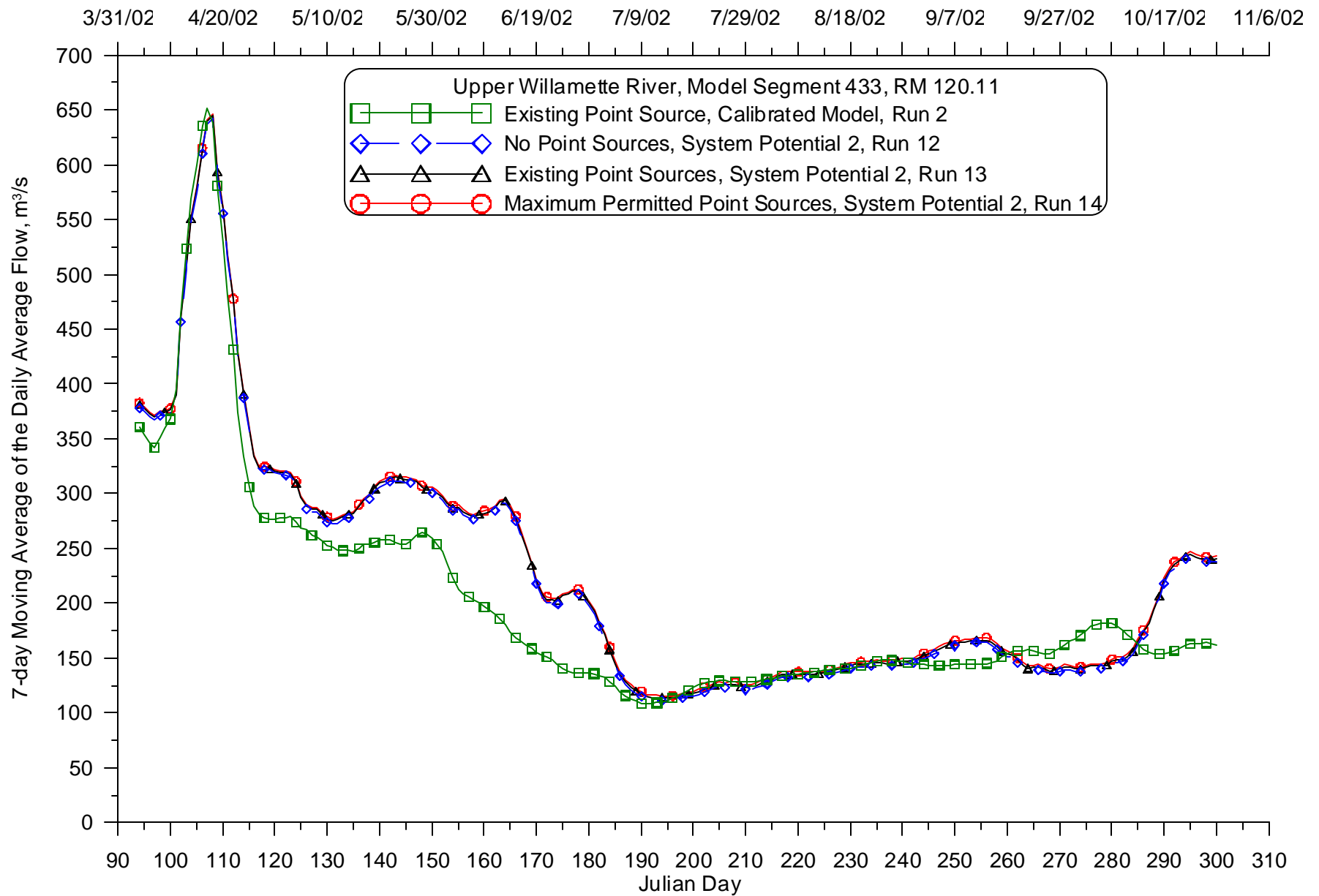




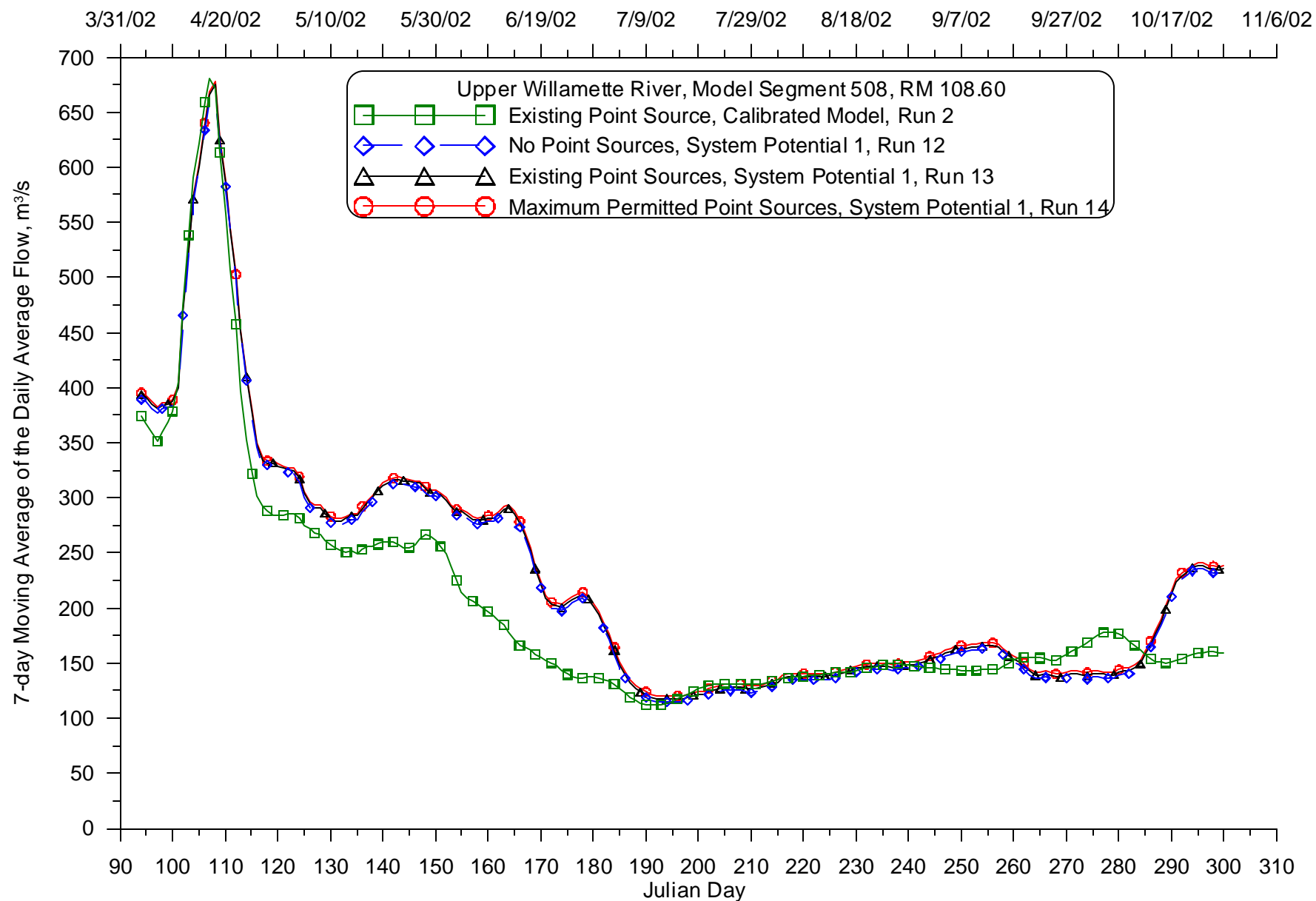
**Figure 407: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 149.4**



**Figure 408: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 133**



**Figure 409: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 120.11**



**Figure 410: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 108.6**

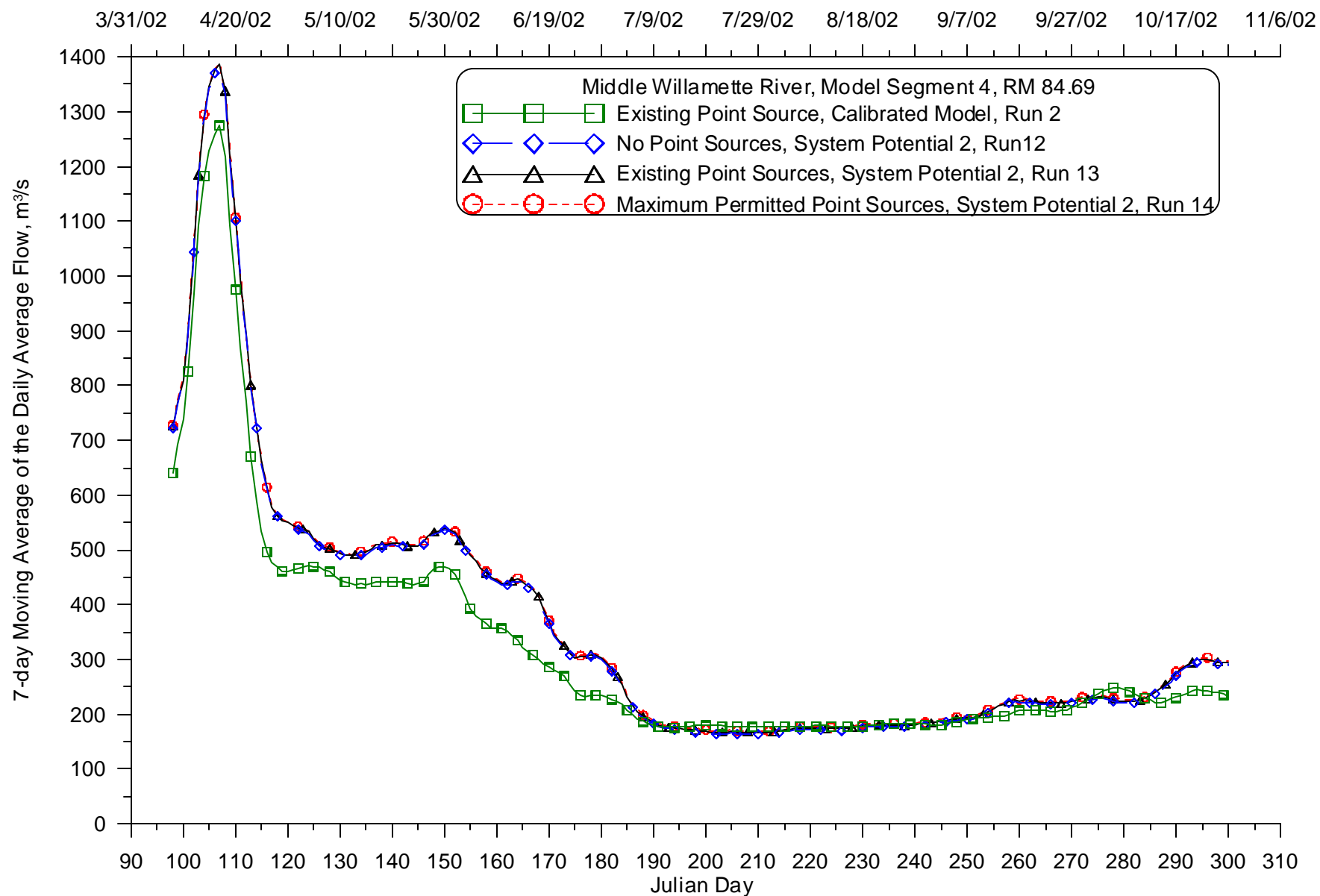
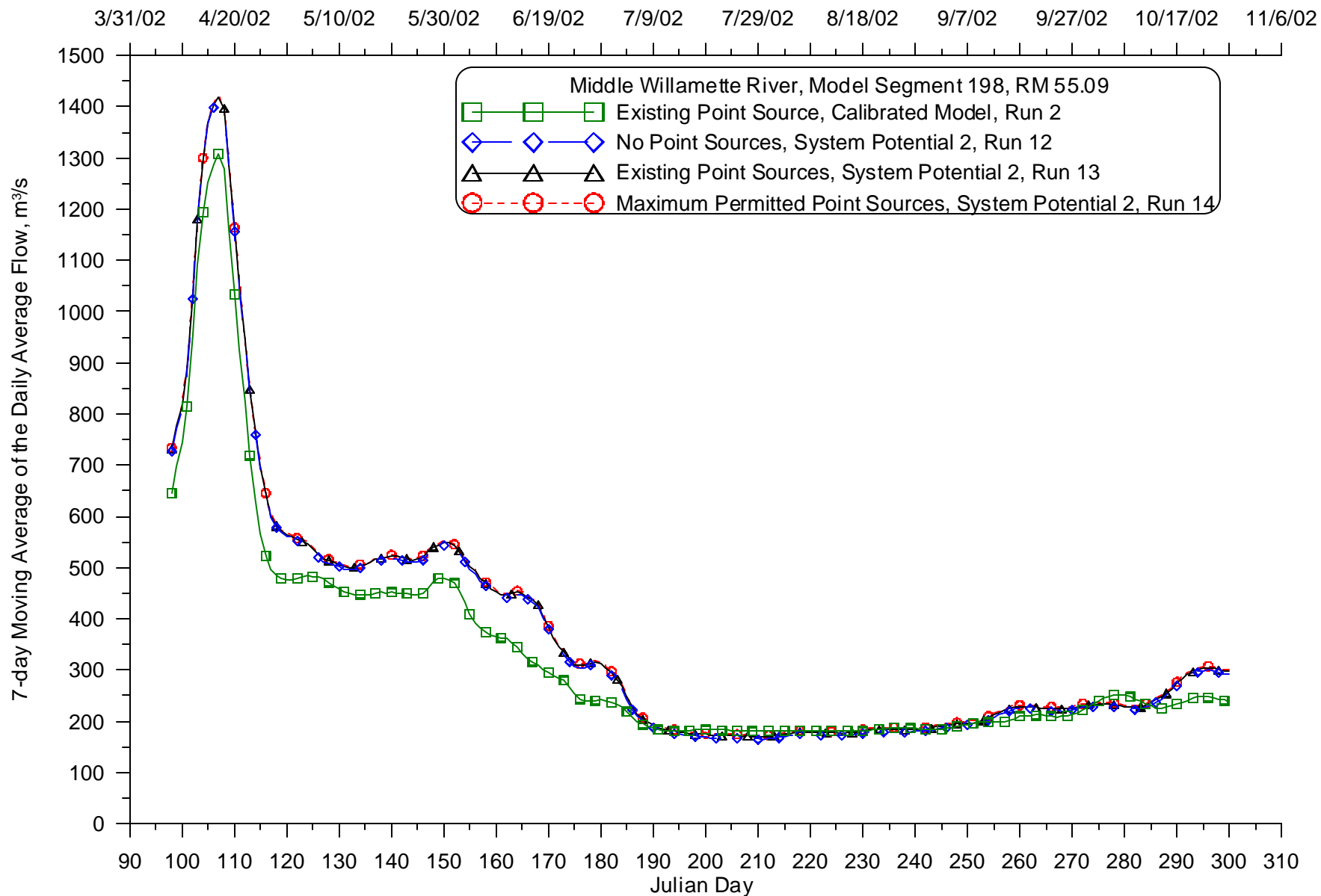


Figure 411: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 84.69



**Figure 412: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 55.09**

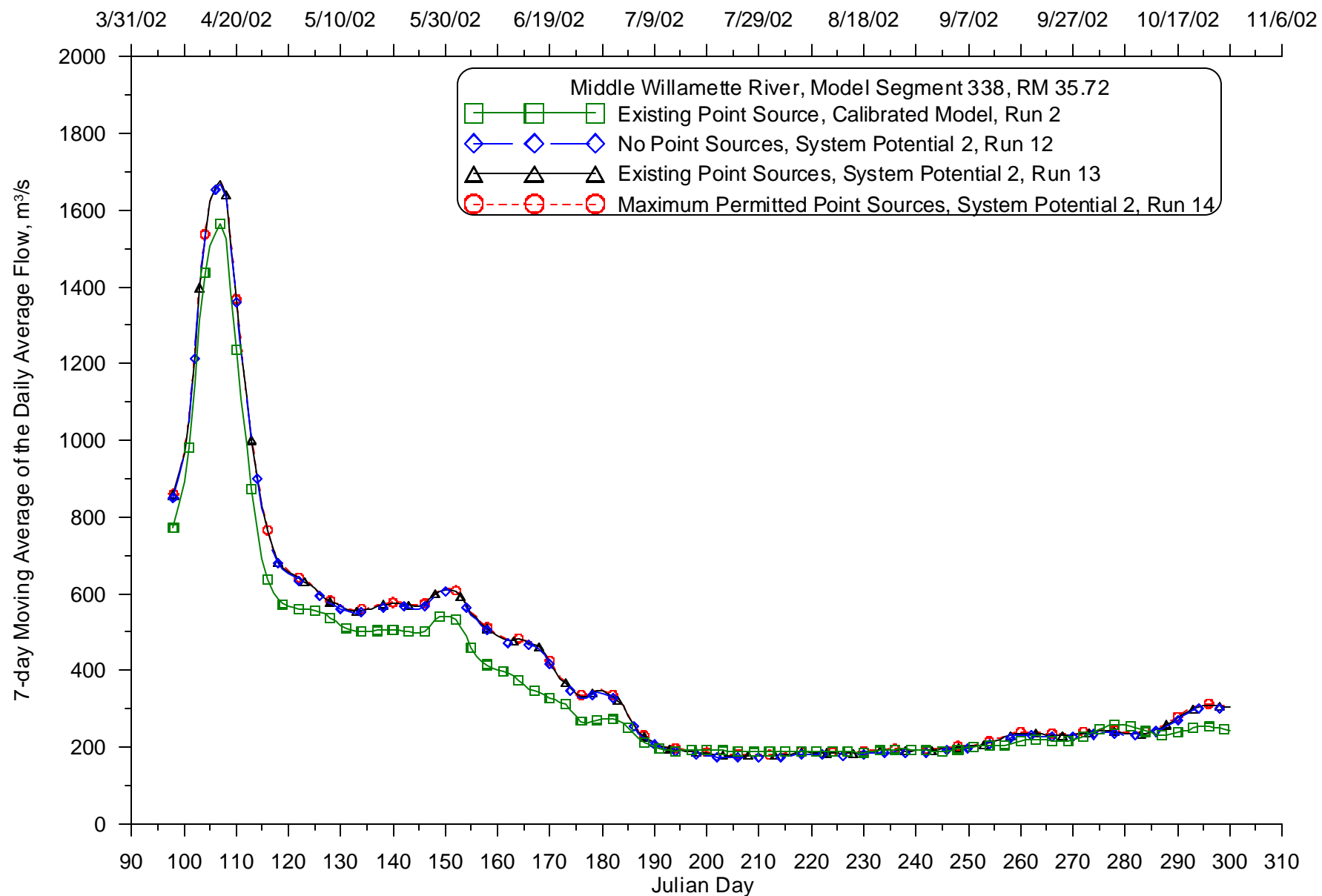
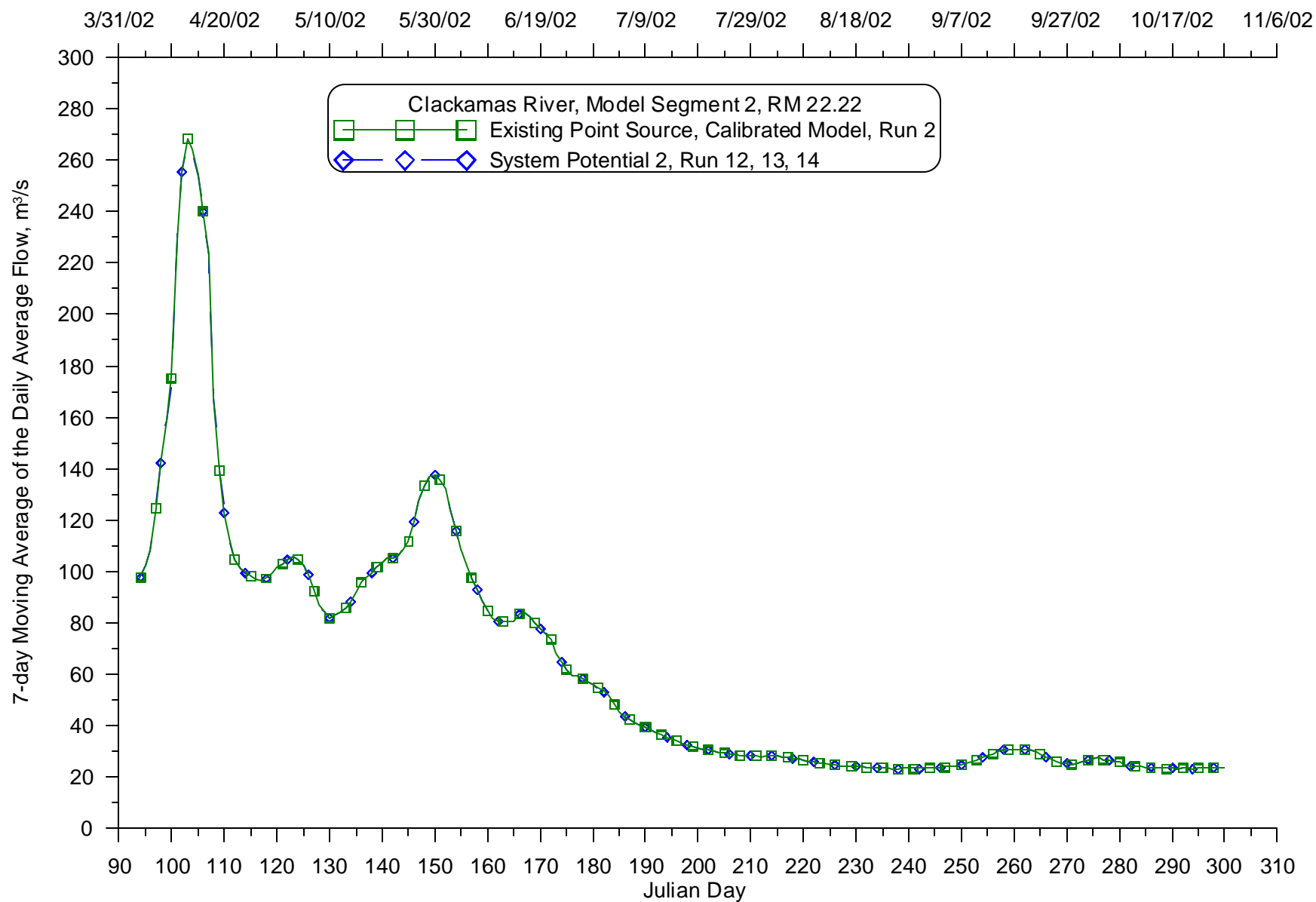
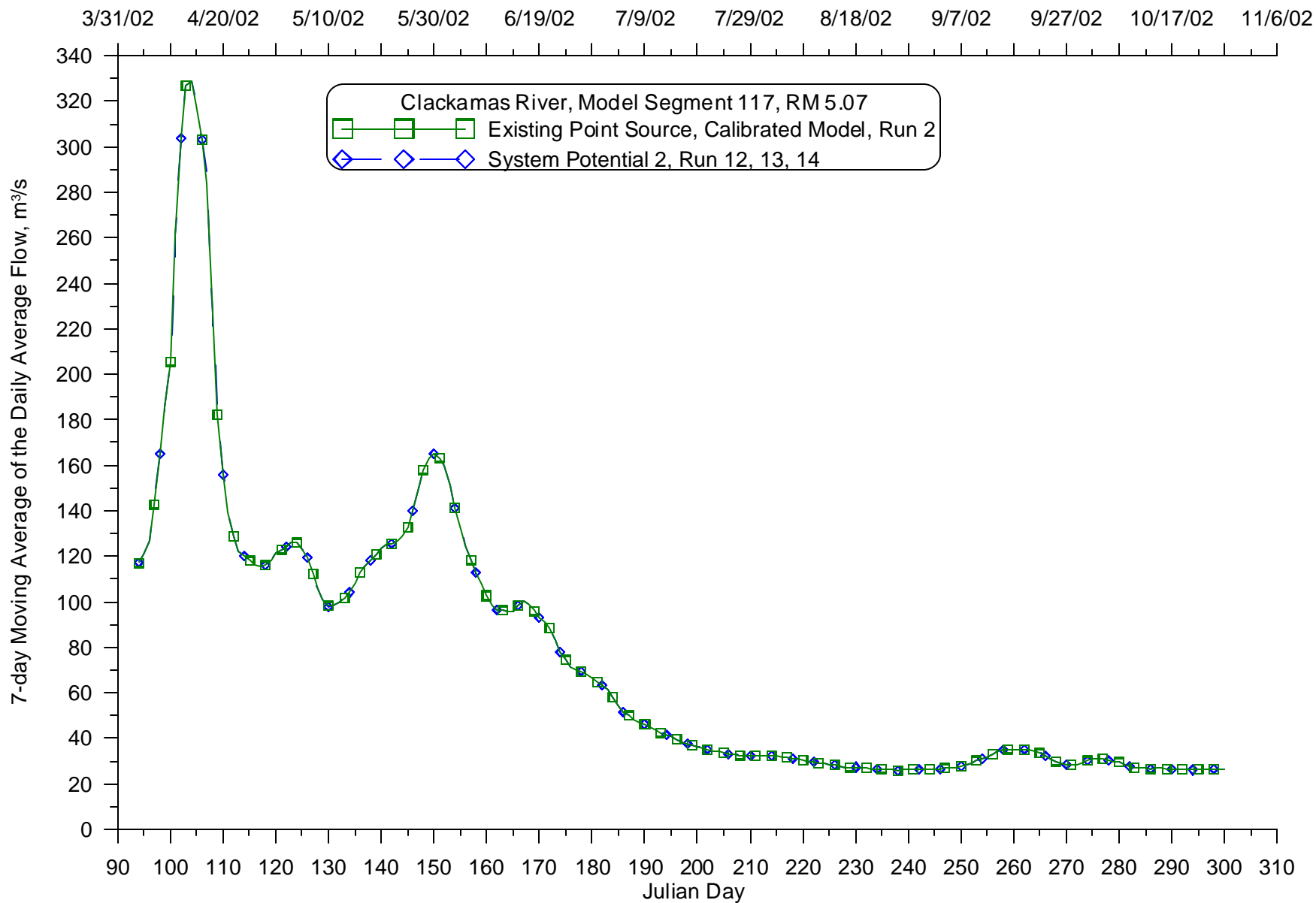


Figure 413: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 35.72

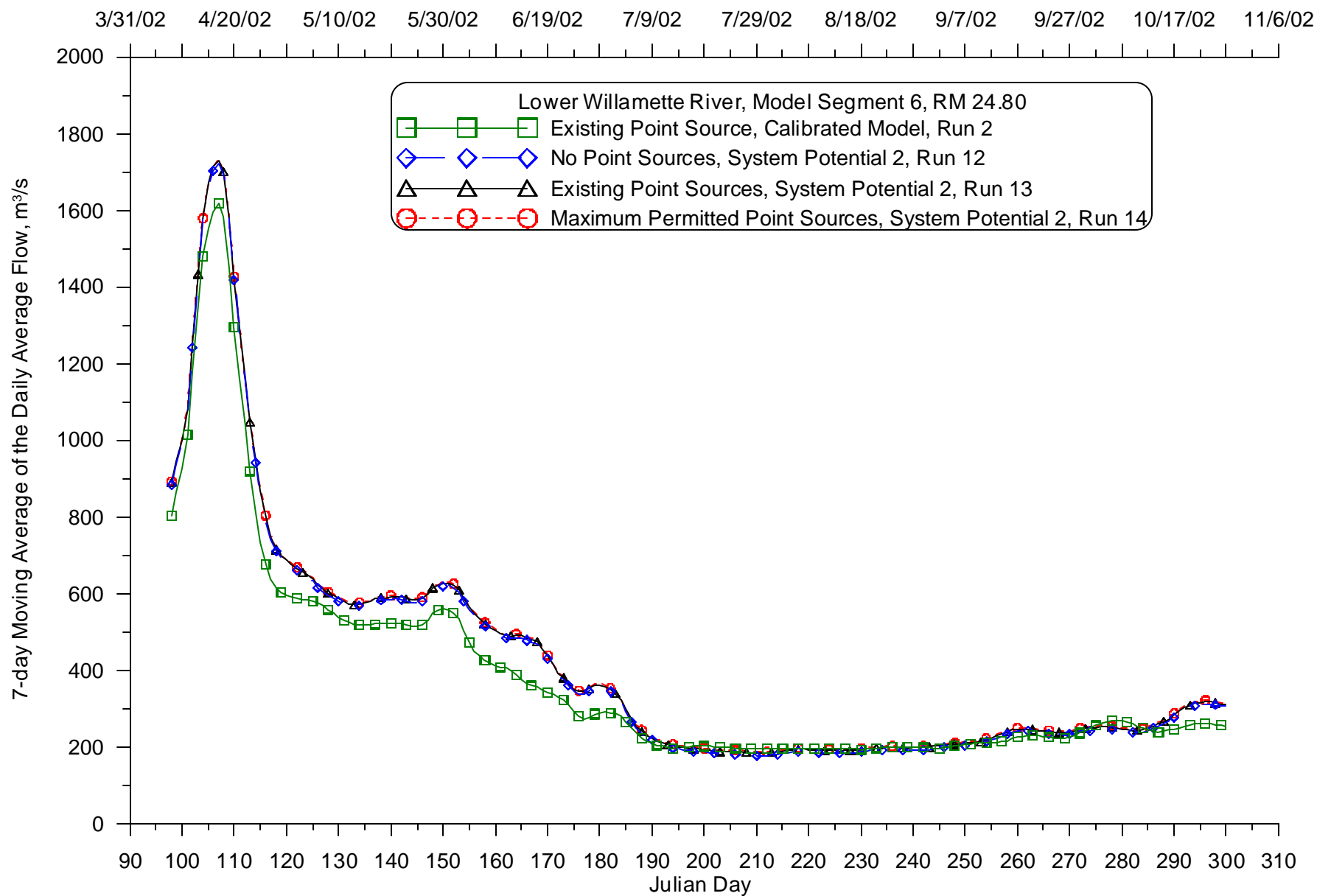


**Figure 414: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Clackamas River at RM 22.22**

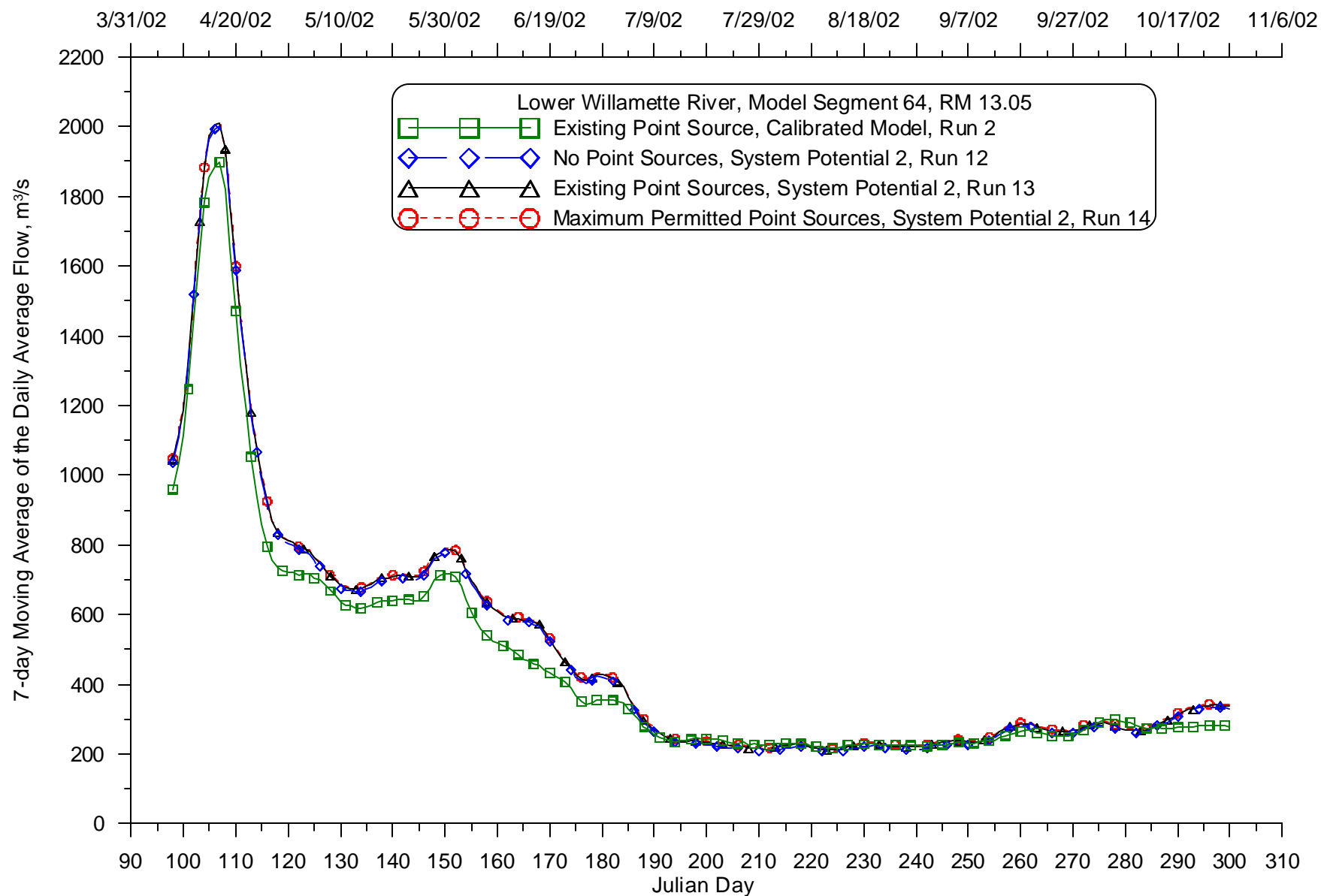




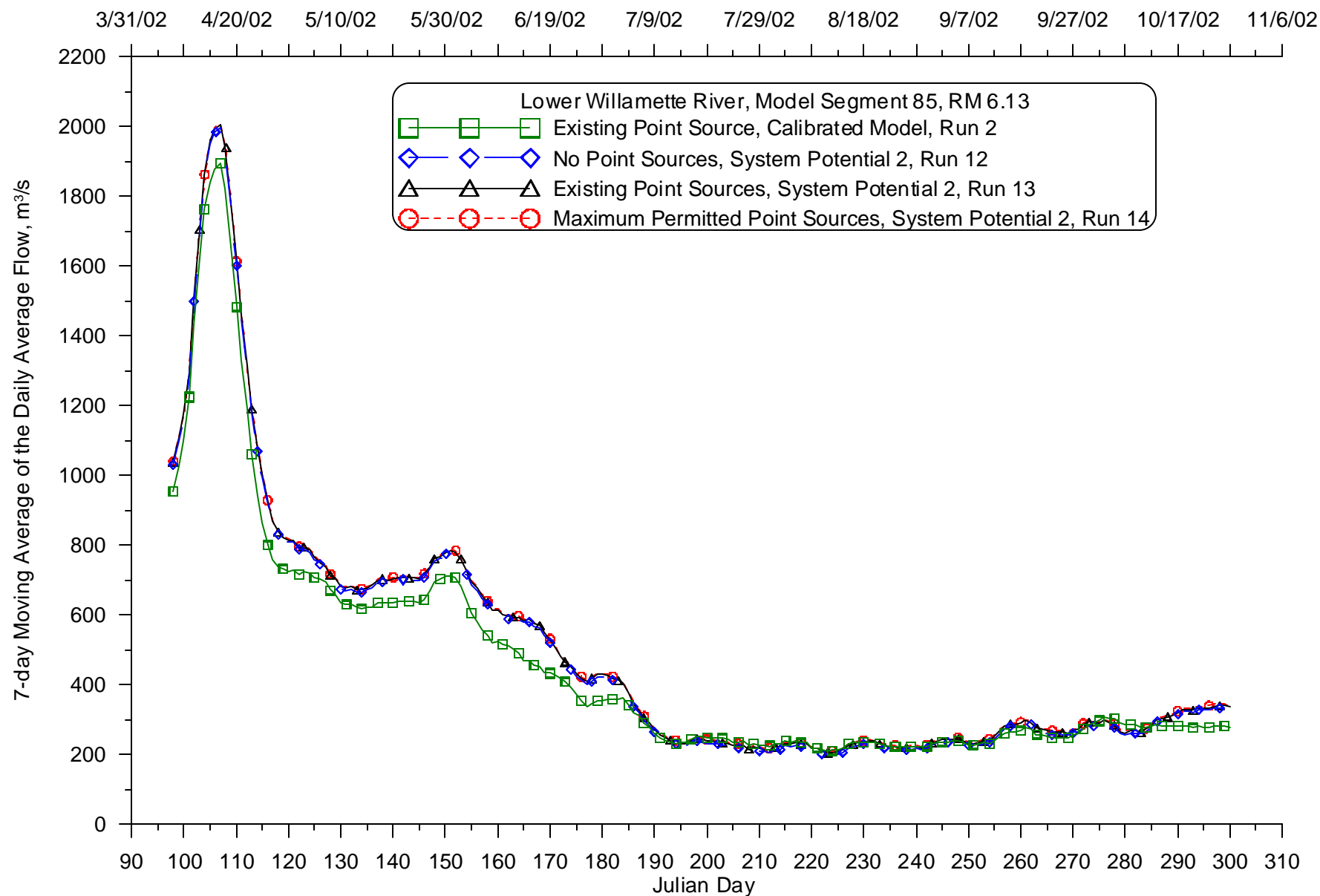
**Figure 415: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Clackamas River at RM 5.07**



**Figure 416: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 24.8**



**Figure 417: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 13.05**

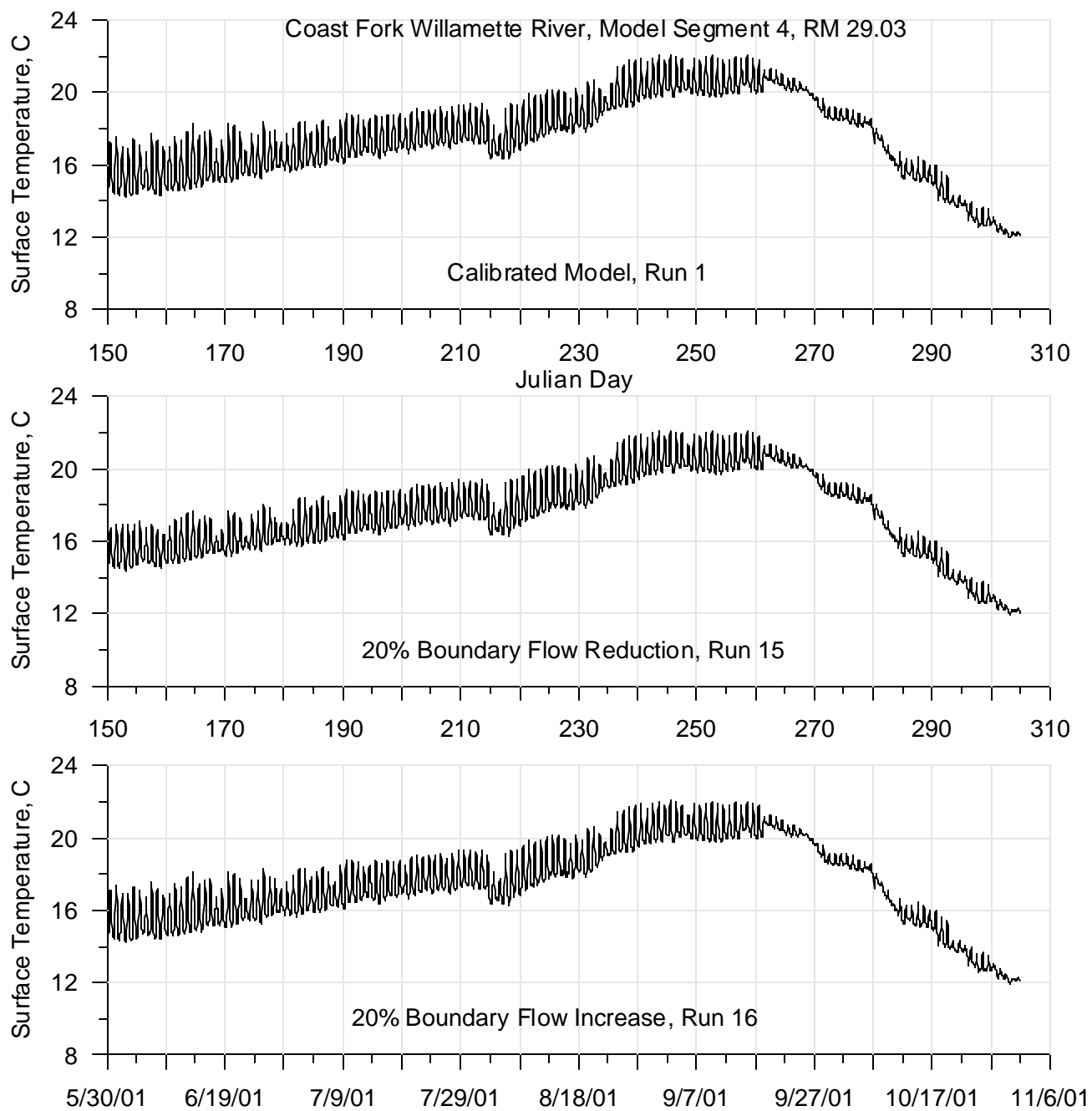


**Figure 418: Calibrated model and System Potential 2 (varying point source discharges) 7-day moving average of the daily average flow comparison for 2002 for the Willamette River at RM 6.13**

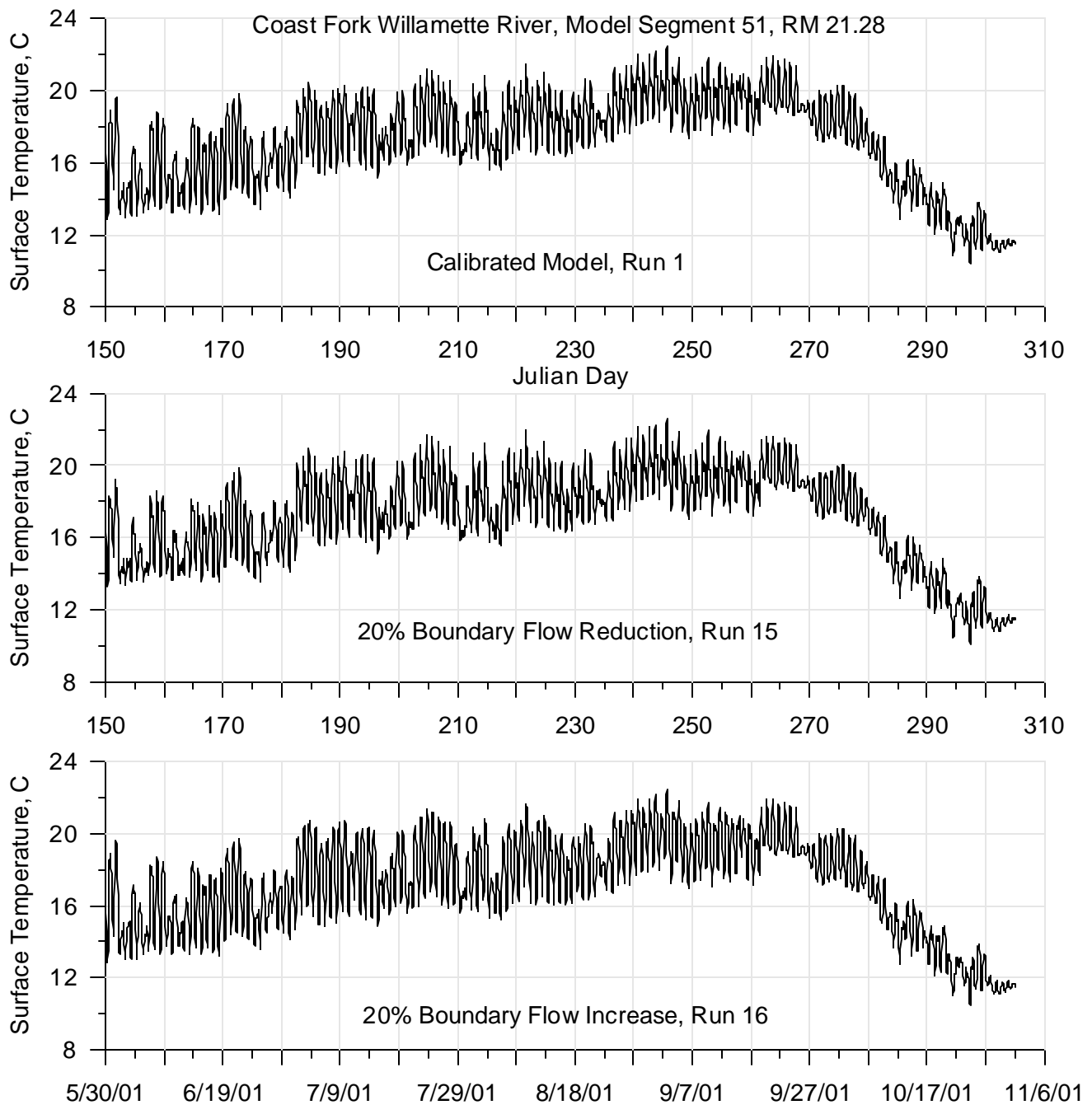
## ***Sensitivity to boundary flow rate***

The sensitivity of the model to upstream boundary flows was examined by simulating the summer of 2001 and adjusting the upstream boundary flows by +/- 20%. These results were then compared with the results of the calibrated model in a series of time series plots. There are four types of time series output for each of the 21 locations identified above in Table 2: continuous temperature, continuous flow, the seven-day moving average of the daily maximum temperature, and the seven-day average of daily average flow.

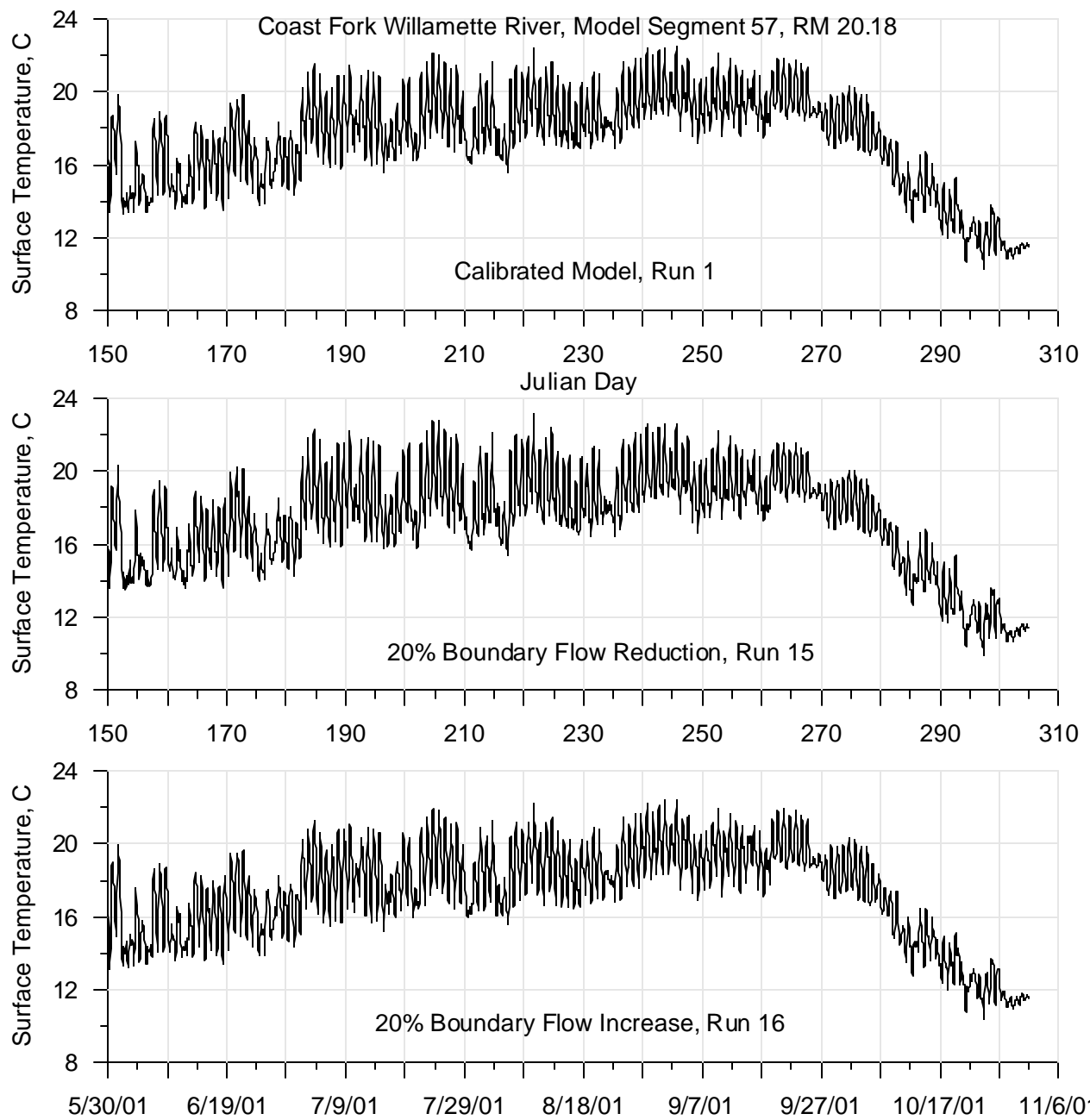
### **Continuous Temperature**



**Figure 419: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Coast Fork Willamette River at RM 29.03**

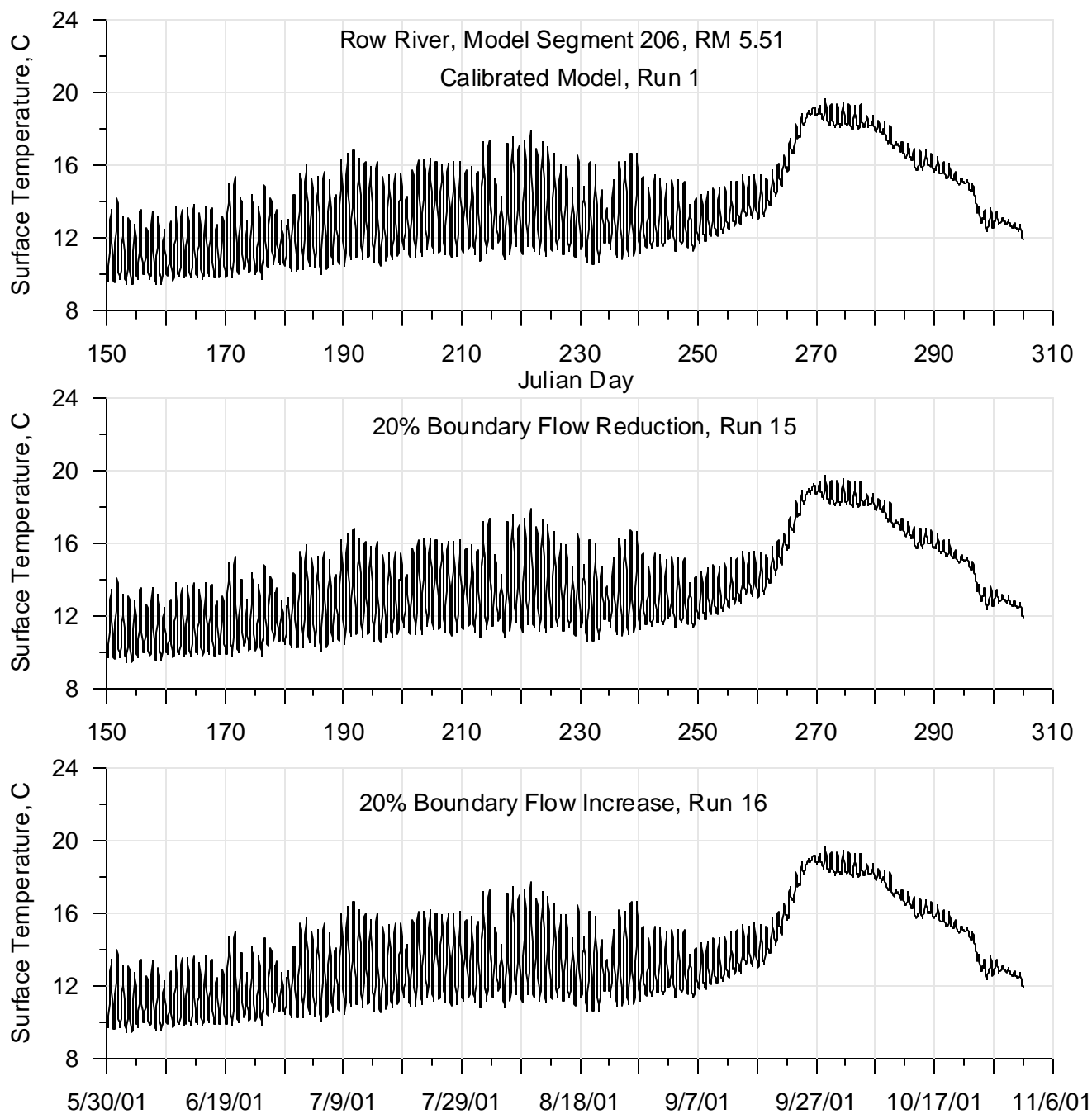


**Figure 420: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Coast Fork Willamette River at RM 21.28**

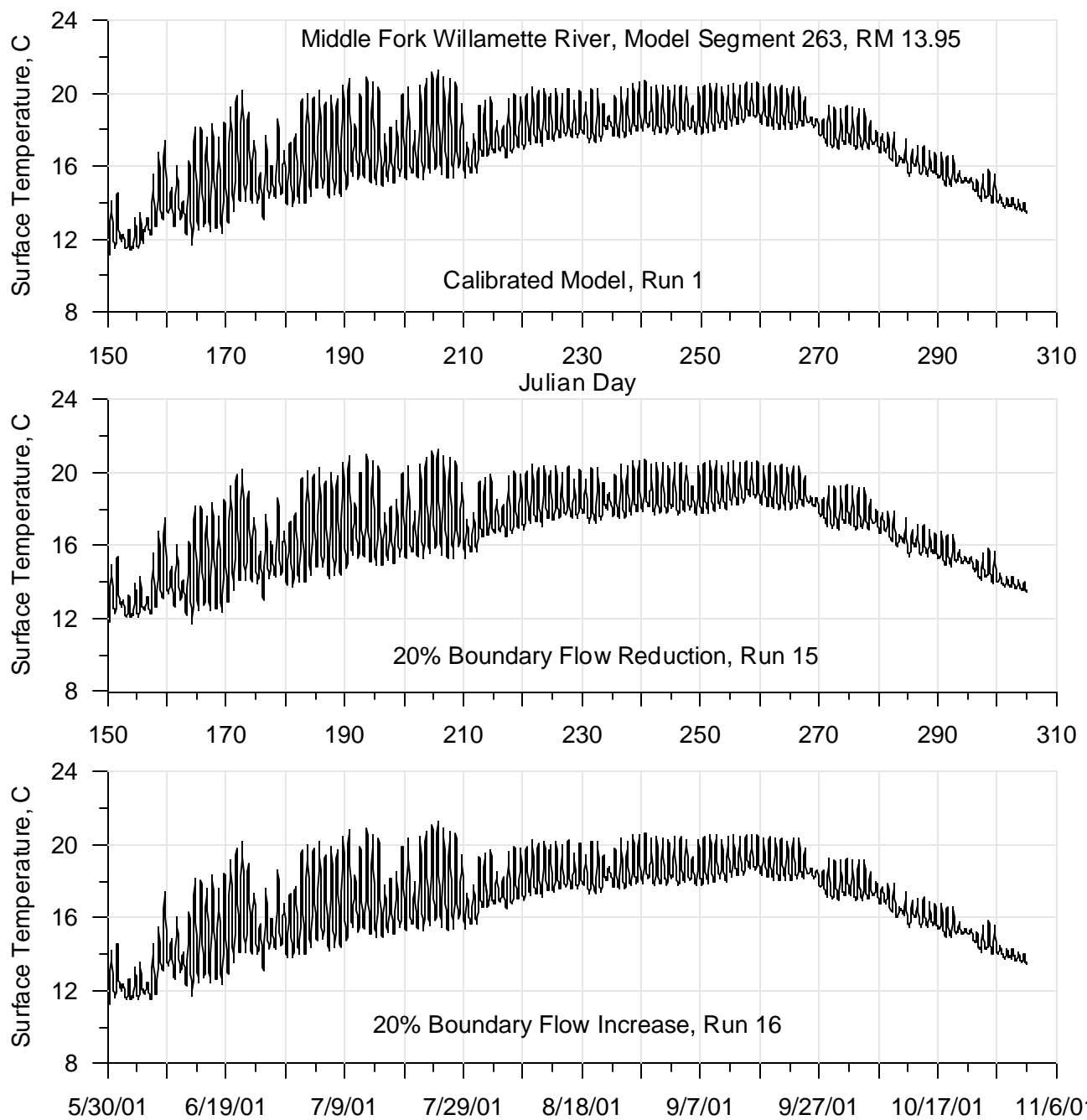


**Figure 421: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Coast Fork Willamette River at RM 20.18**

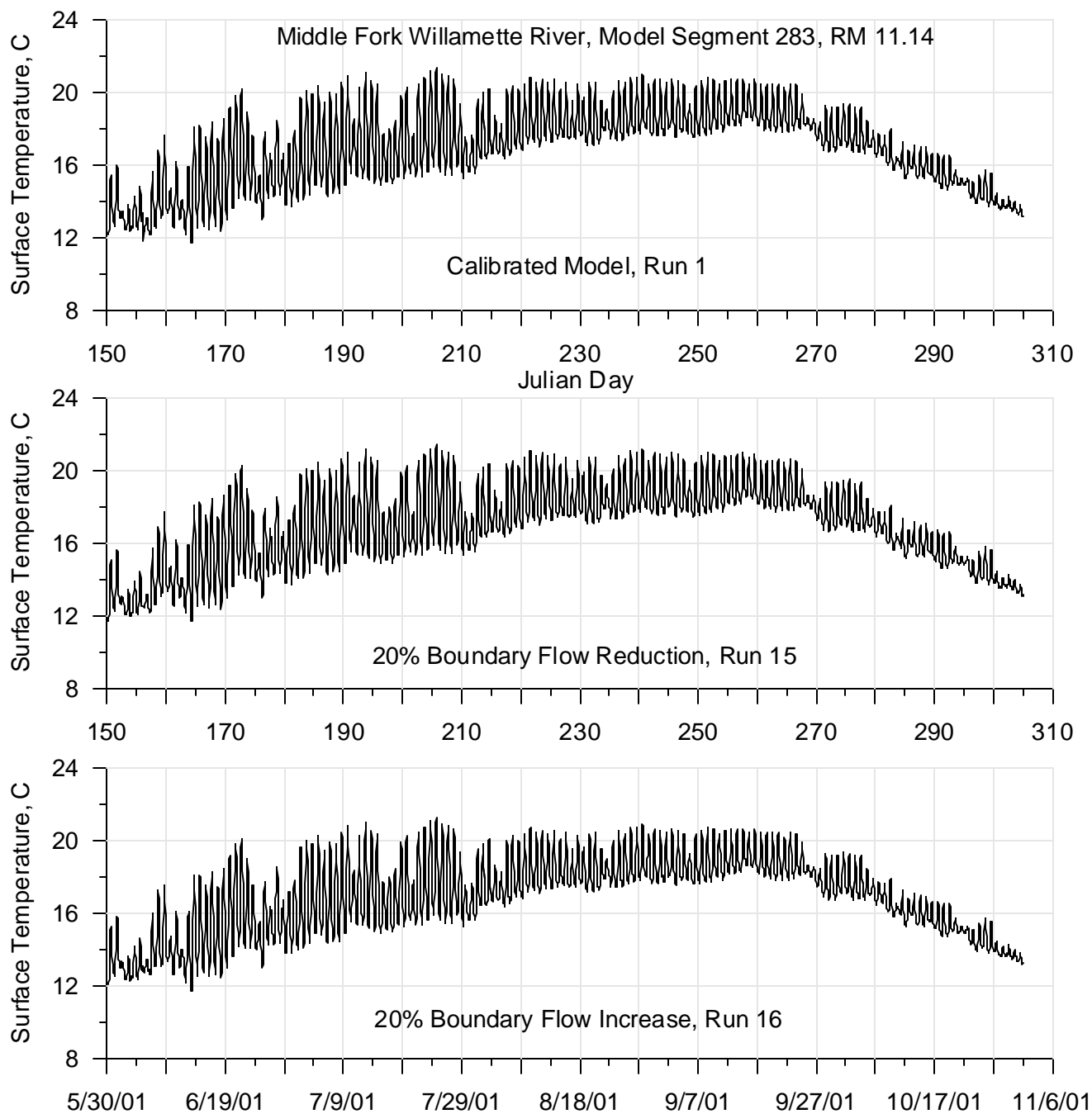




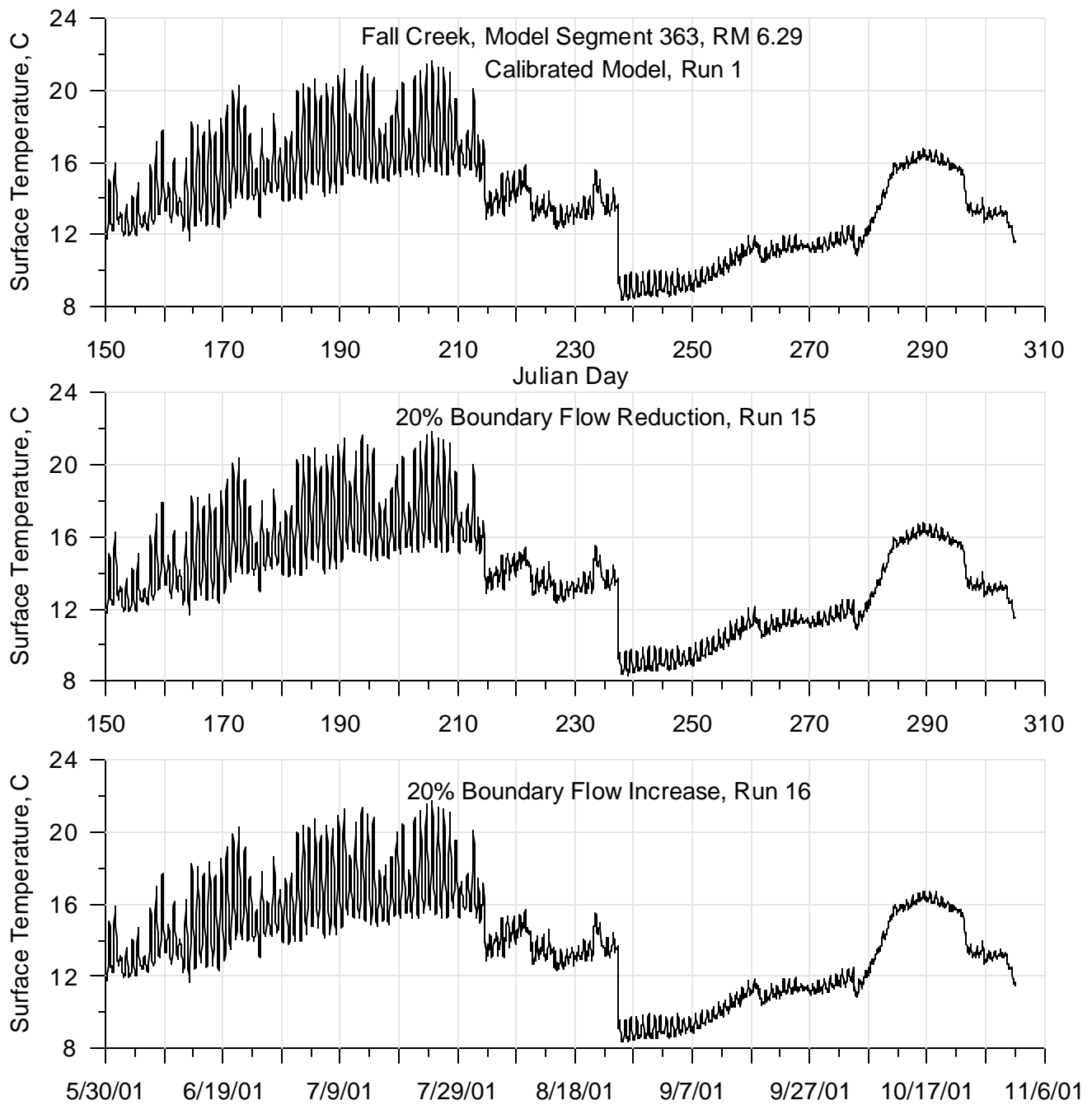
**Figure 422: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Row River at RM 5.51**



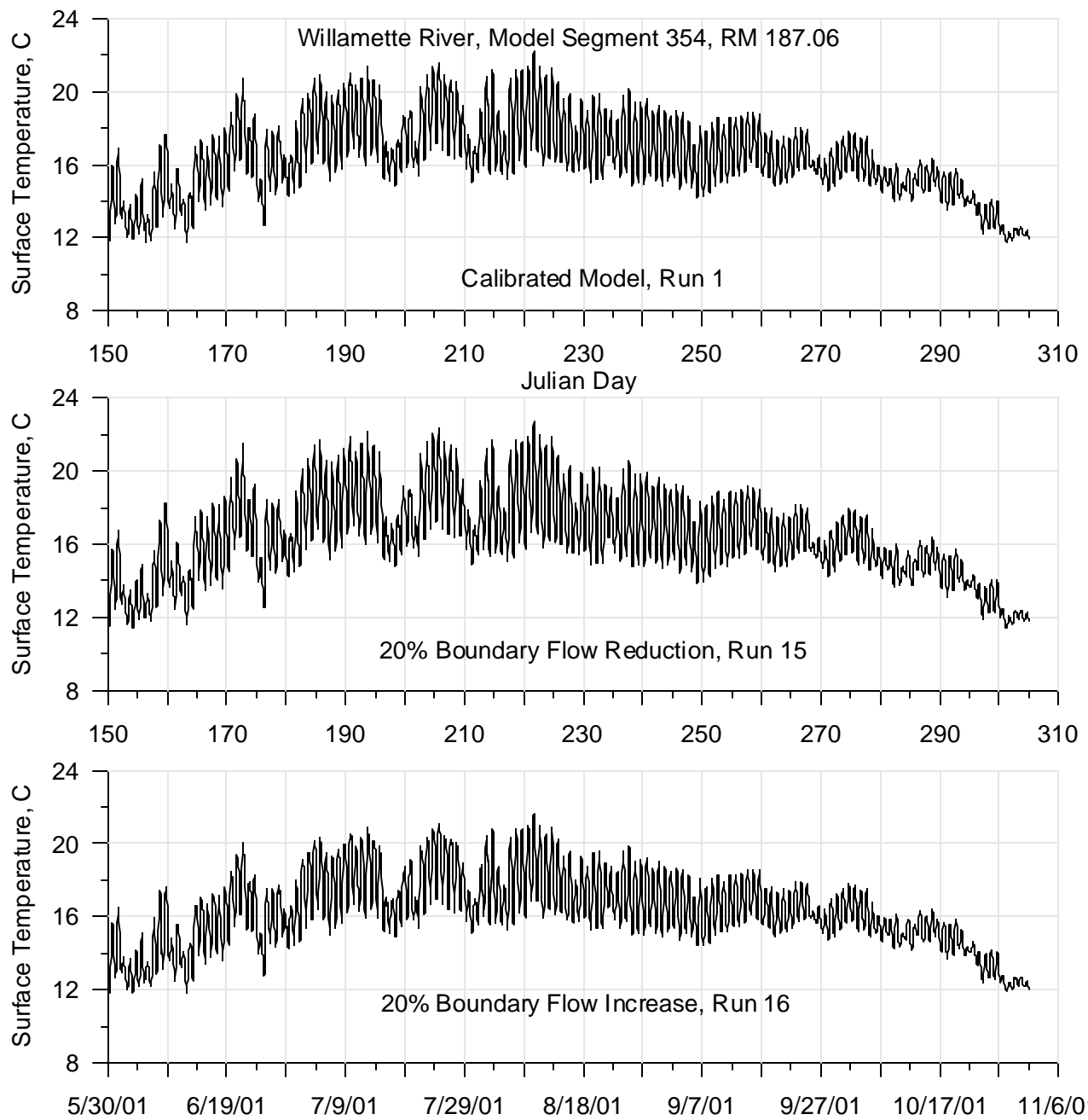
**Figure 423: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Middle Fork Willamette River at RM 13.95**



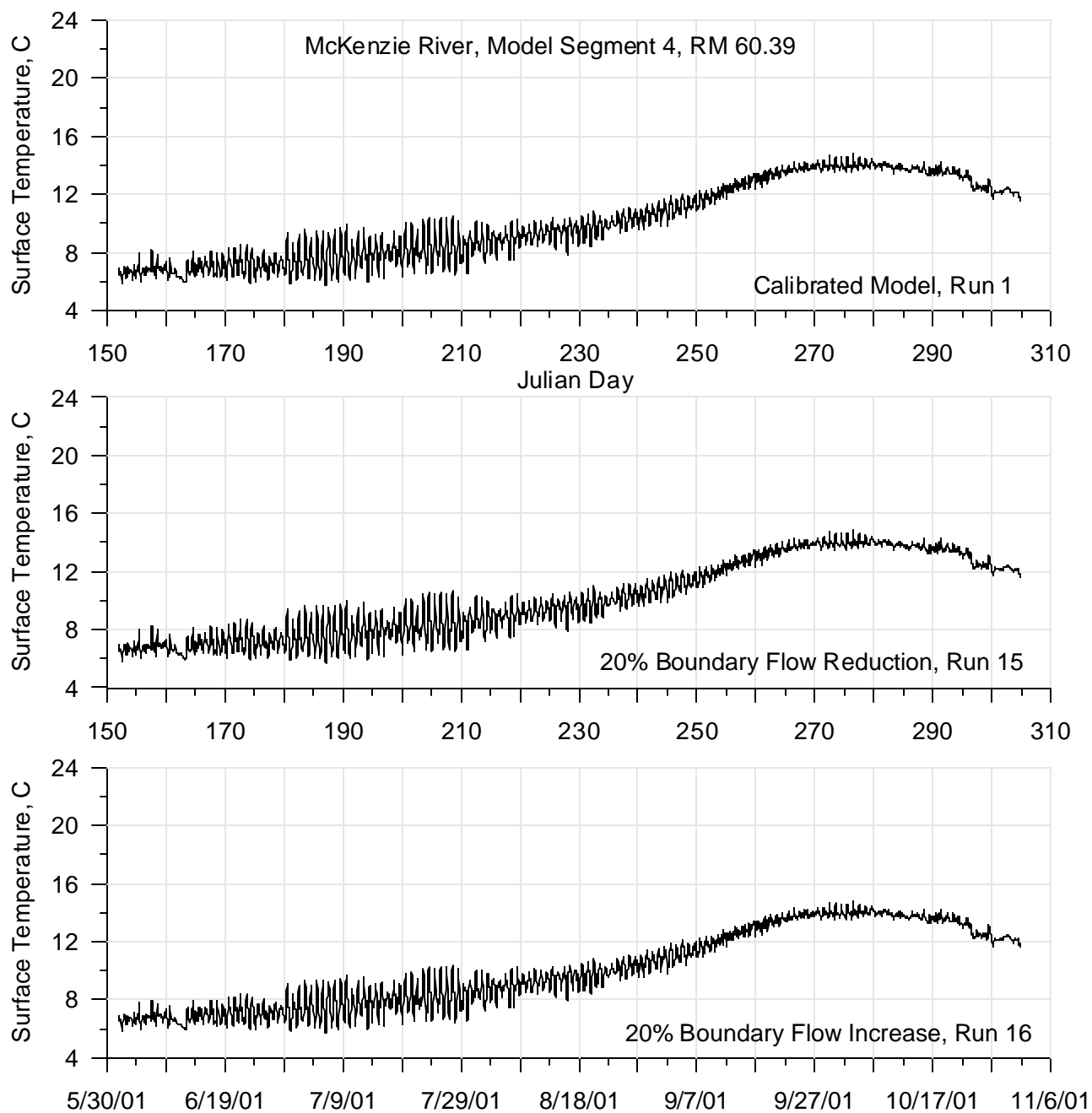
**Figure 424: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Middle Fork Willamette River at RM 11.14**



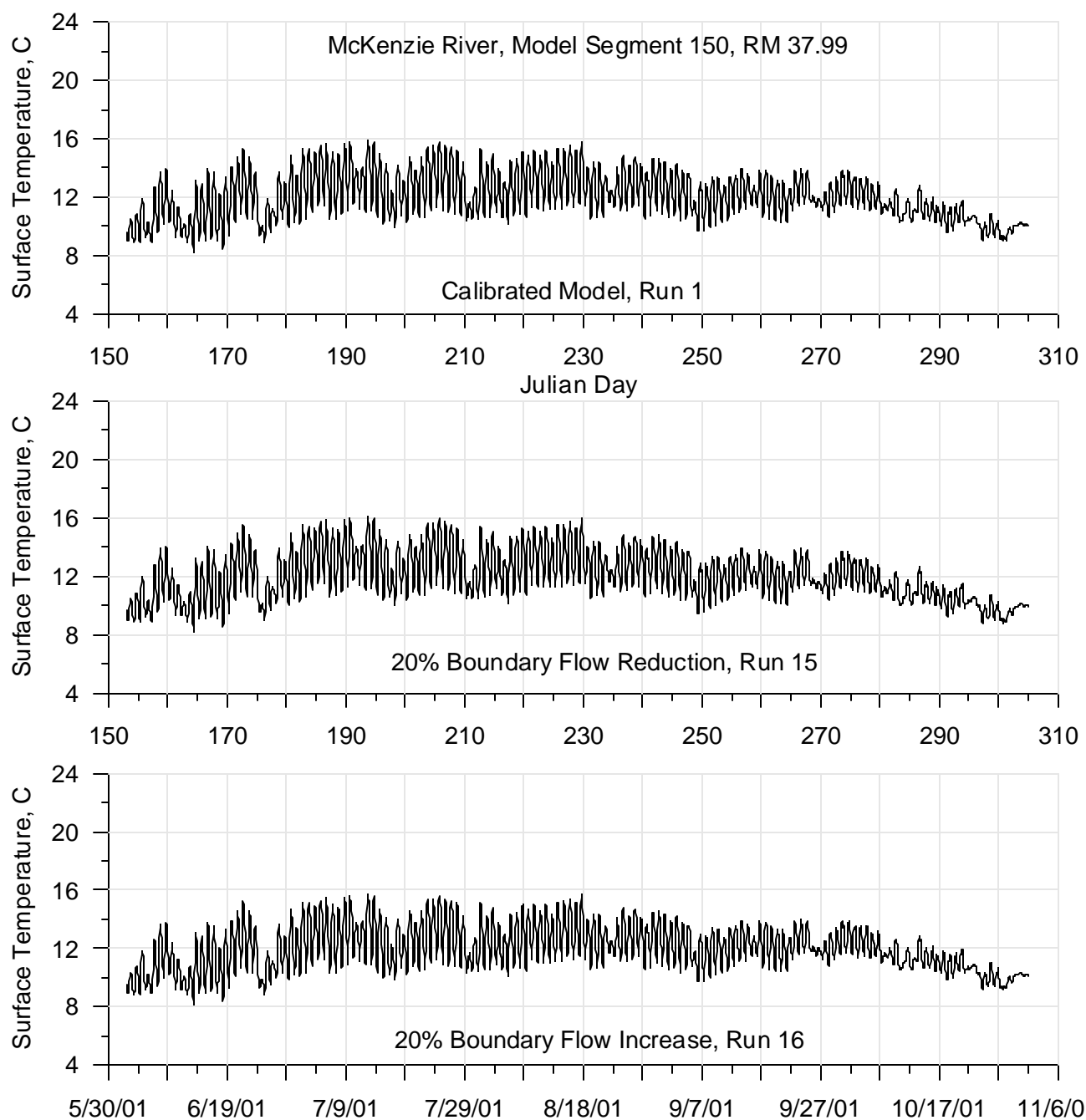
**Figure 425: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for Fall Creek at RM 6.29**



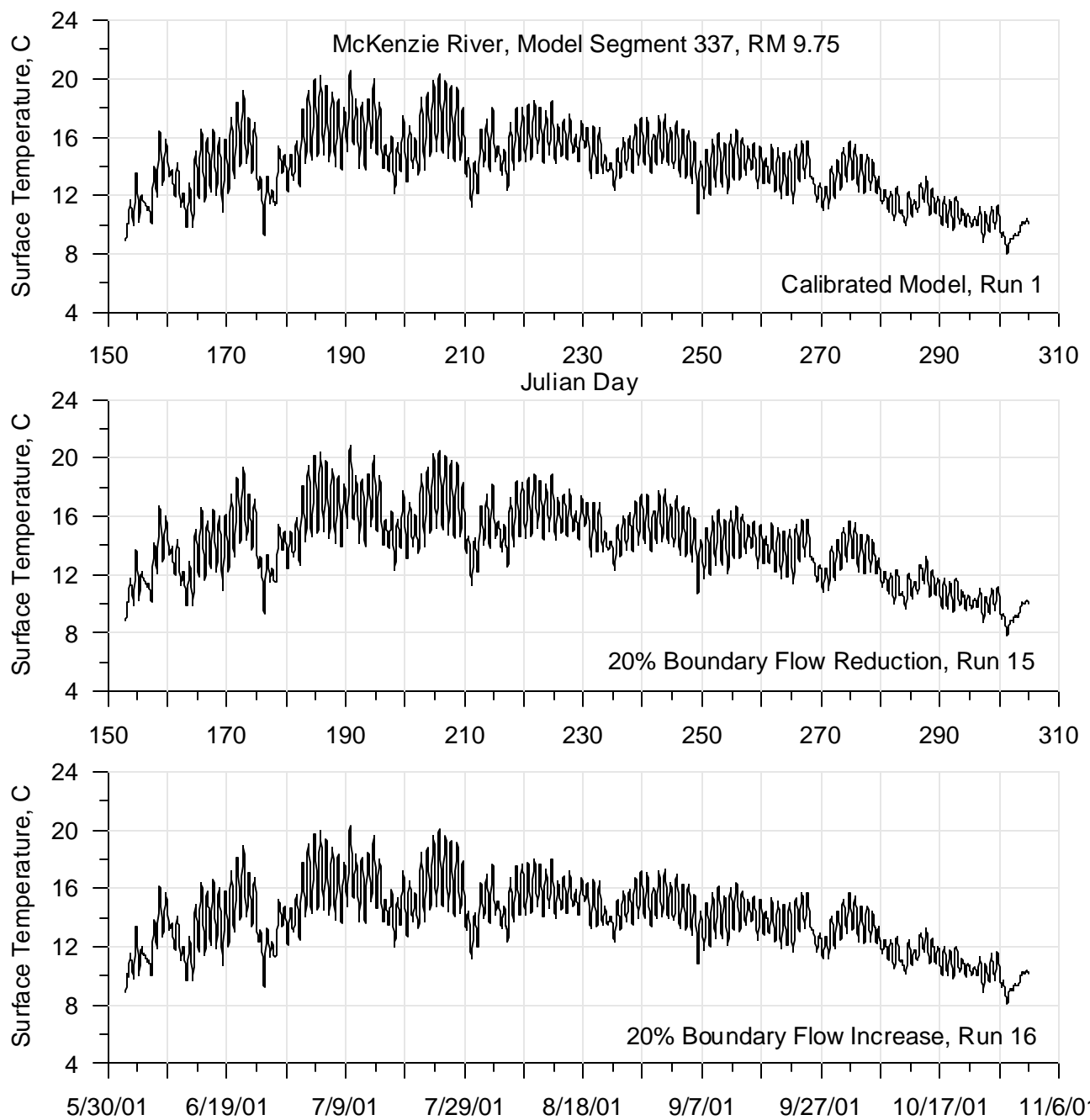
**Figure 426: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 187.06**



**Figure 427: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the McKenzie River at RM 60.39**

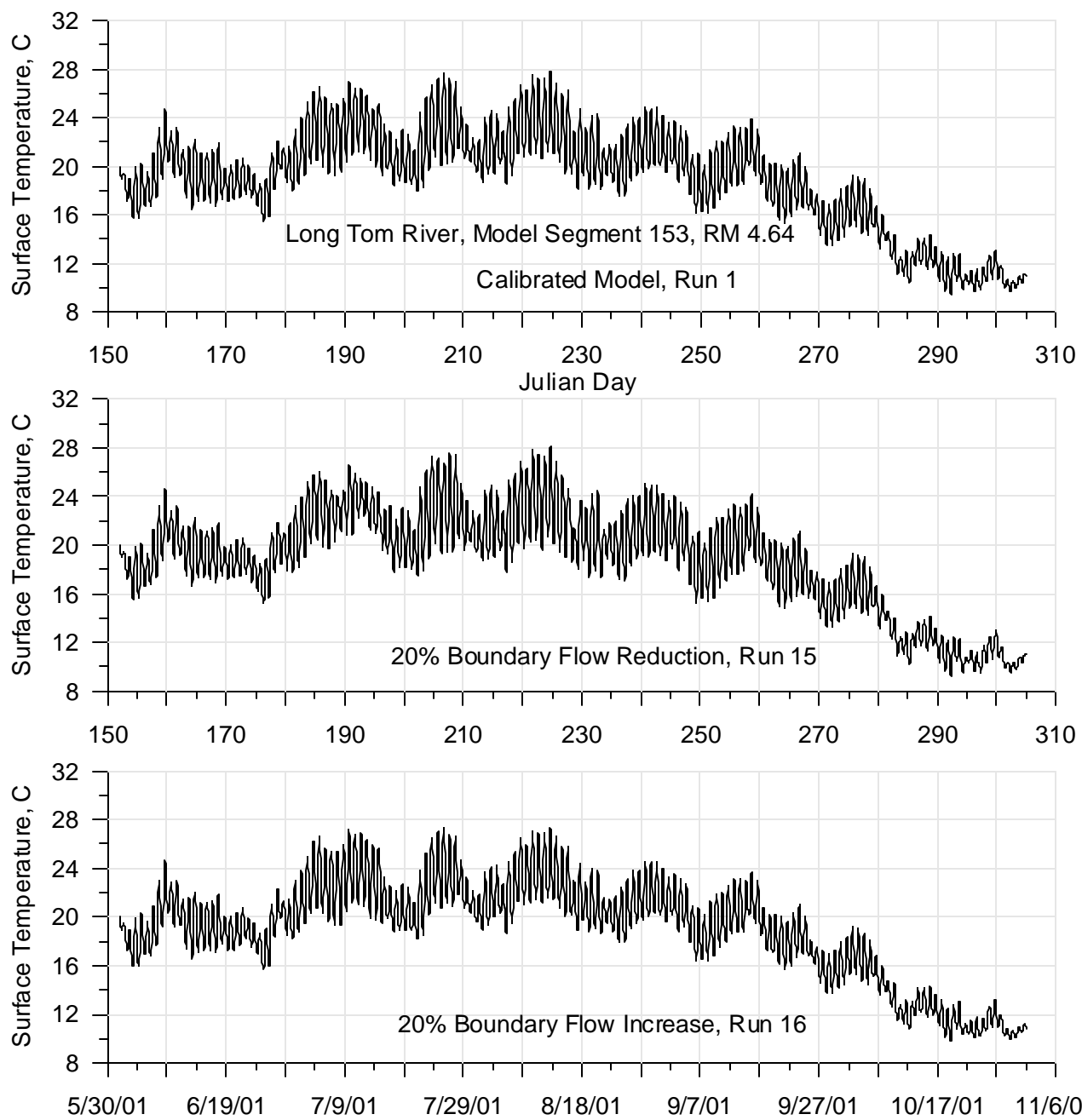


**Figure 428: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the McKenzie River at RM 37.99**

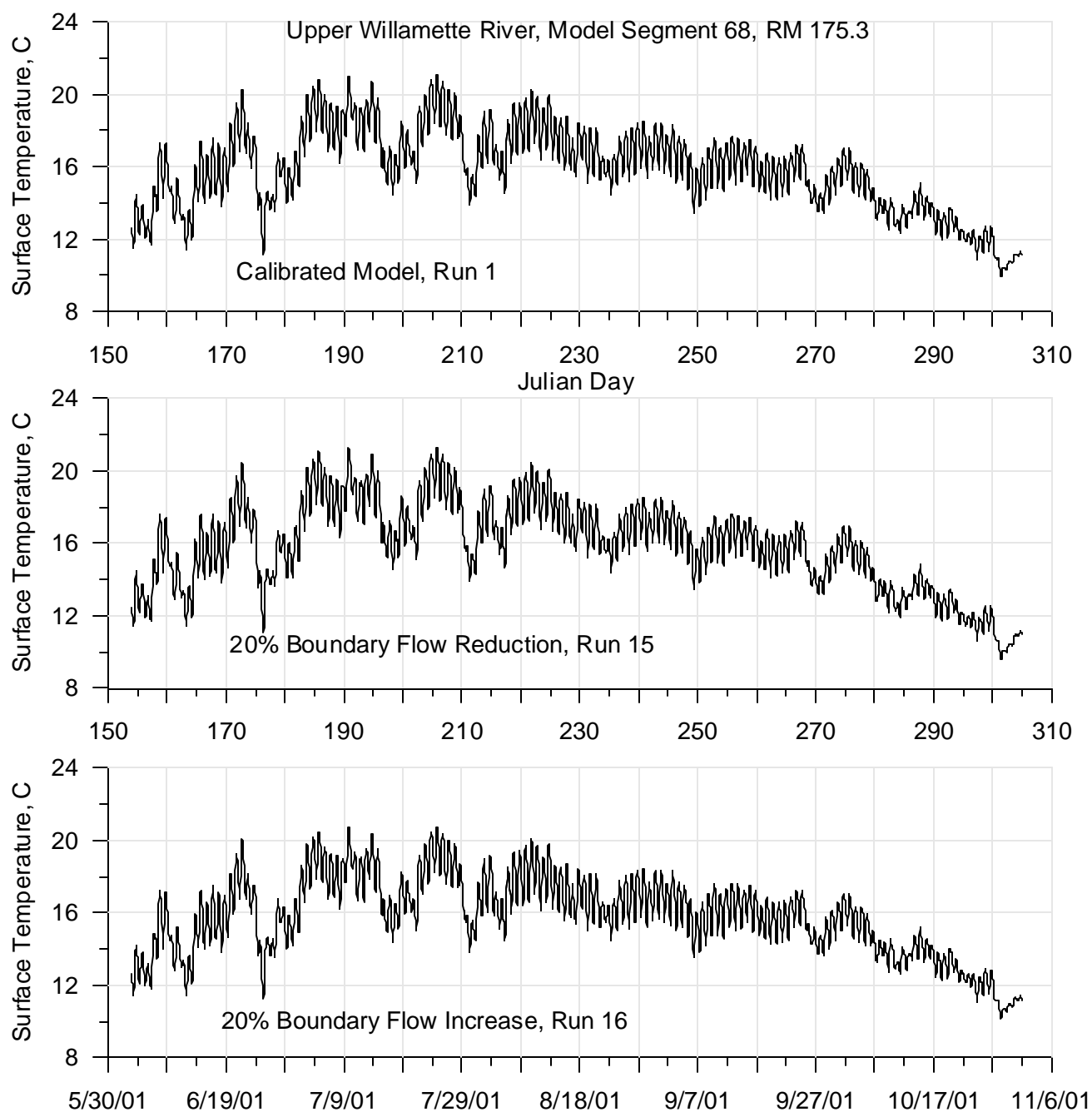


**Figure 429: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the McKenzie River at RM 9.75**

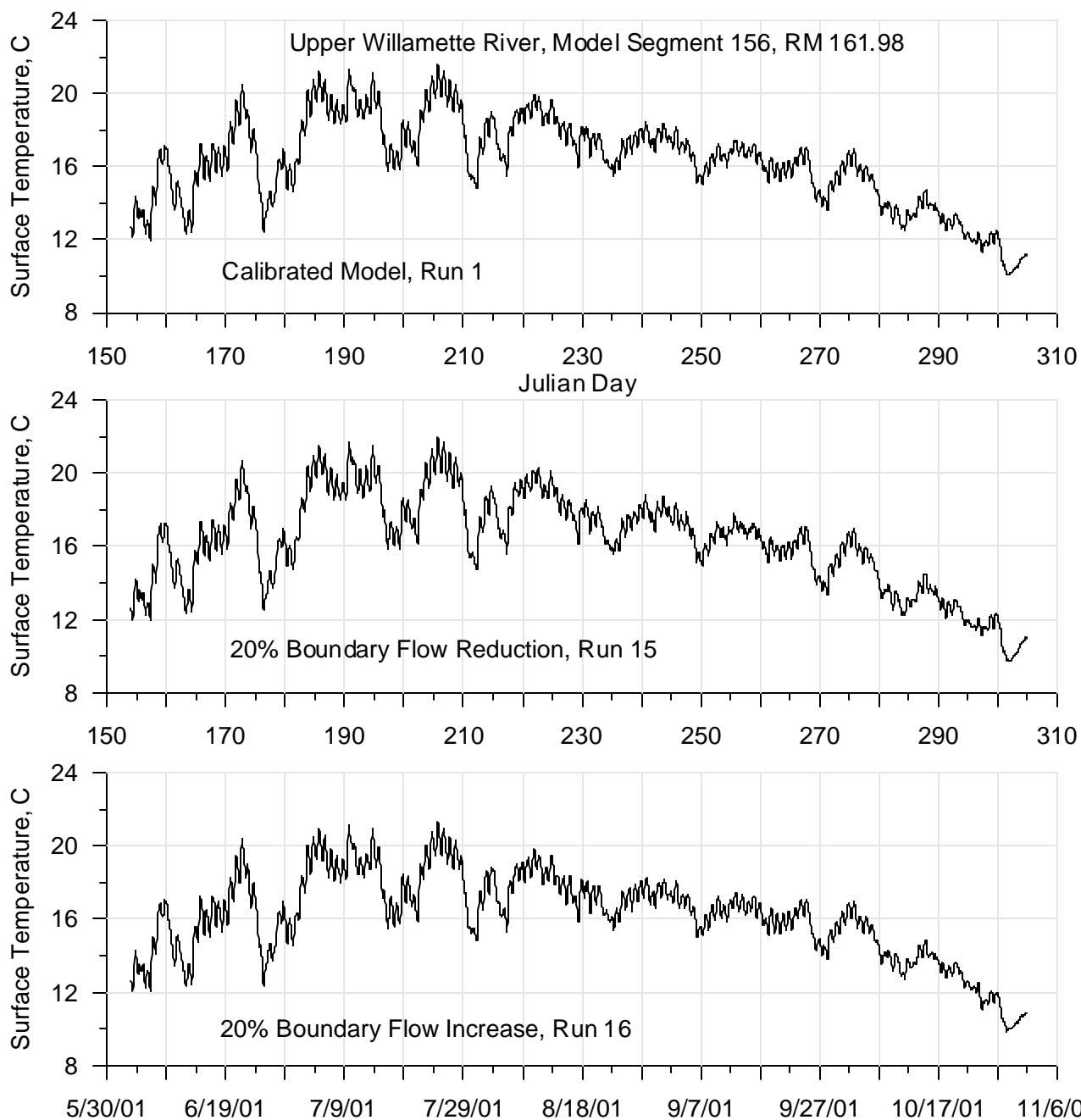




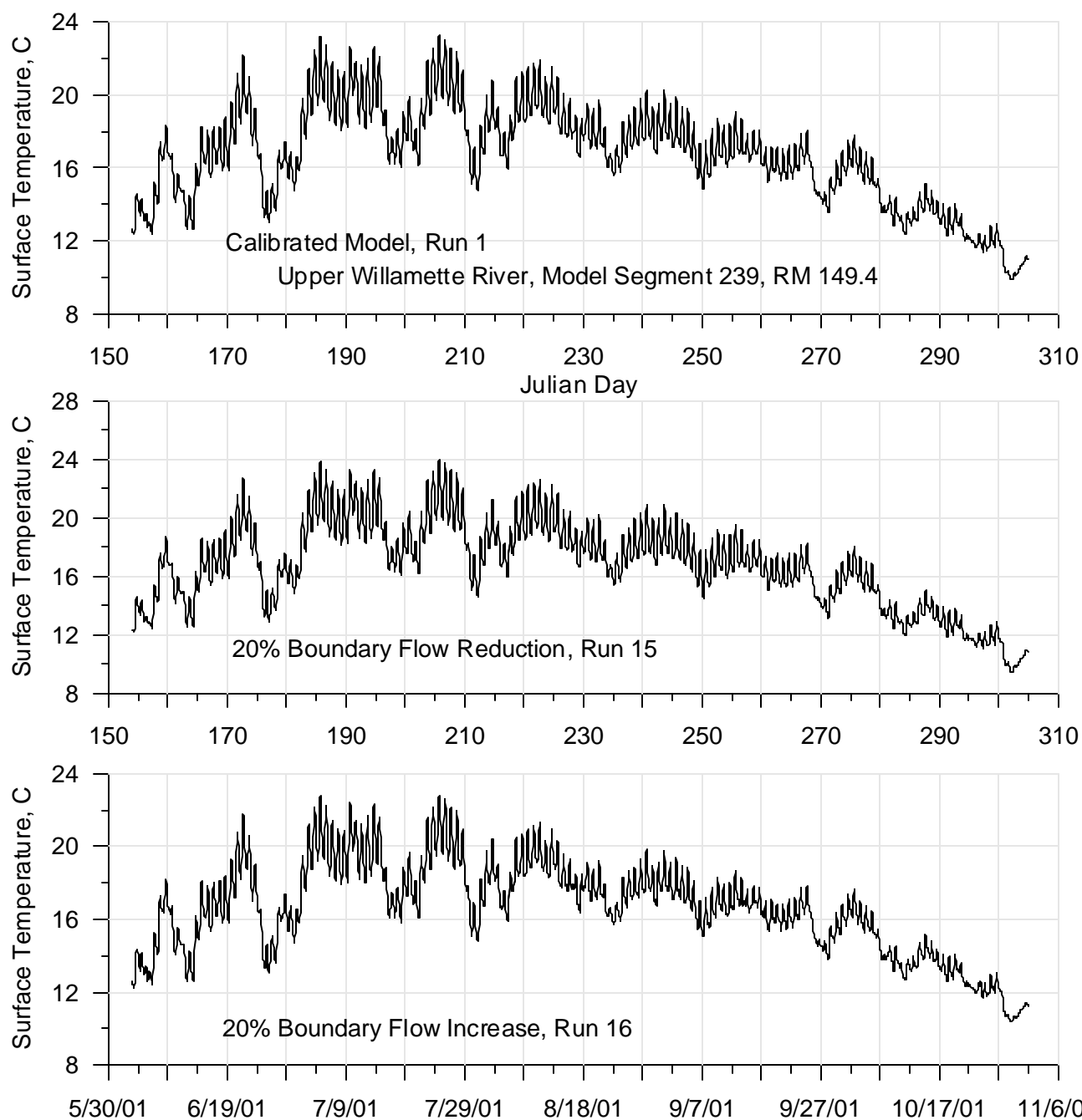
**Figure 430: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Long Tom River at RM 4.64**



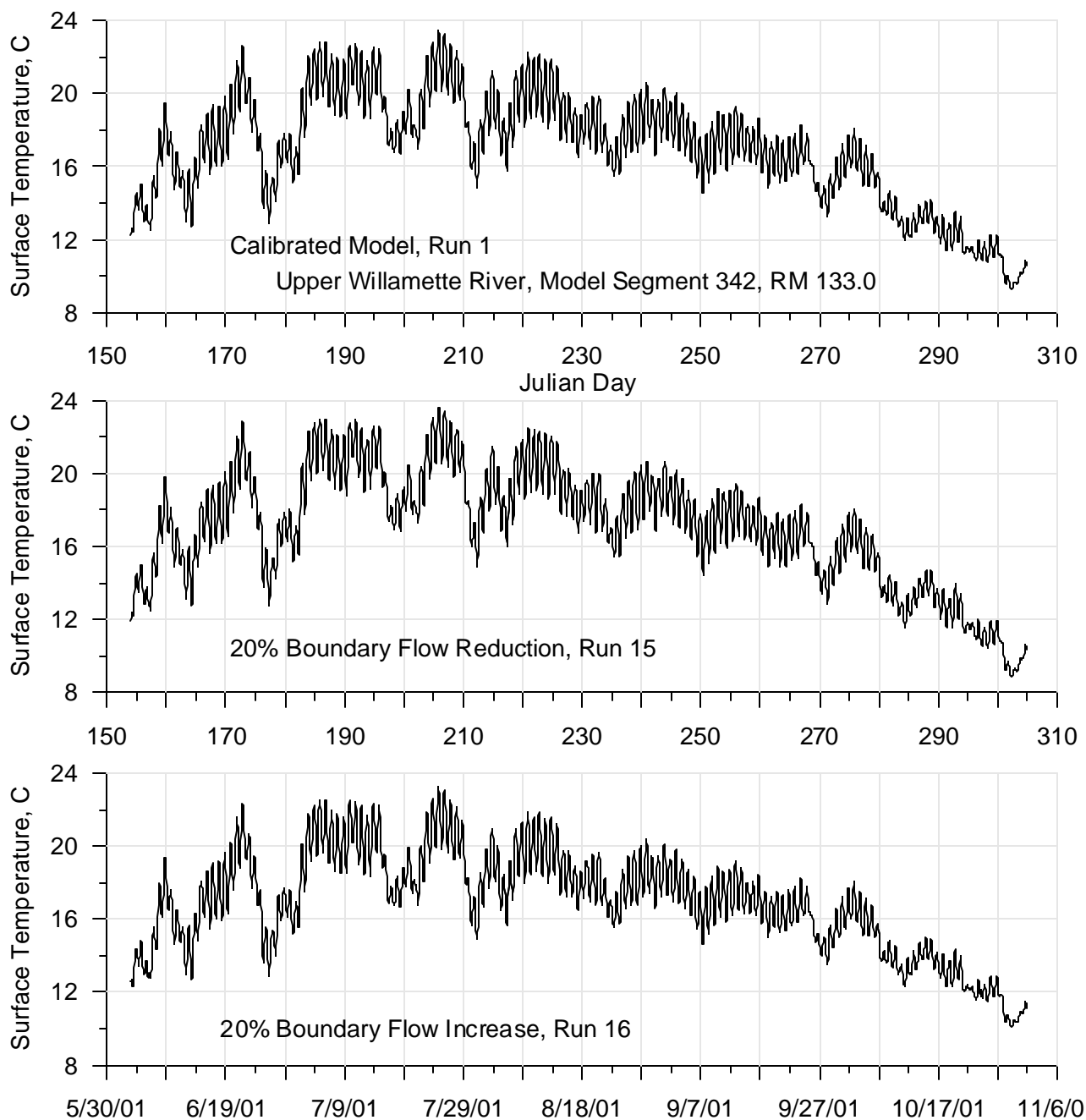
**Figure 431: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 175.3**



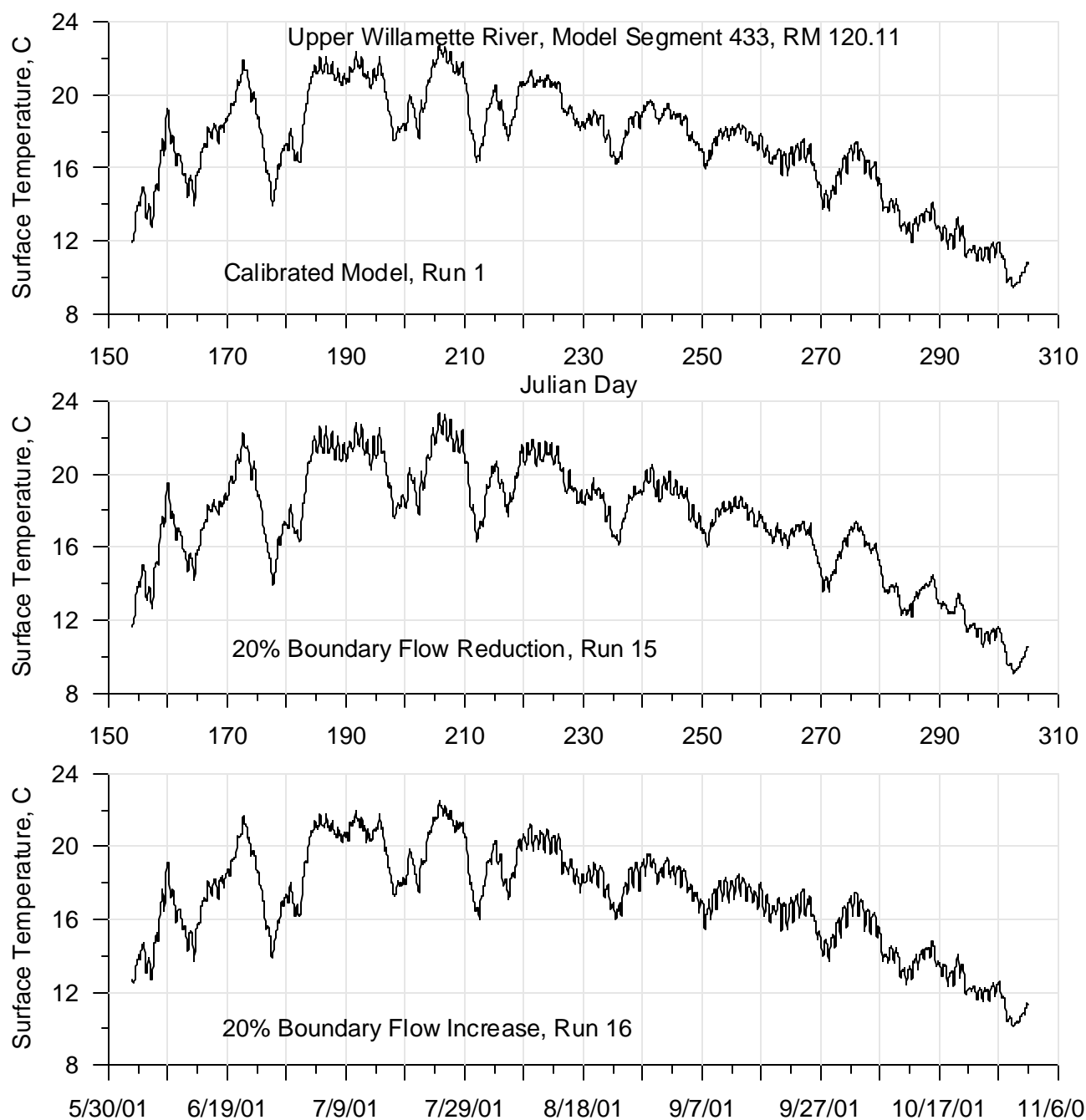
**Figure 432: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 161.98**



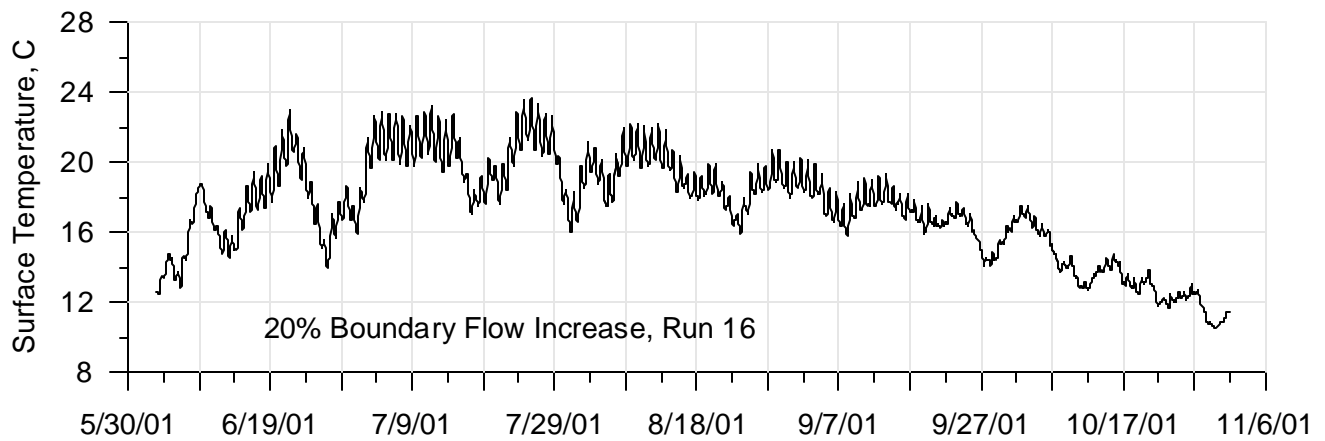
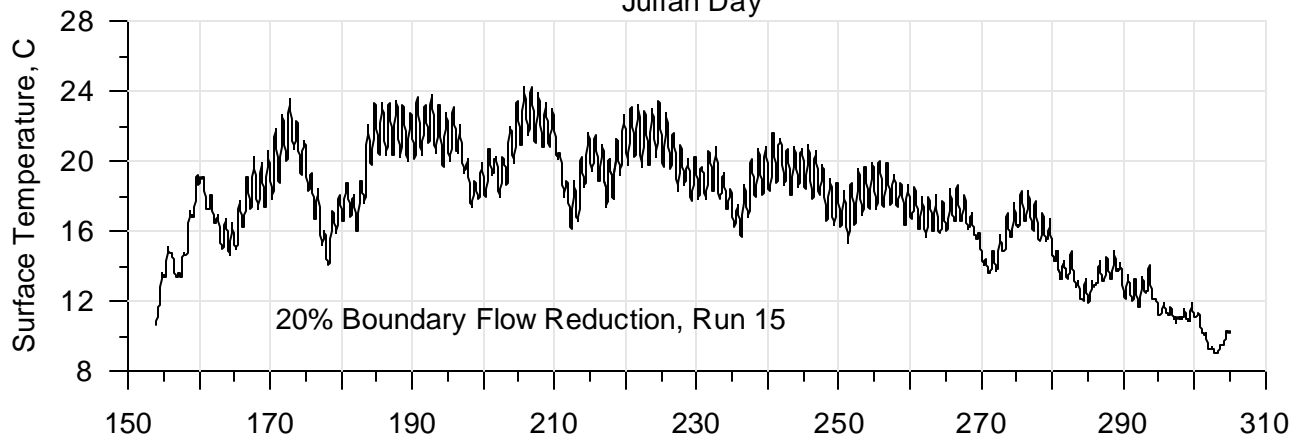
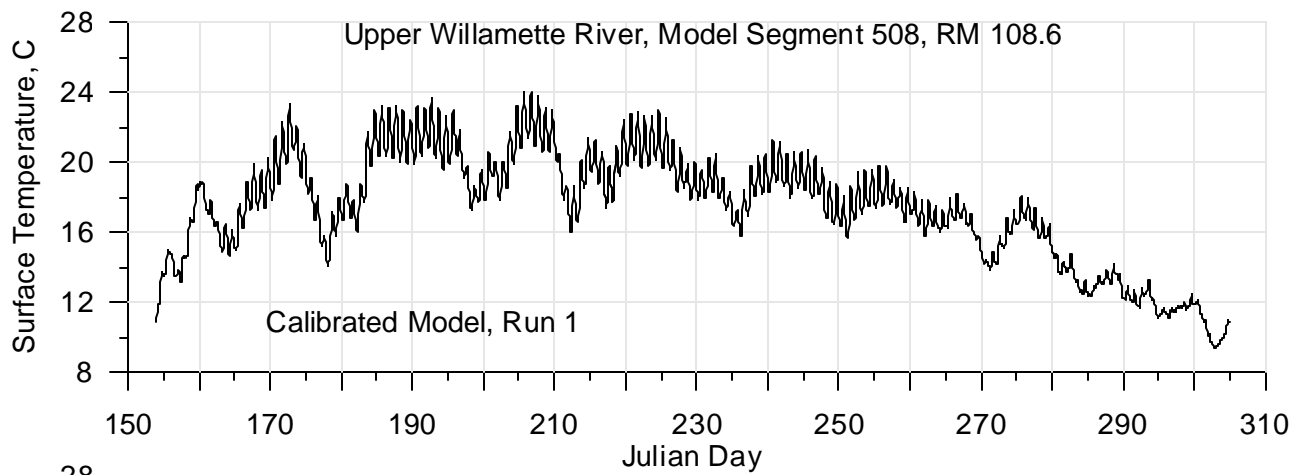
**Figure 433: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 149.4**



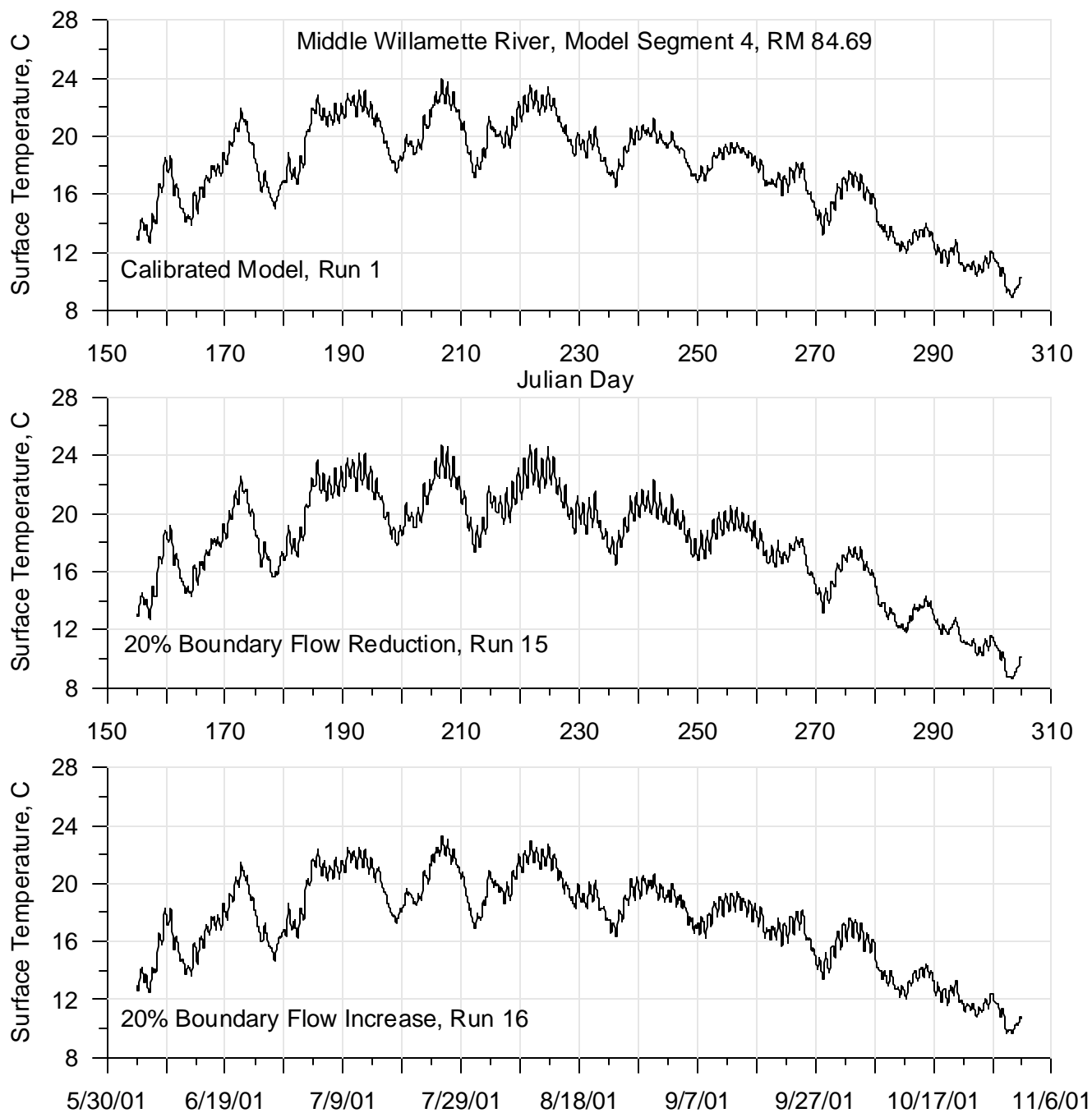
**Figure 434: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 133**



**Figure 435: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 120.11**

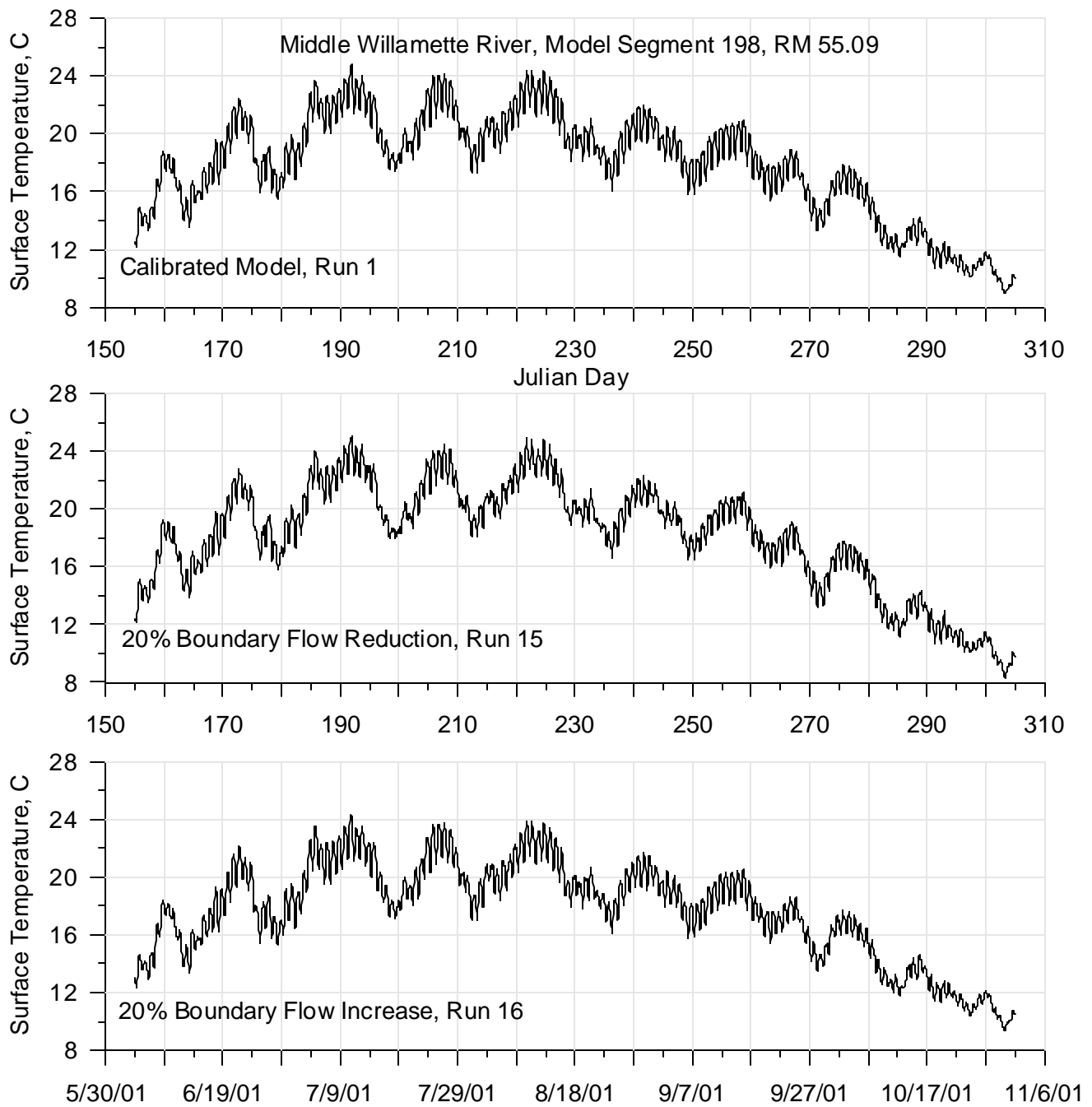


**Figure 436: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 108.6**

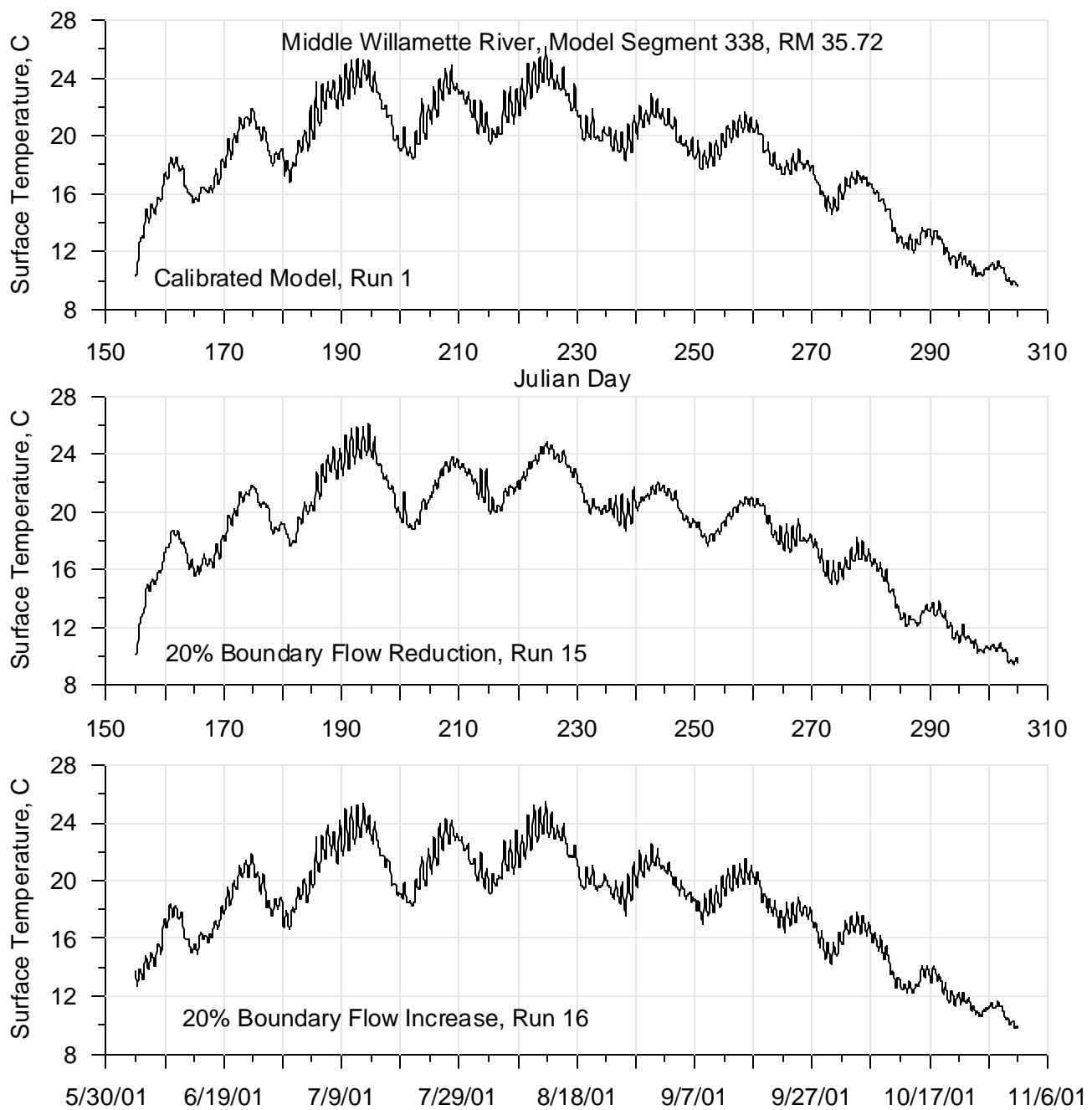


**Figure 437: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 84.69**

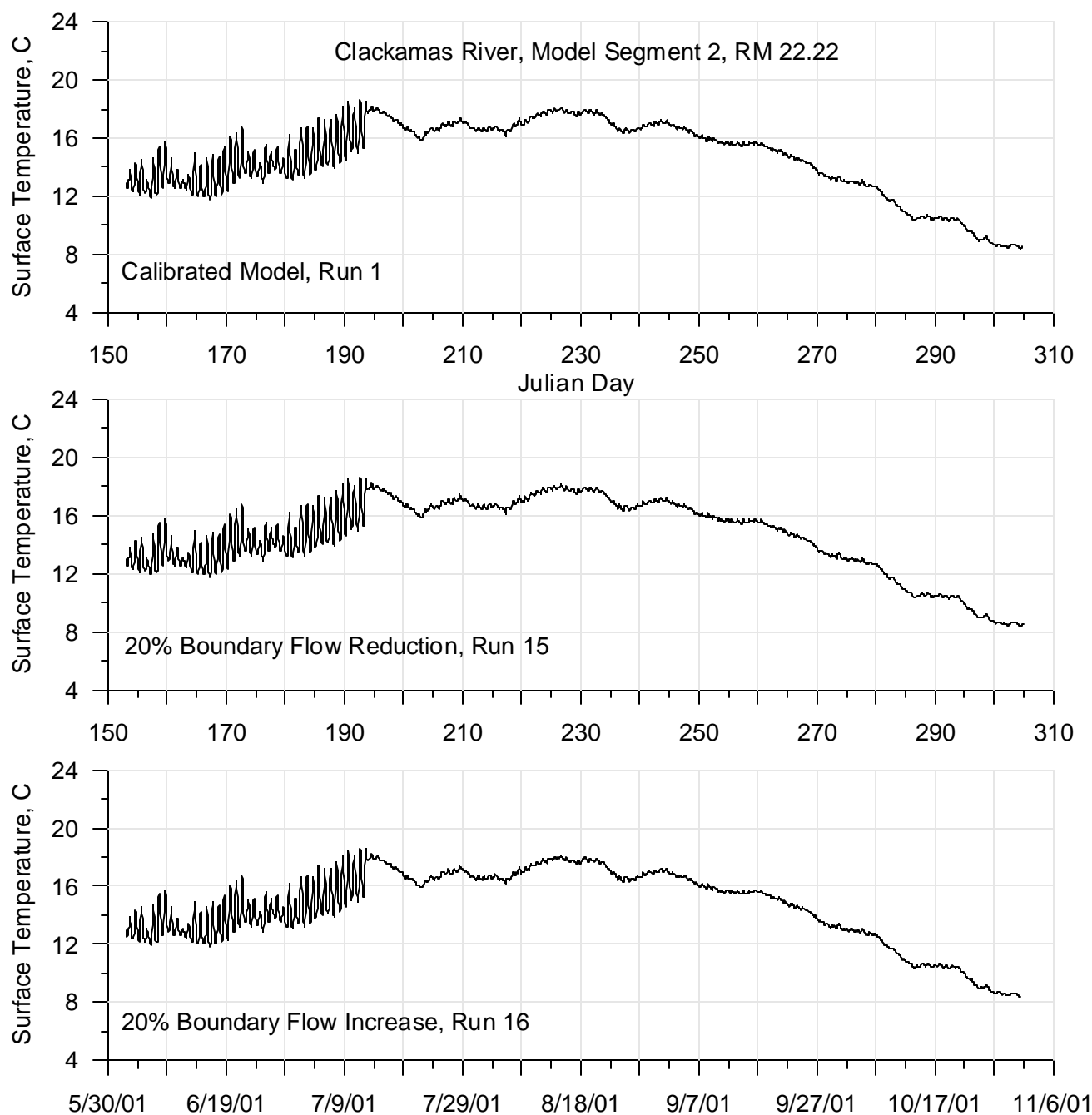




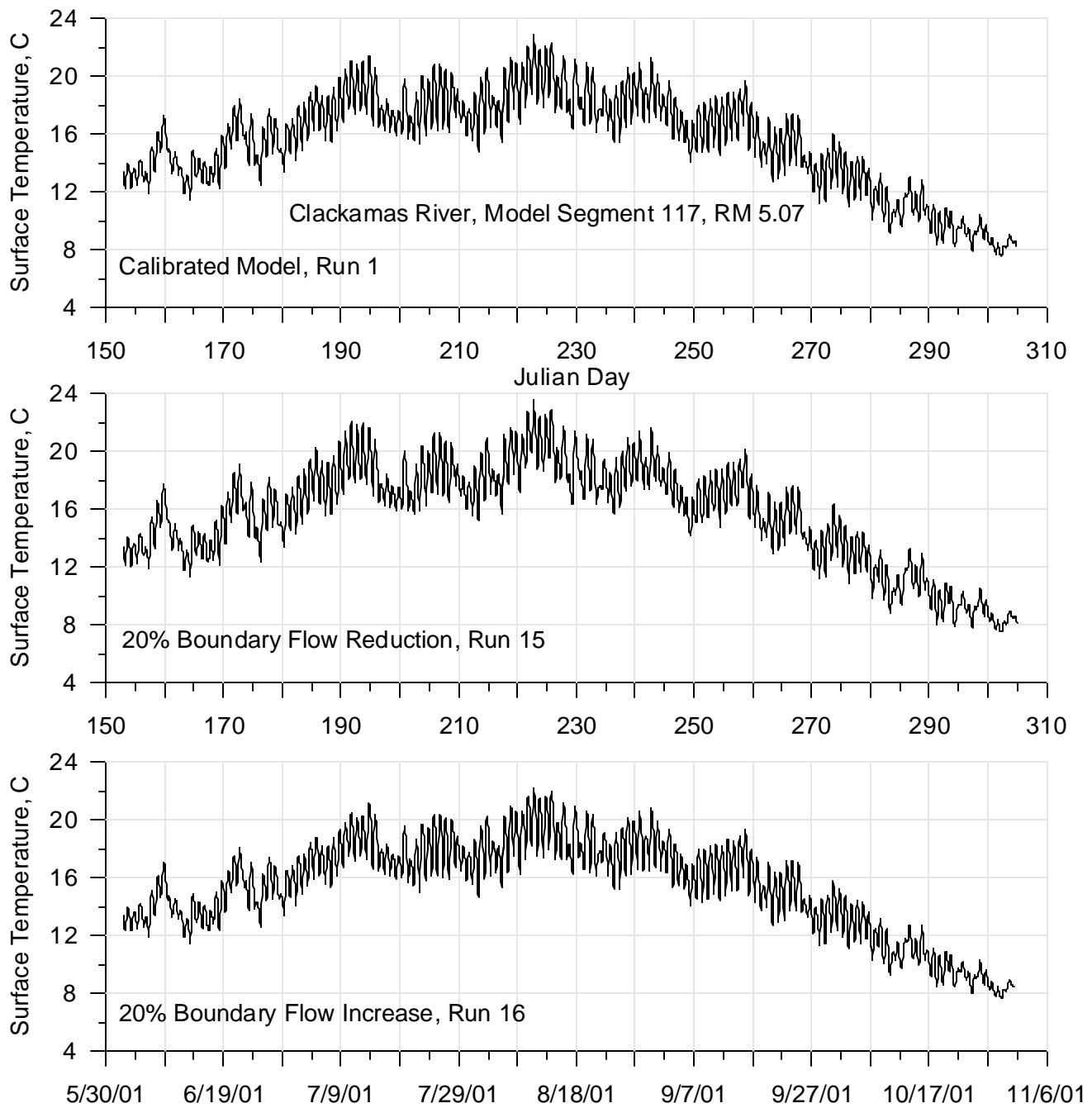
**Figure 438: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 55.09**



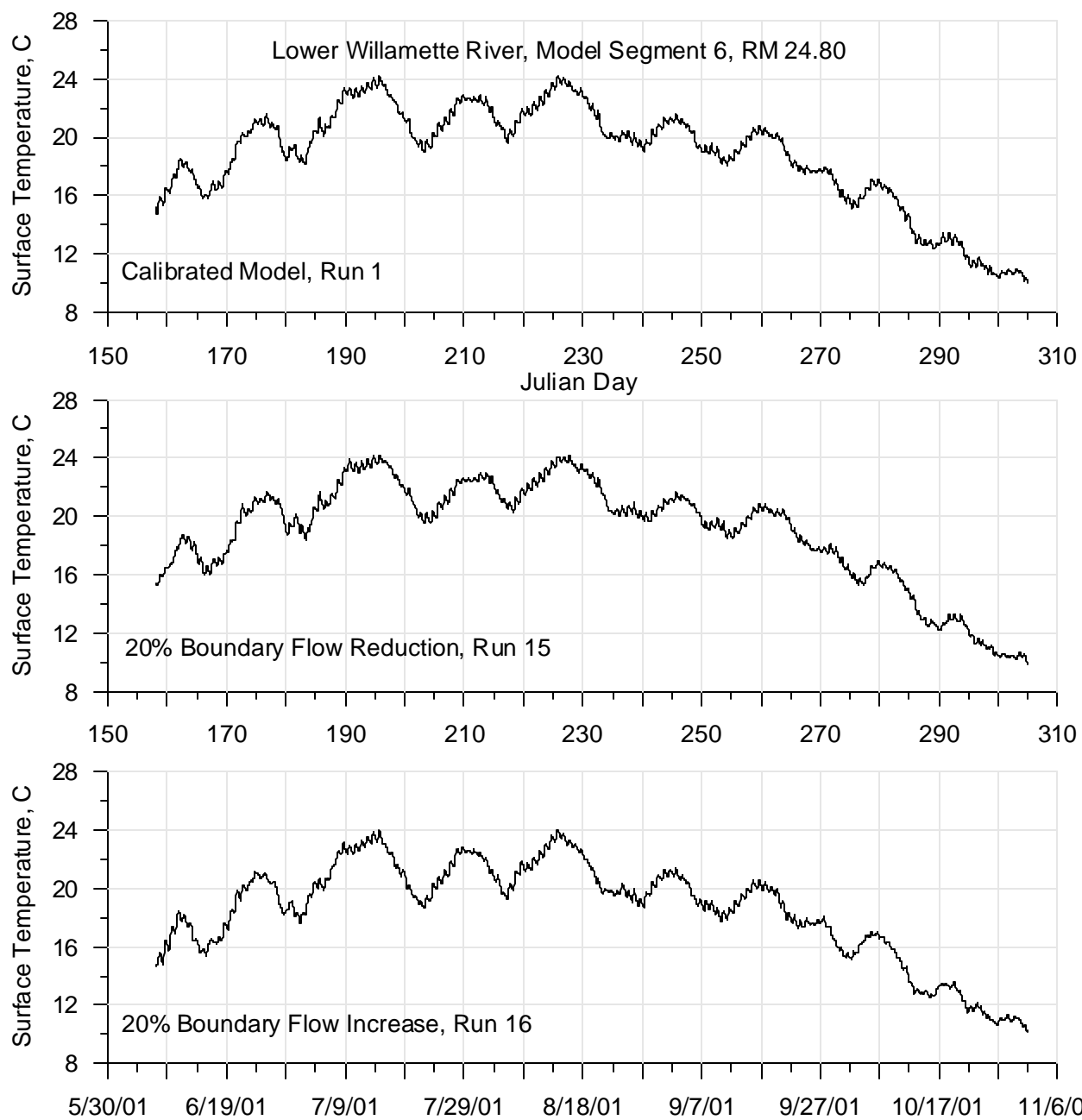
**Figure 439: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 35.72**



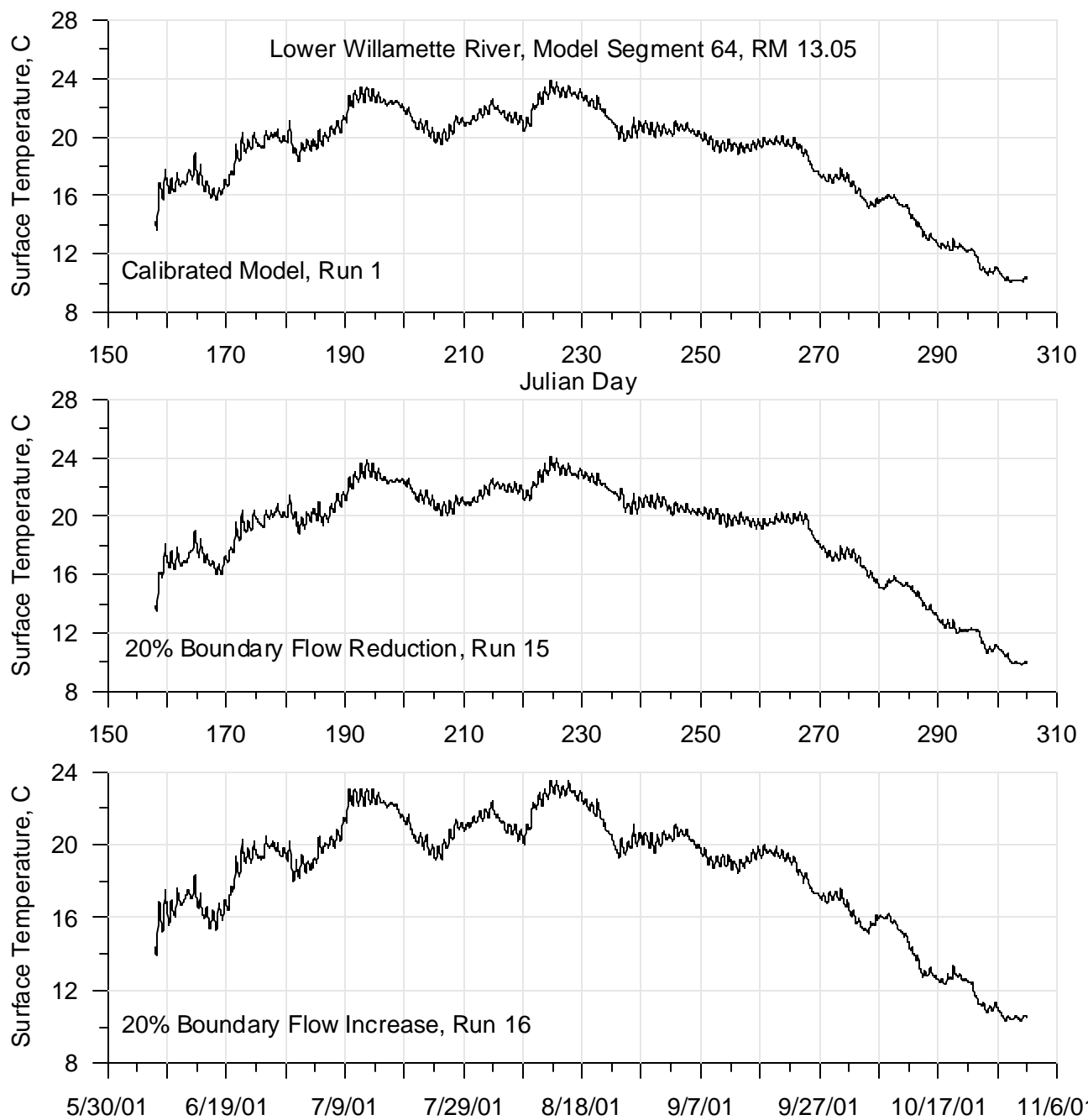
**Figure 440: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Clackamas River at RM 22.22**



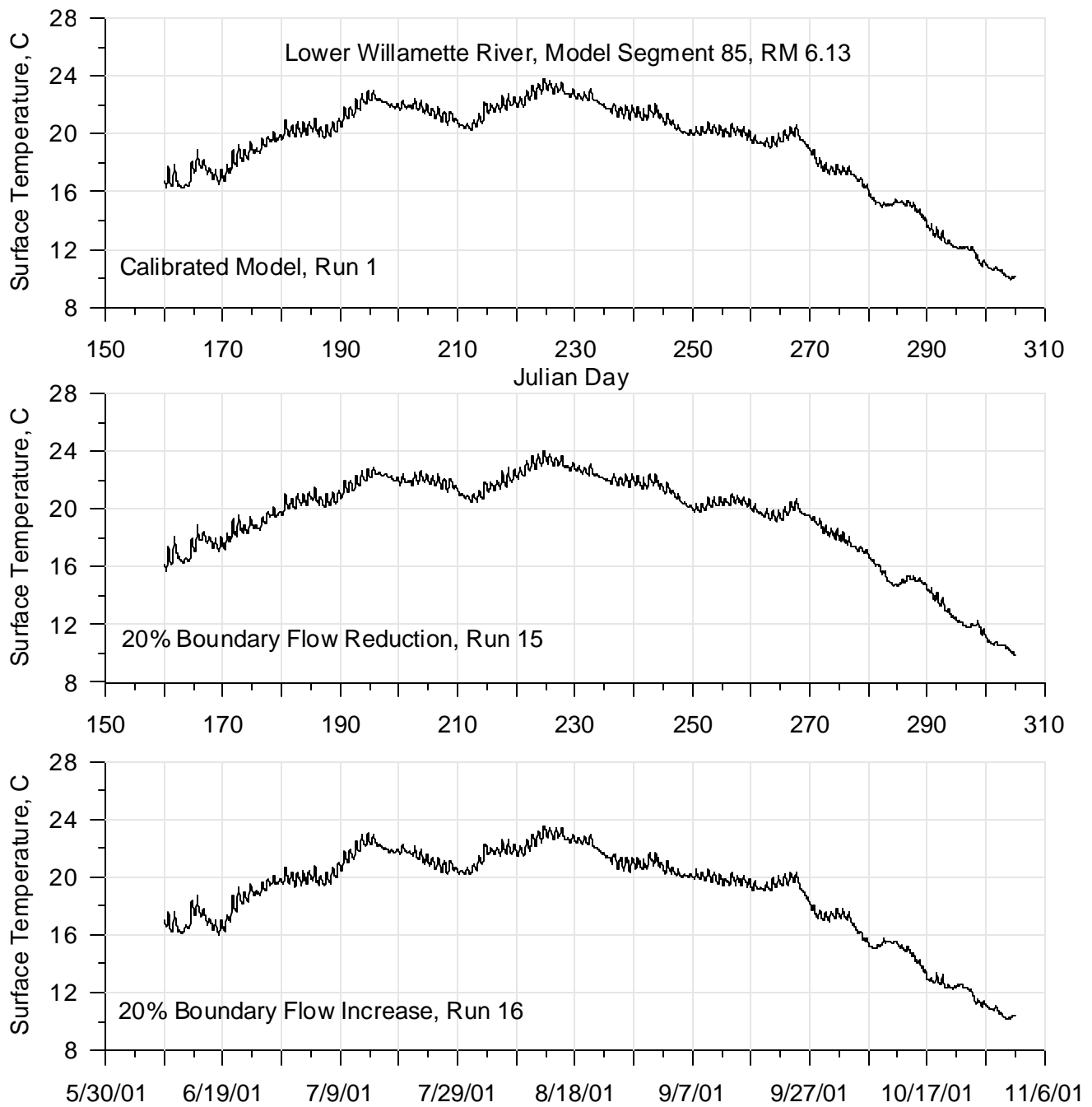
**Figure 441: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Clackamas River at RM 5.07**



**Figure 442: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 24.80**

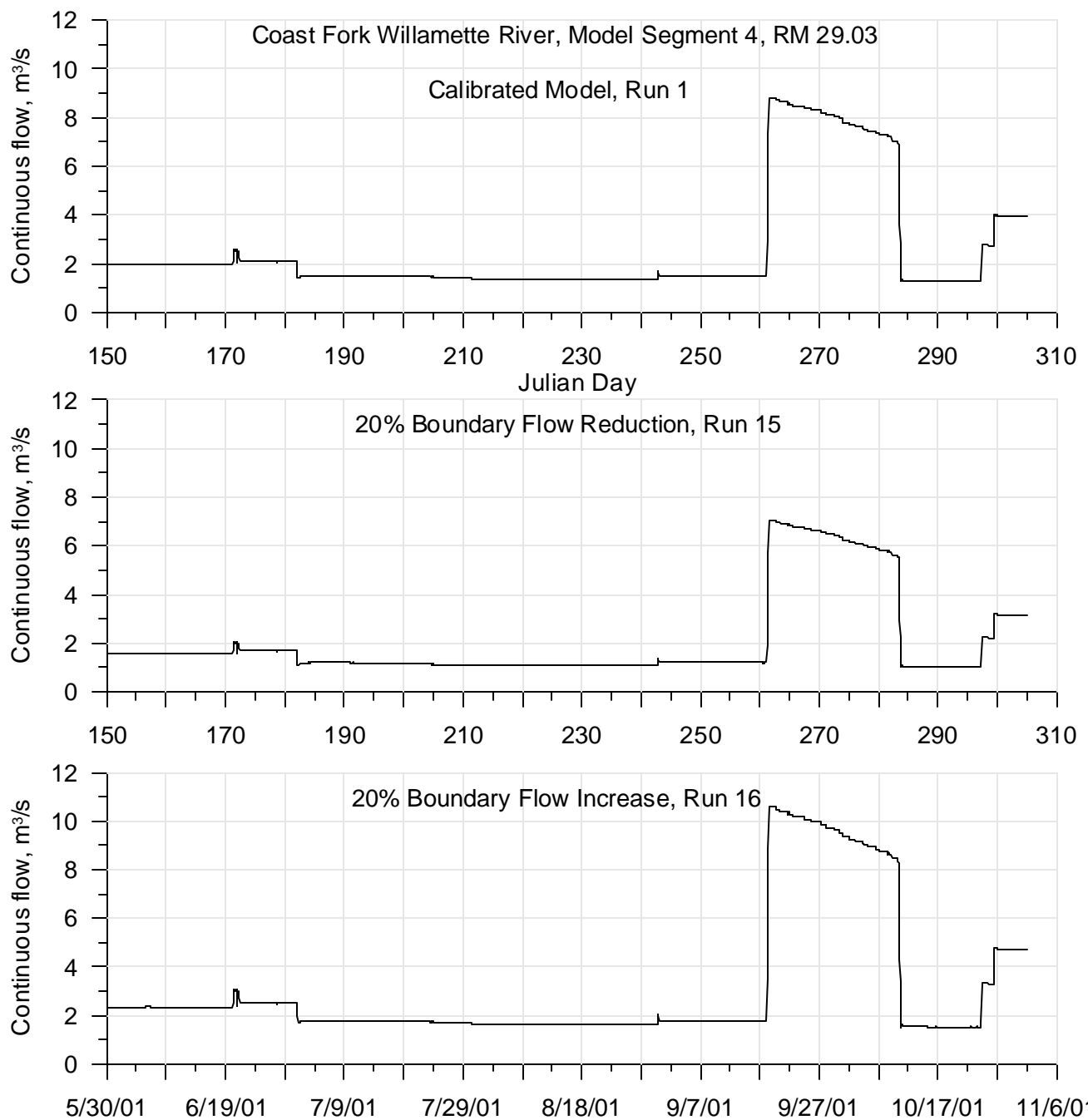


**Figure 443: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 13.05**



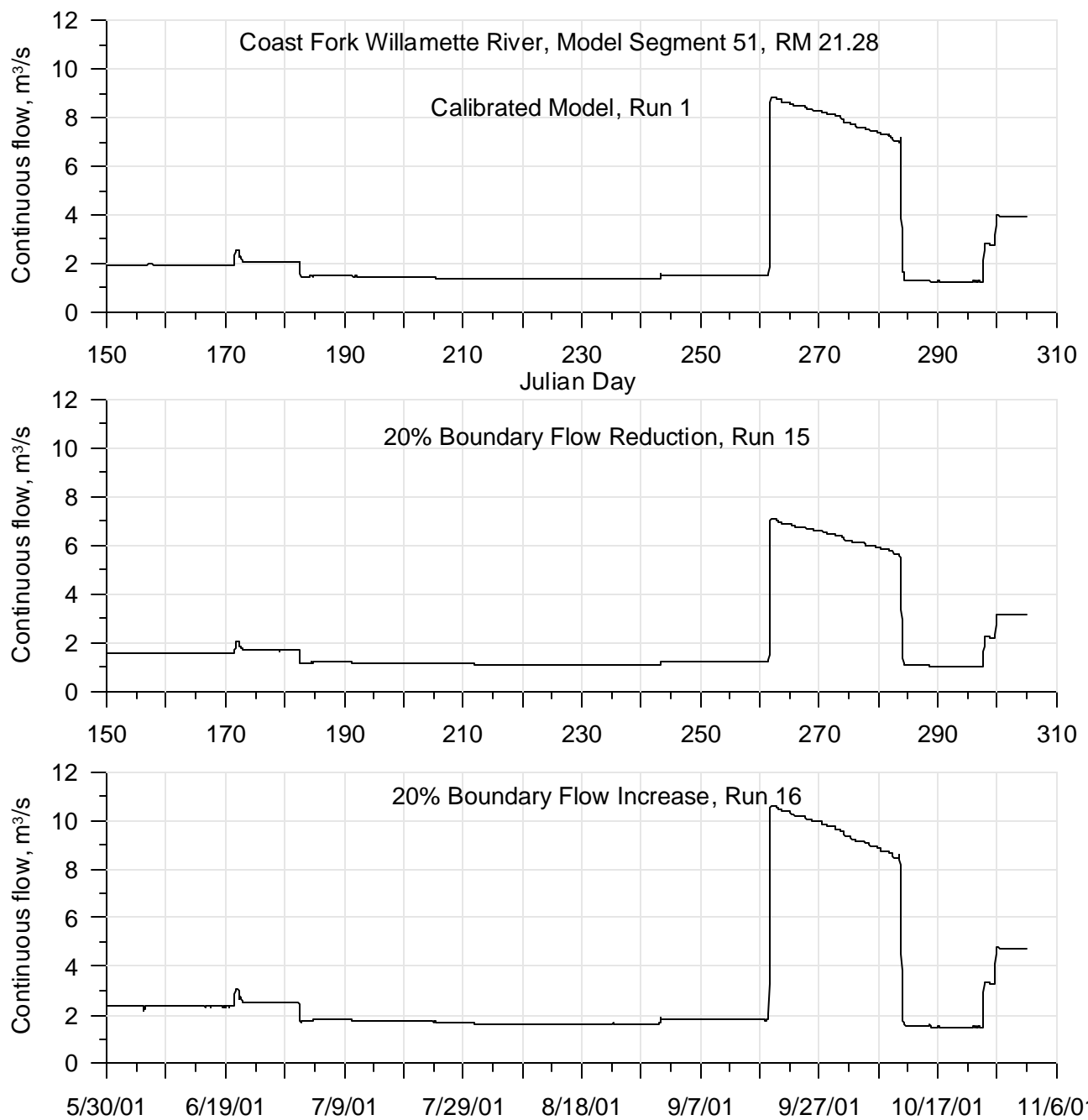
**Figure 444: Calibrated model compared with varying boundary flow (+/- 20%) continuous temperature for 2001 for the Willamette River at RM 6.13**

## Continuous Flow

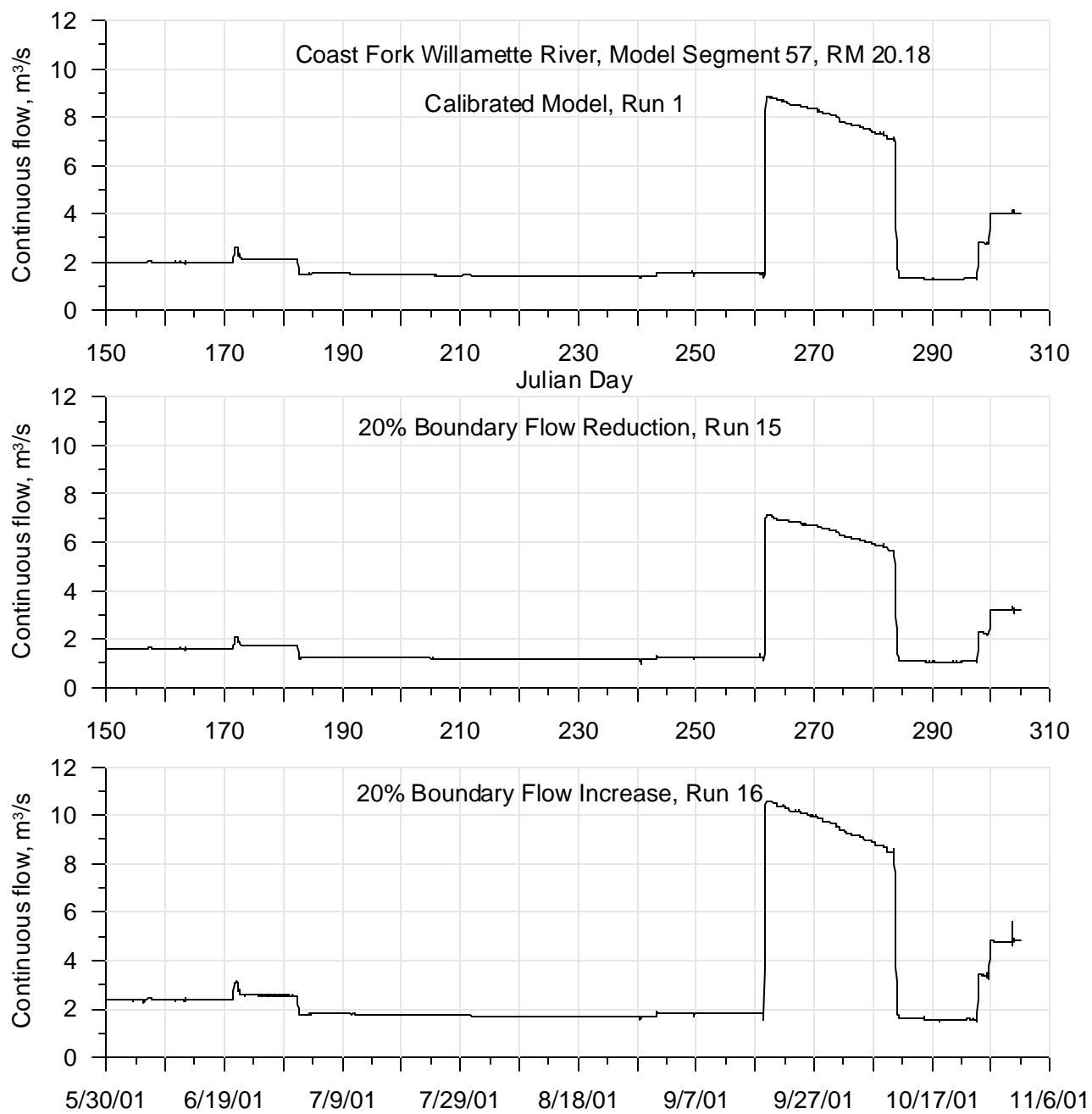


**Figure 445: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Coast Fork Willamette River at RM 29.03**

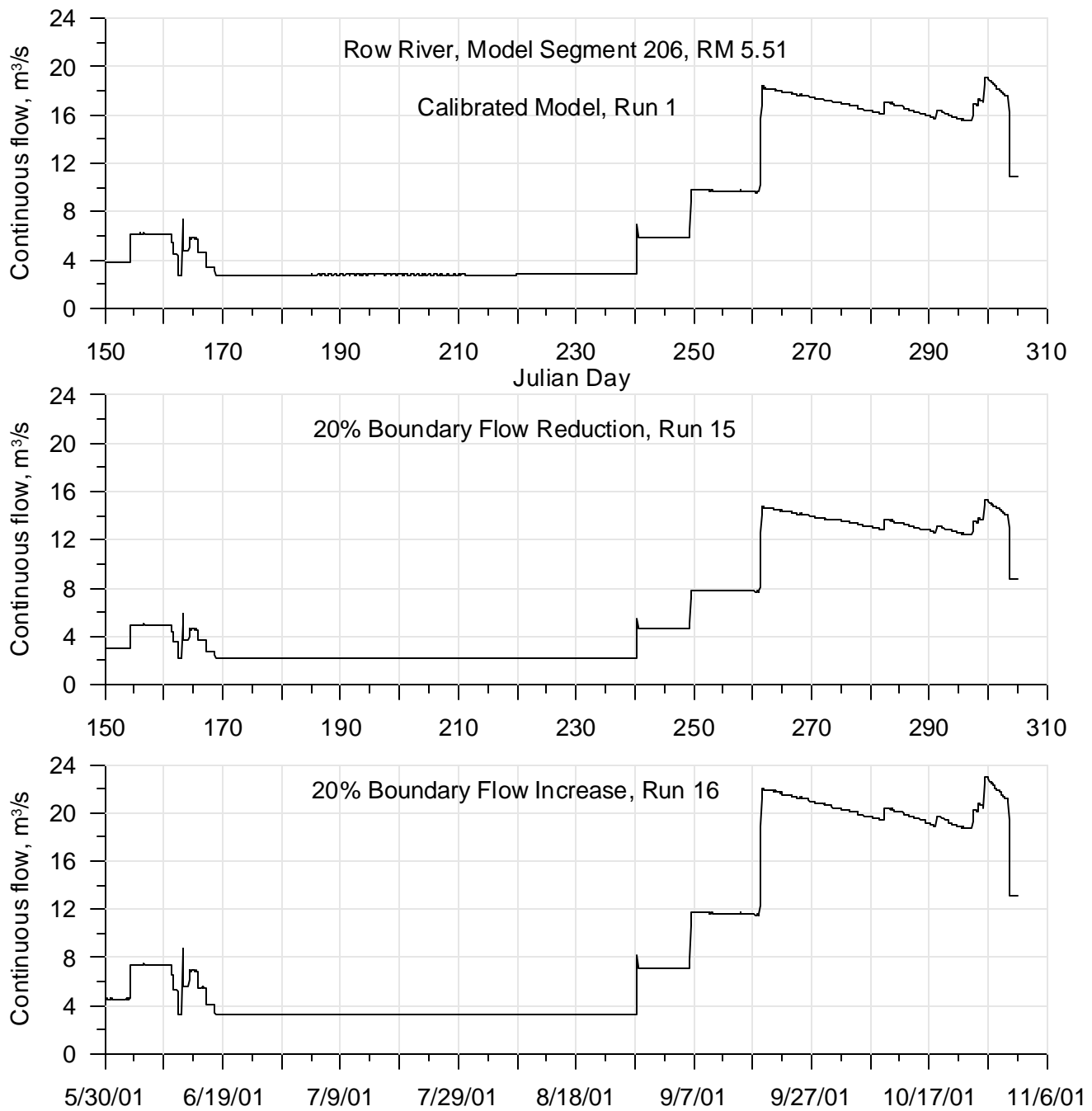




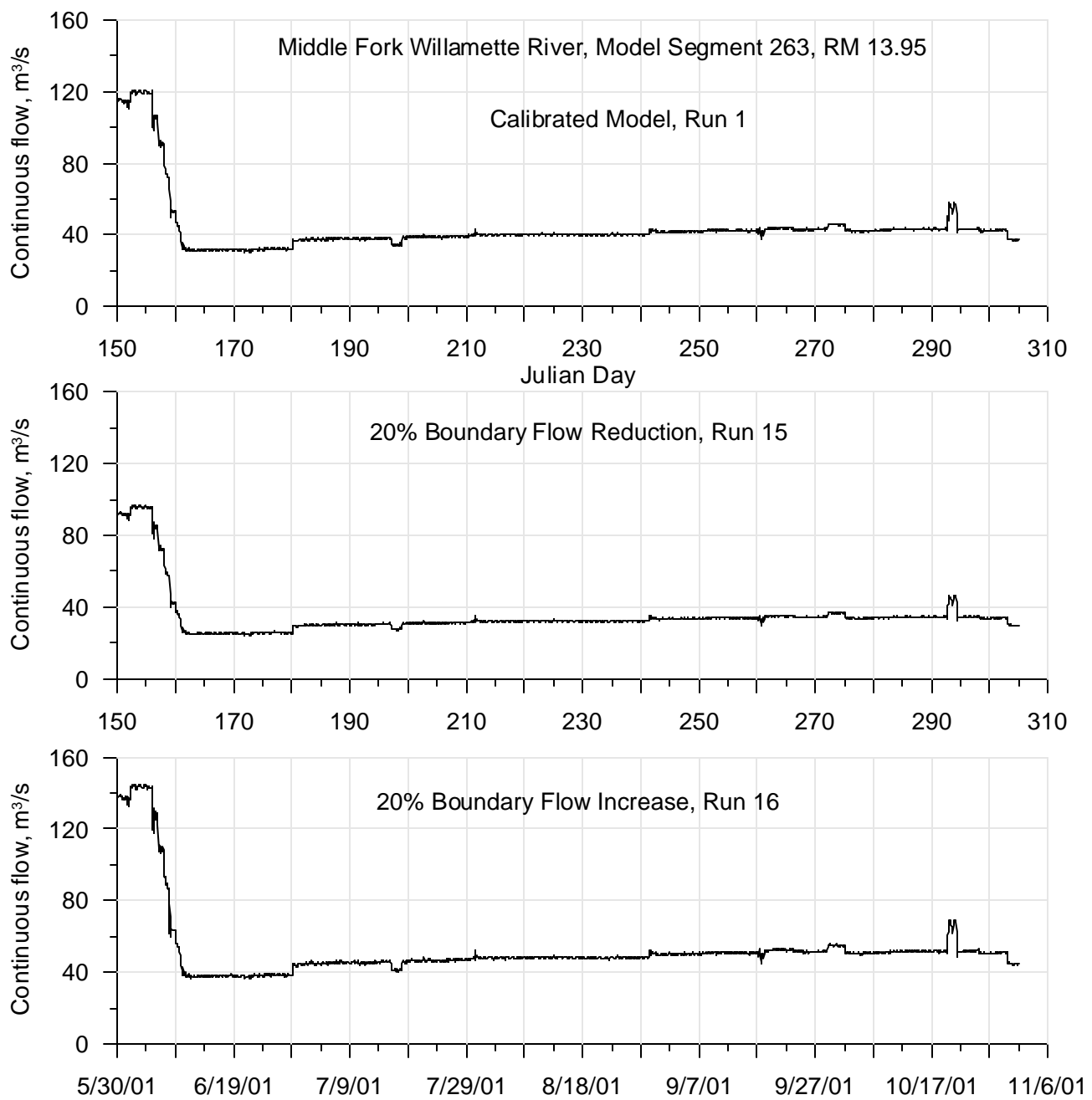
**Figure 446: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Coast Fork Willamette River at RM 21.28**



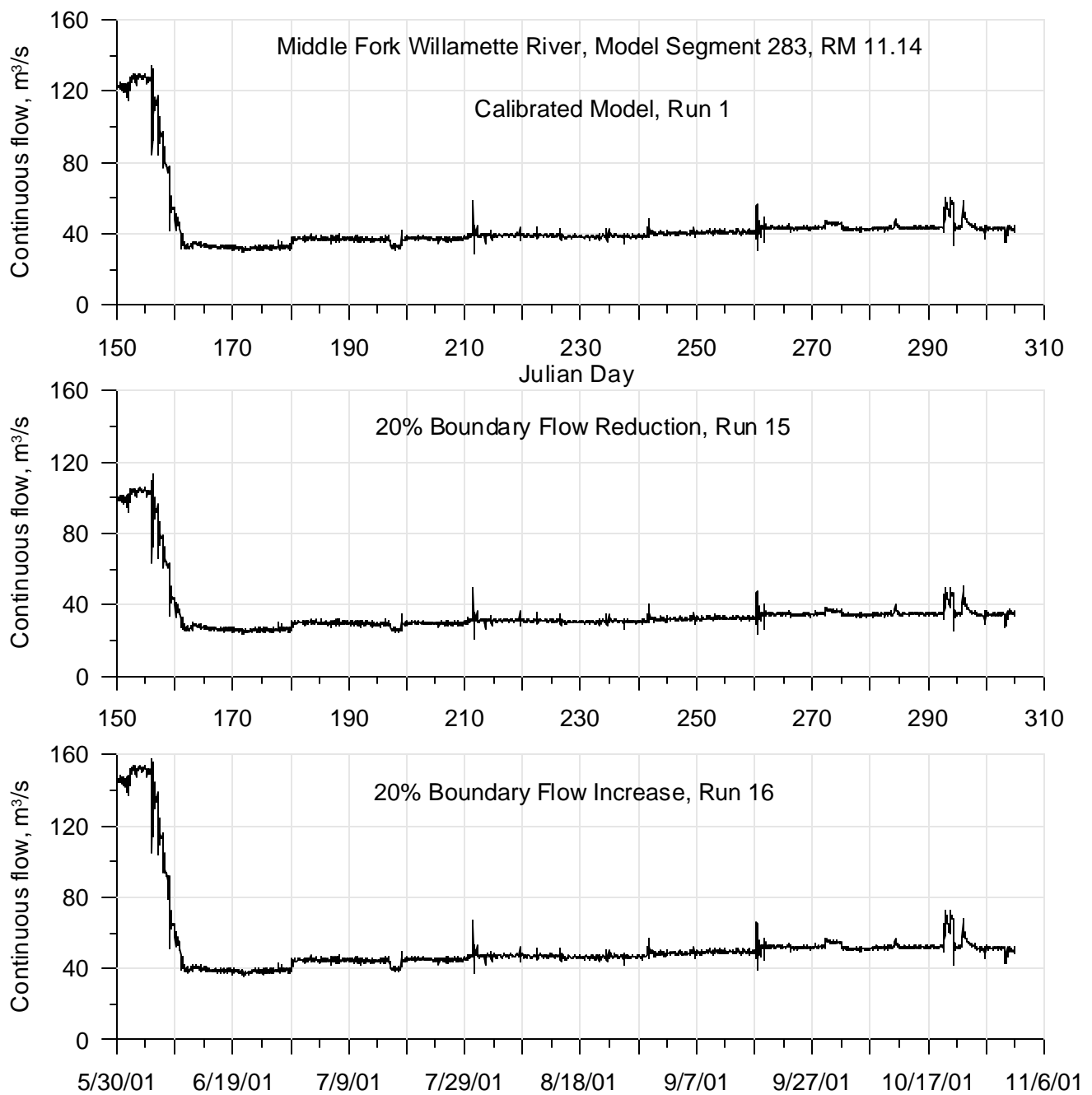
**Figure 447: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Coast Fork Willamette River at RM 20.18**



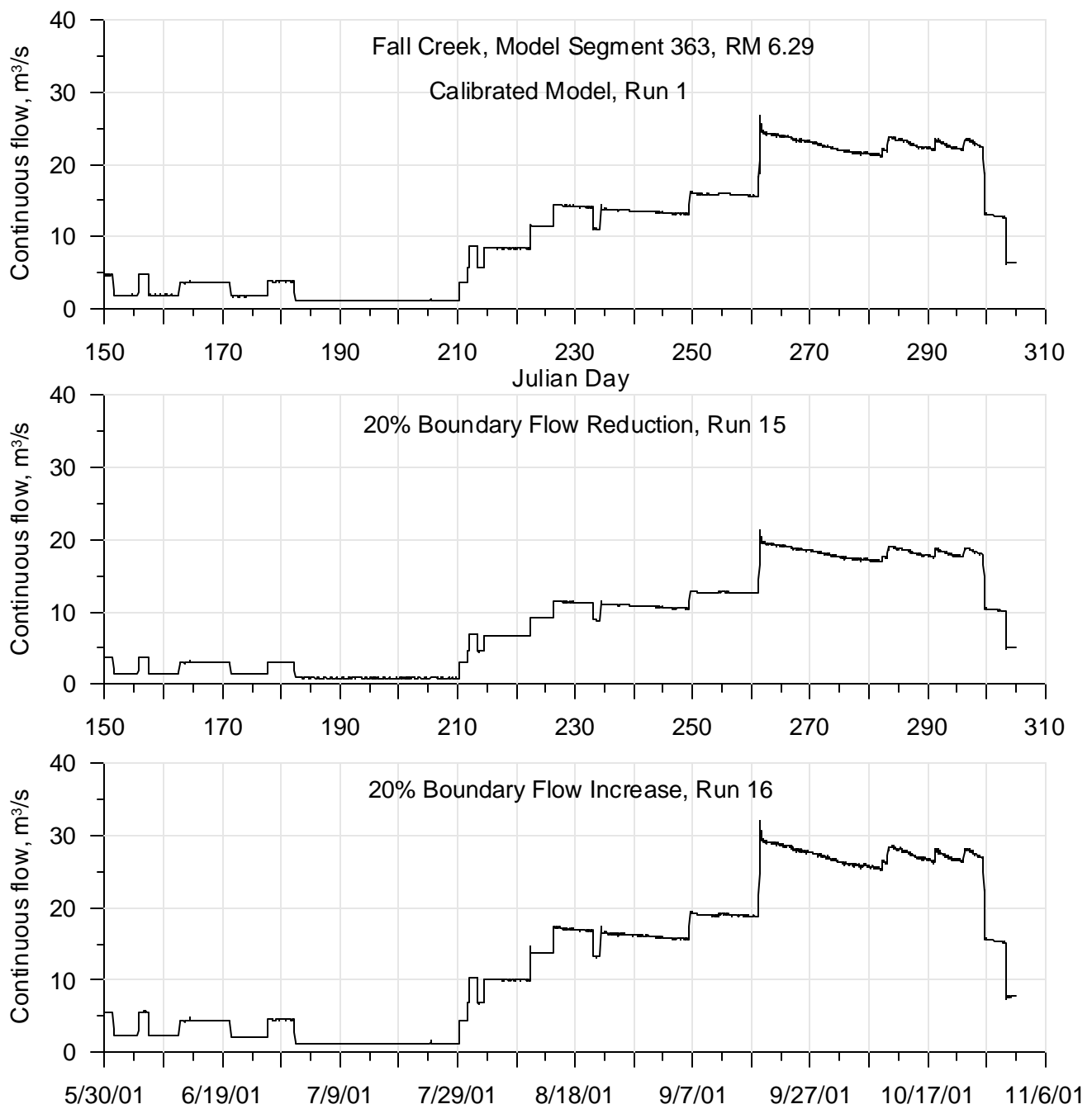
**Figure 448: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Row River at RM 5.51**



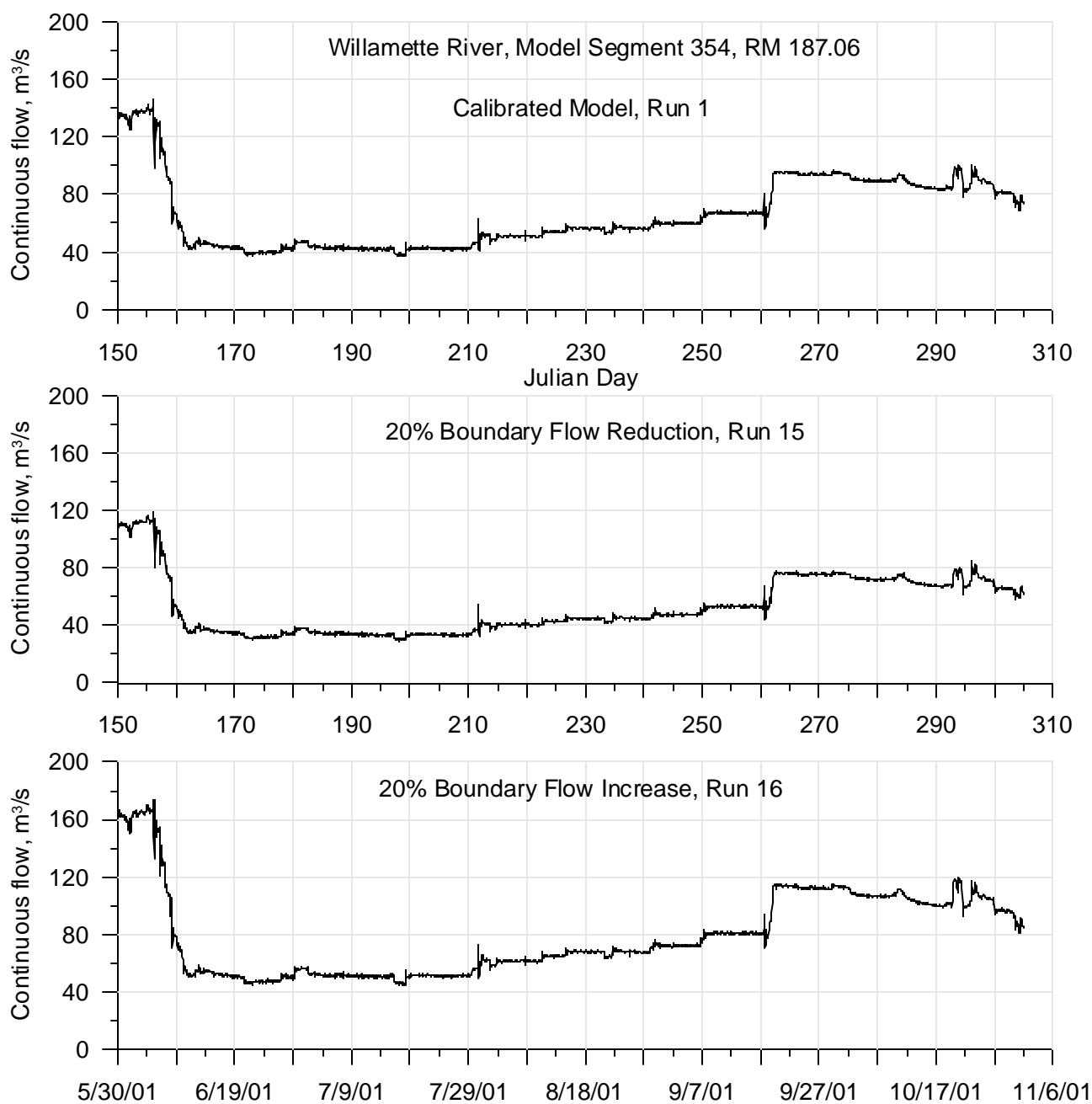
**Figure 449: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Middle Fork Willamette River at RM 13.95**



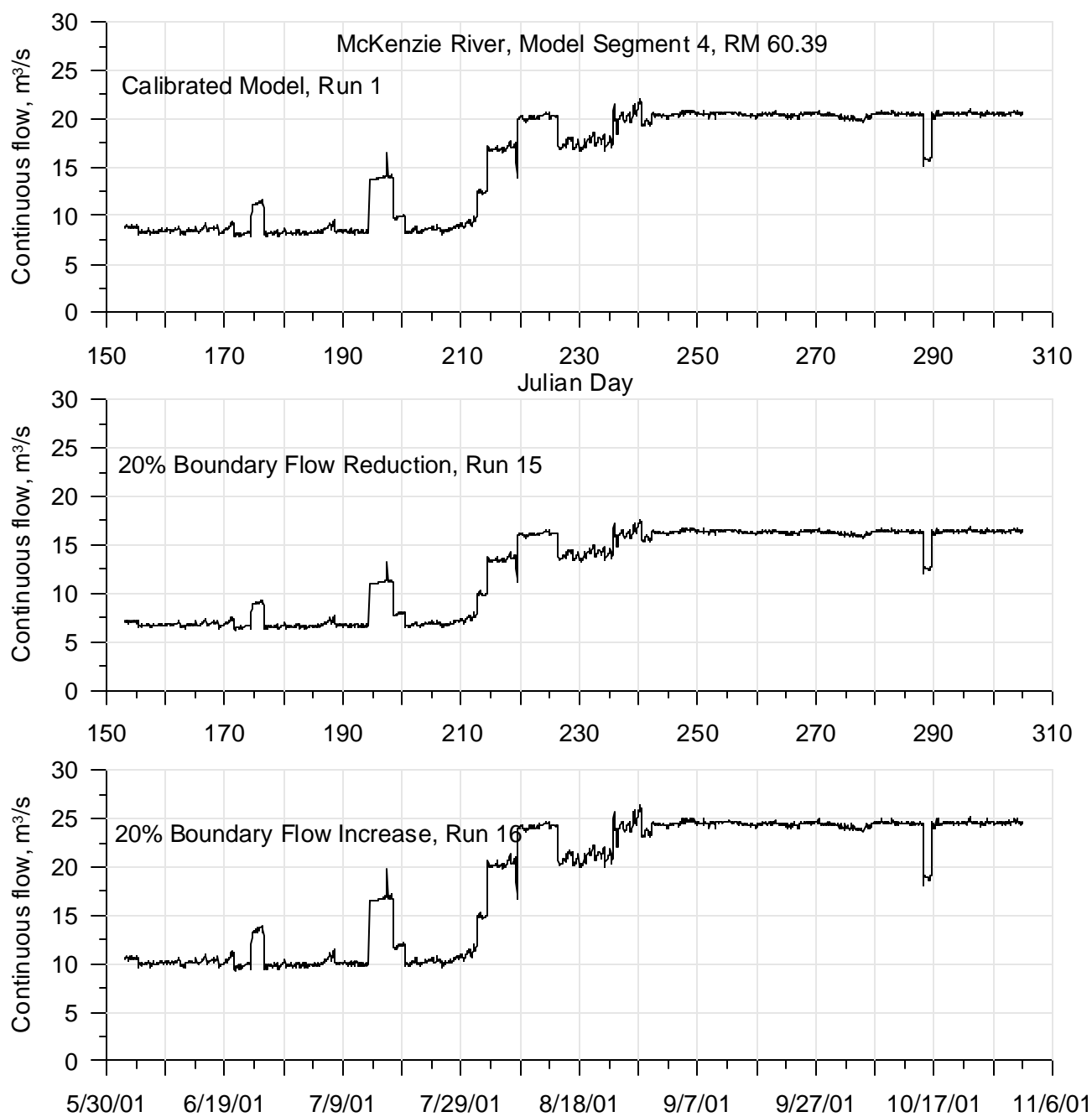
**Figure 450: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Middle Fork Willamette River at RM 11.14**



**Figure 451: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for Fall Creek at RM 6.29**

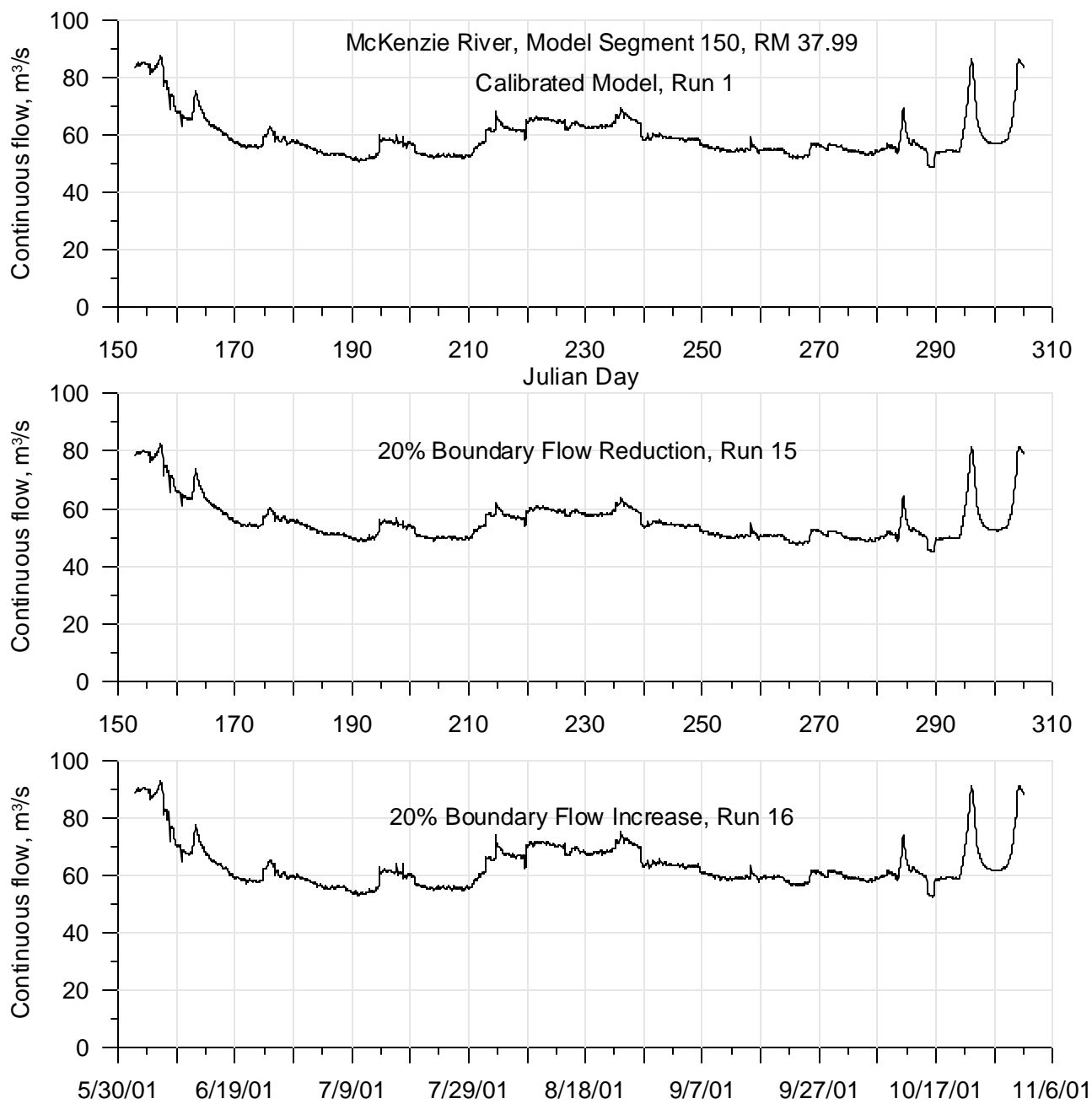


**Figure 452: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 187.06**

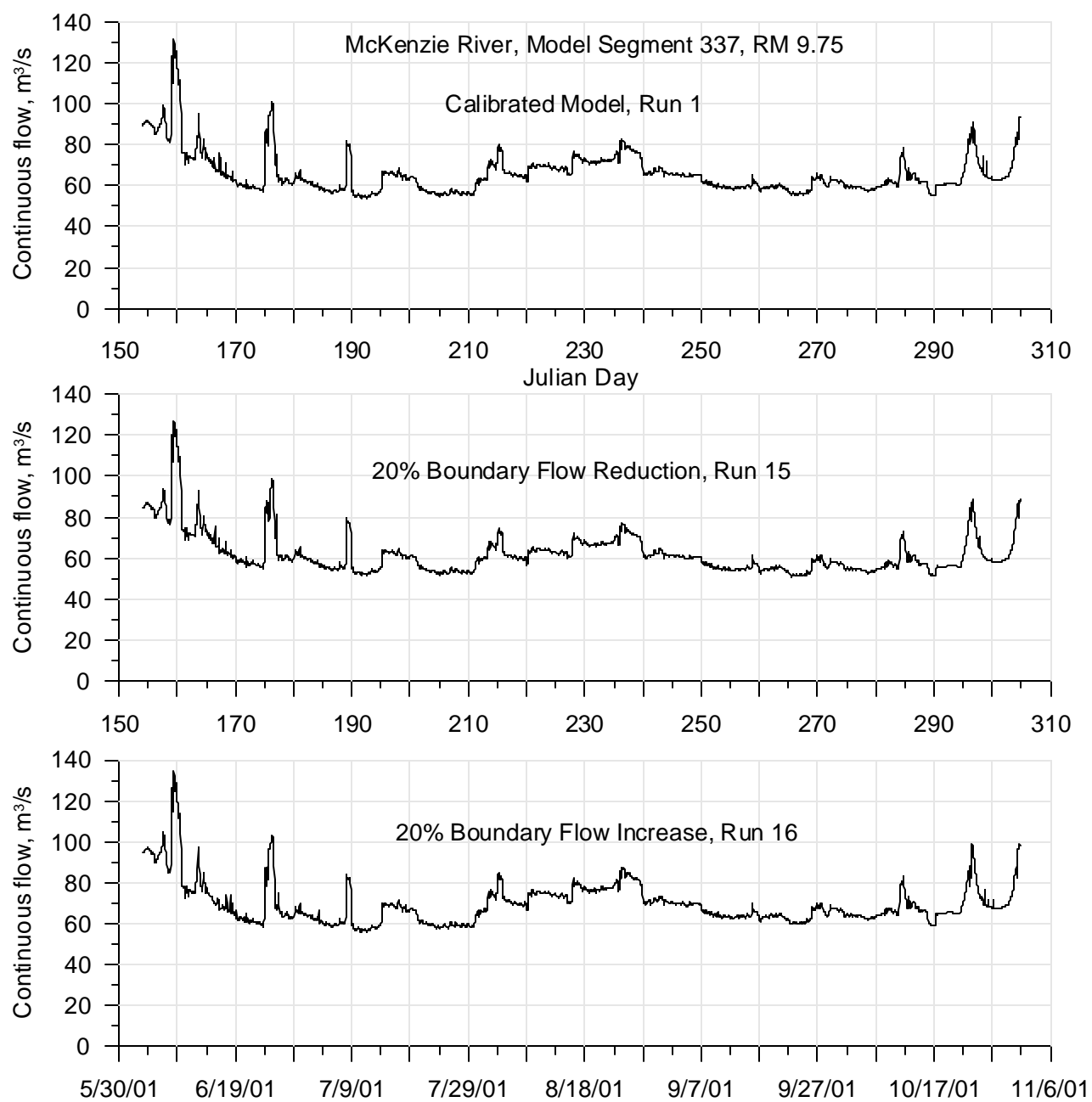


**Figure 453: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the McKenzie River at RM 60.39**

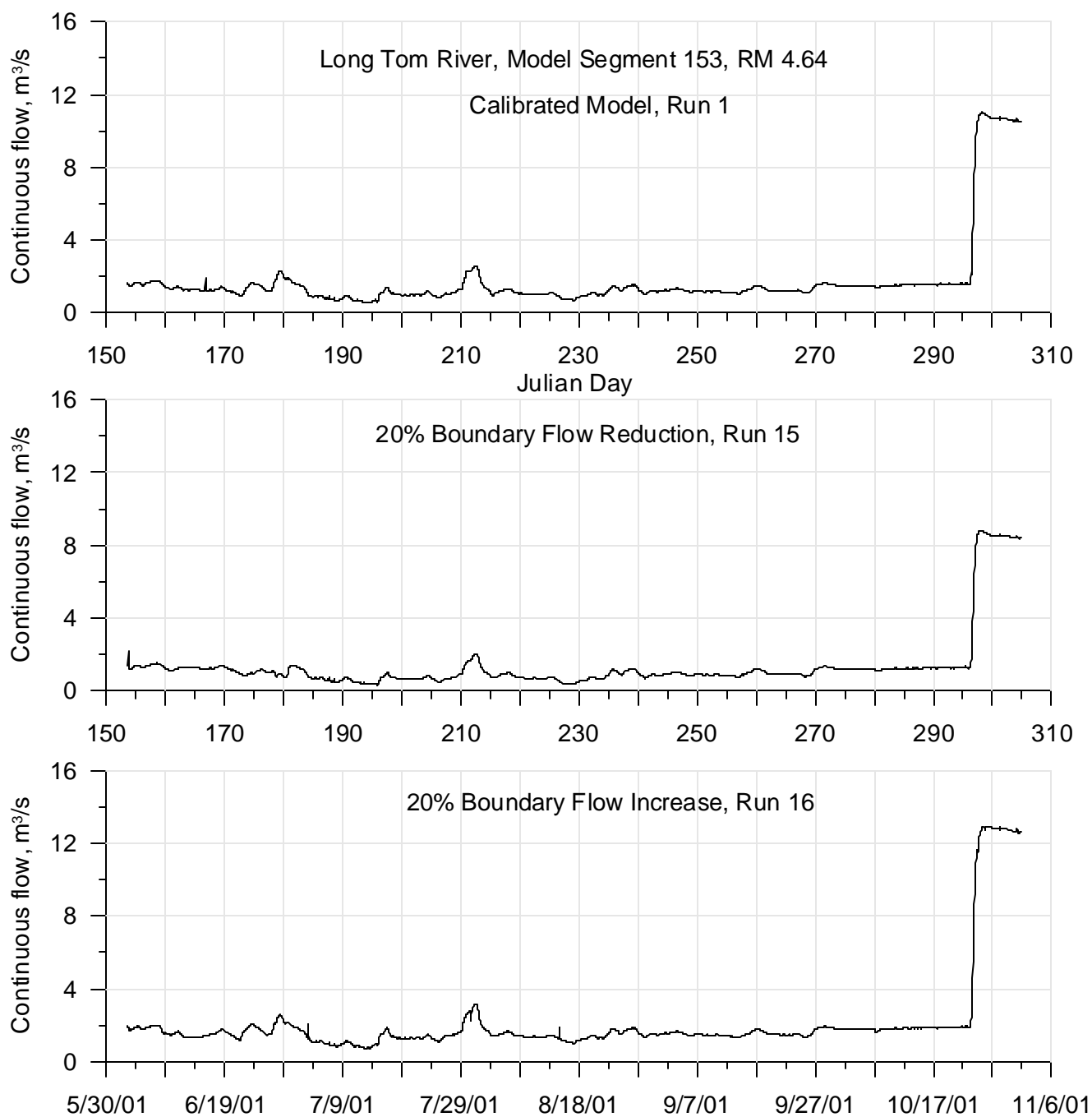




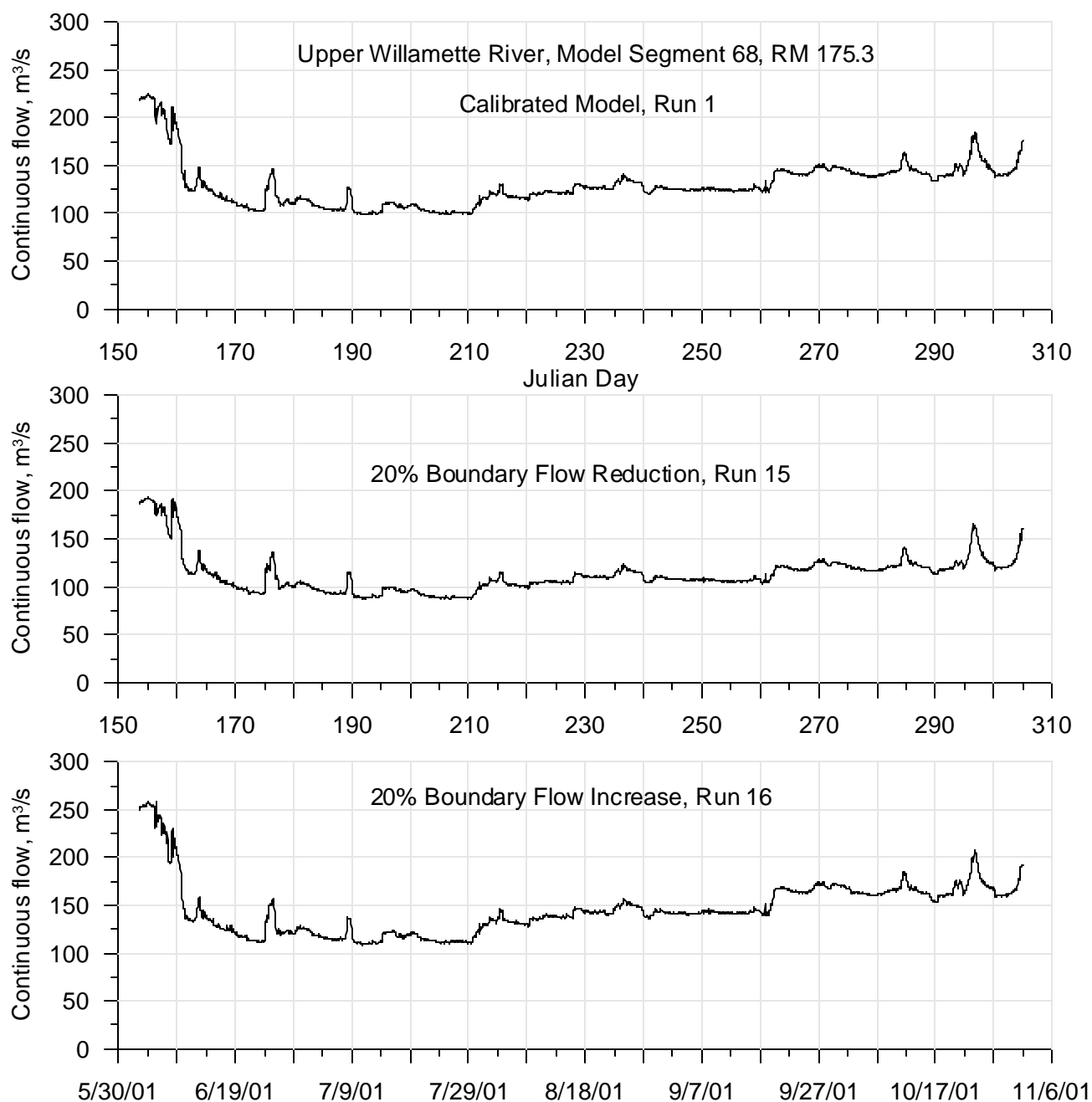
**Figure 454: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the McKenzie River at RM 37.99**



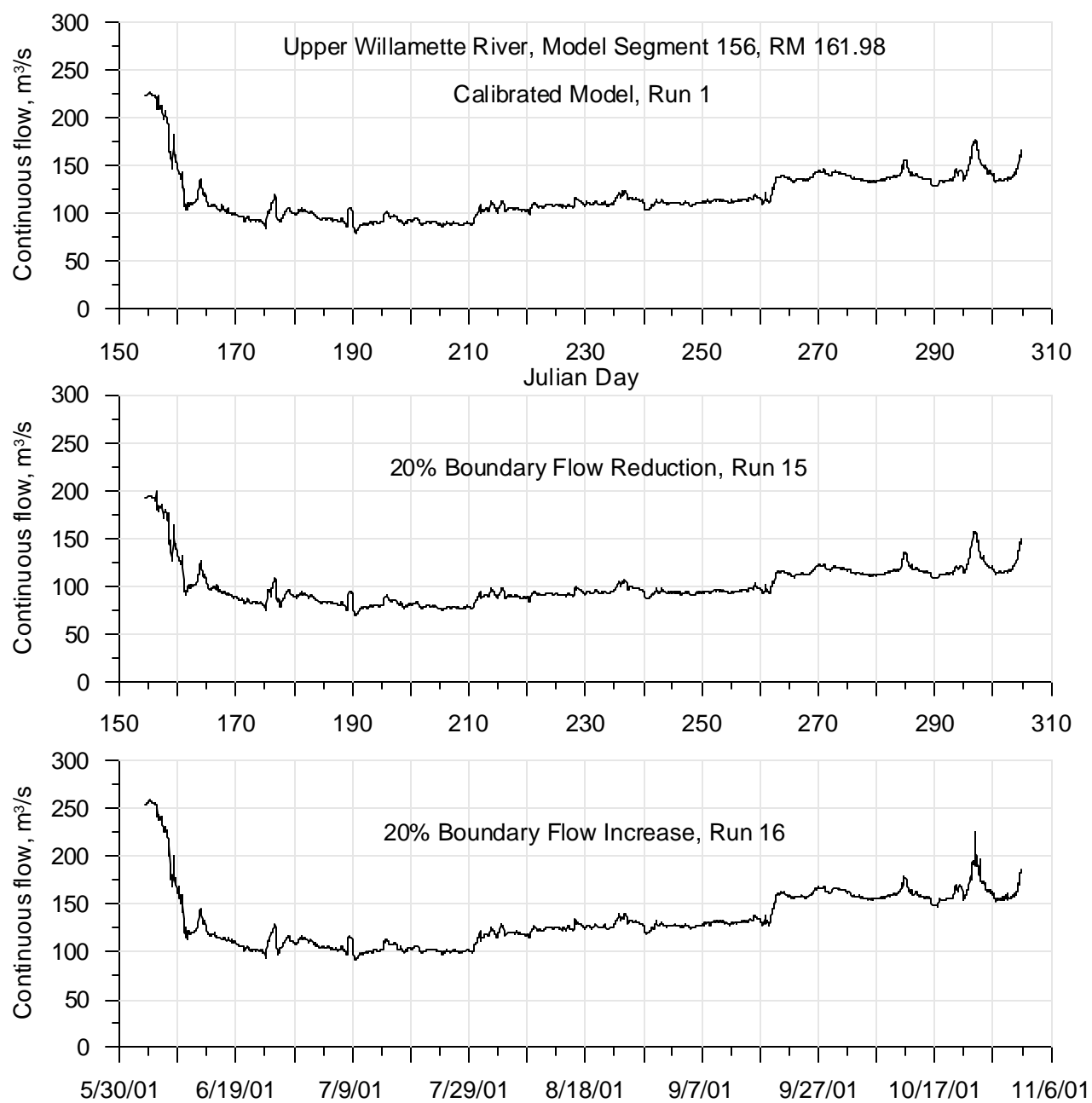
**Figure 455: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the McKenzie River at RM 9.75**



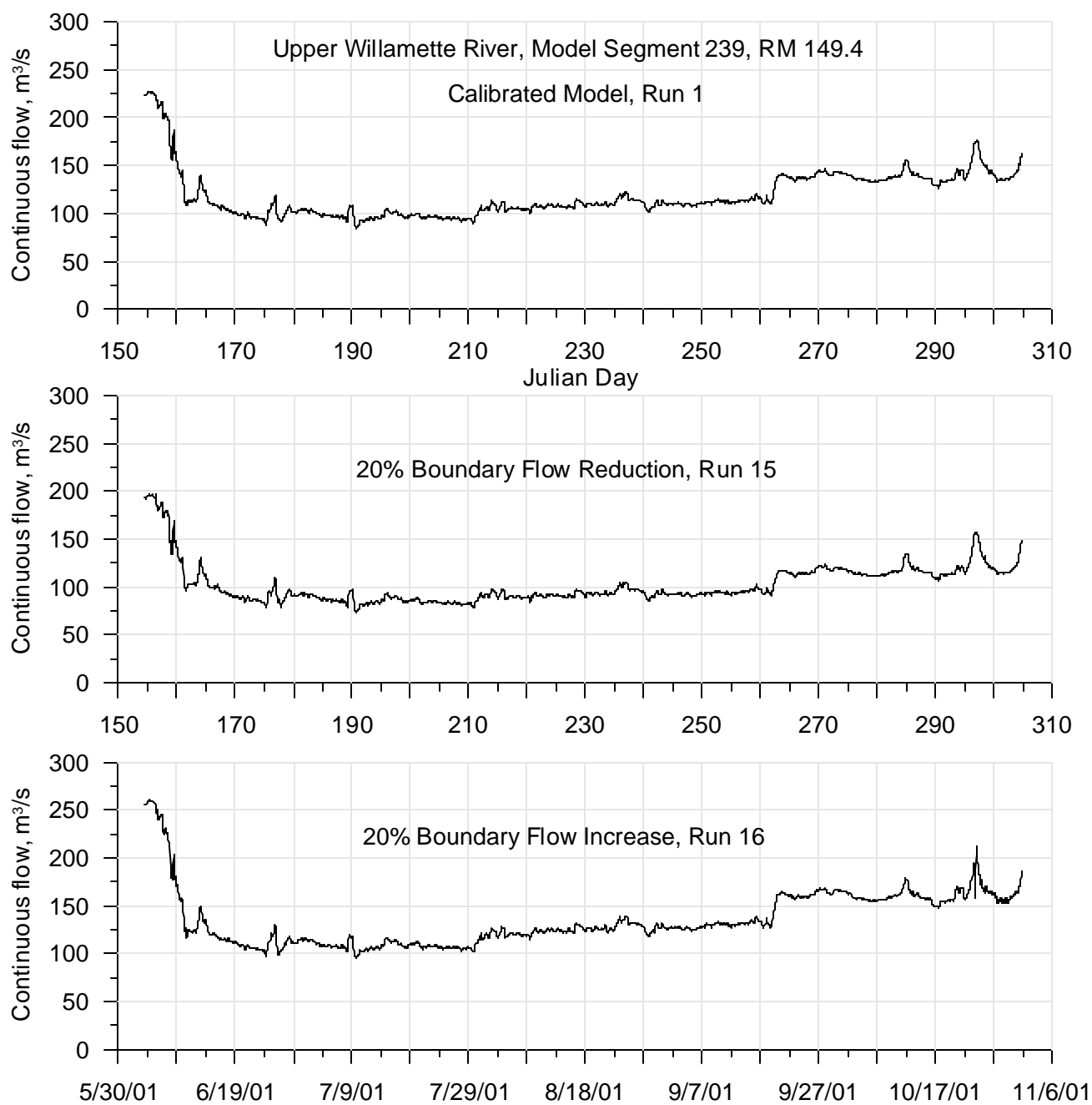
**Figure 456: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Long Tom River at RM 4.64**



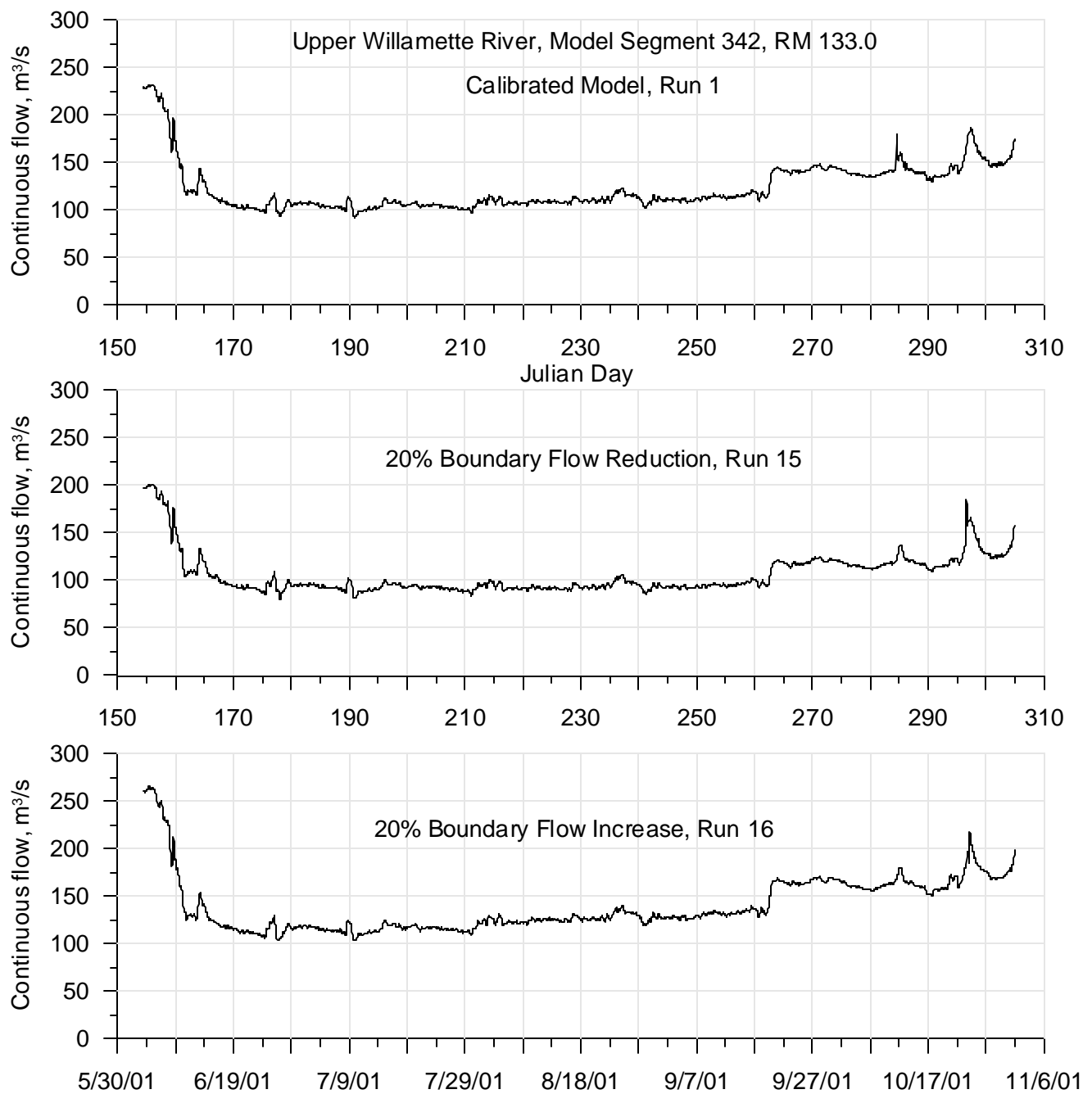
**Figure 457: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 175.3**



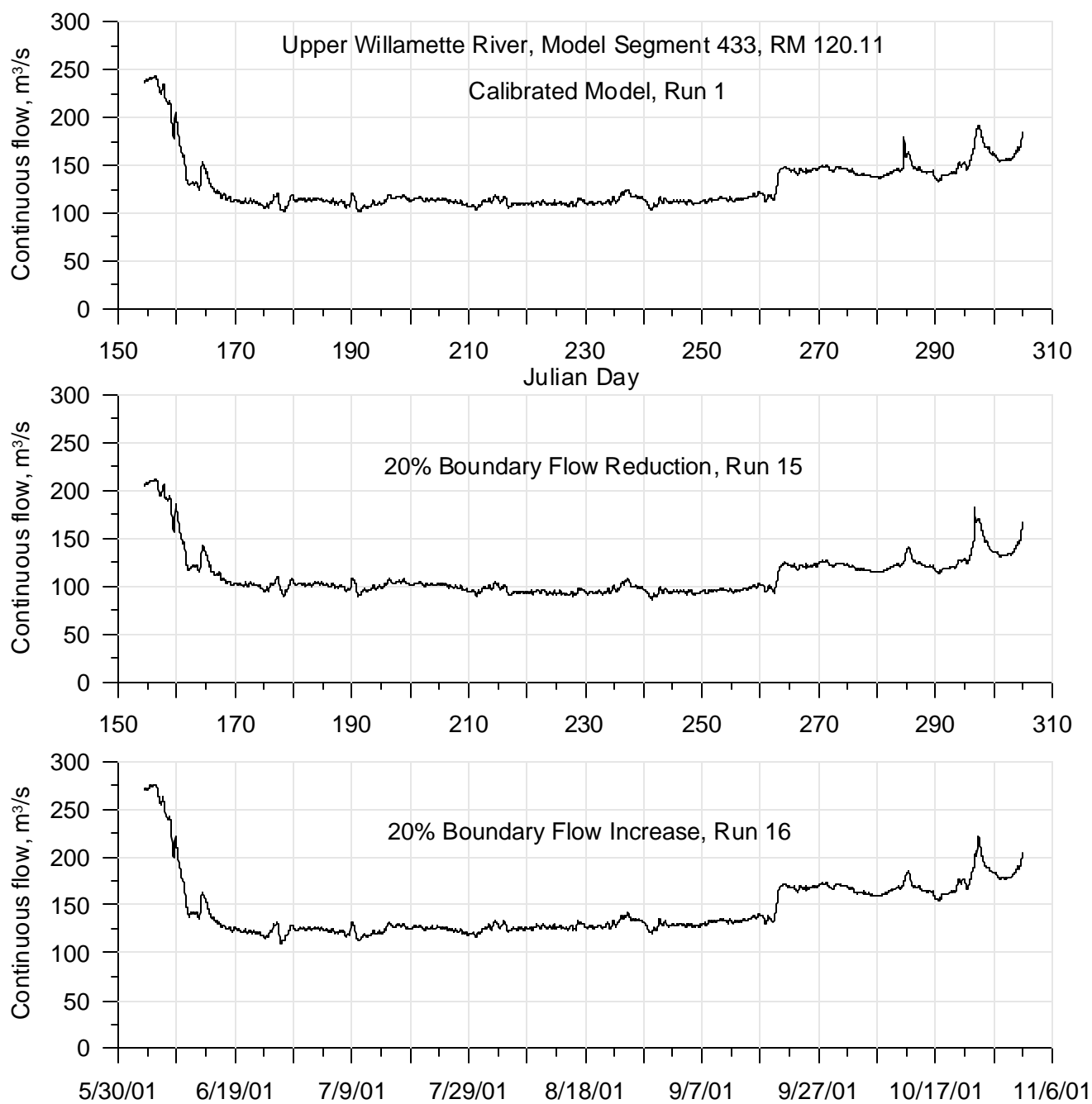
**Figure 458: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 161.98**



**Figure 459: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 149.4**

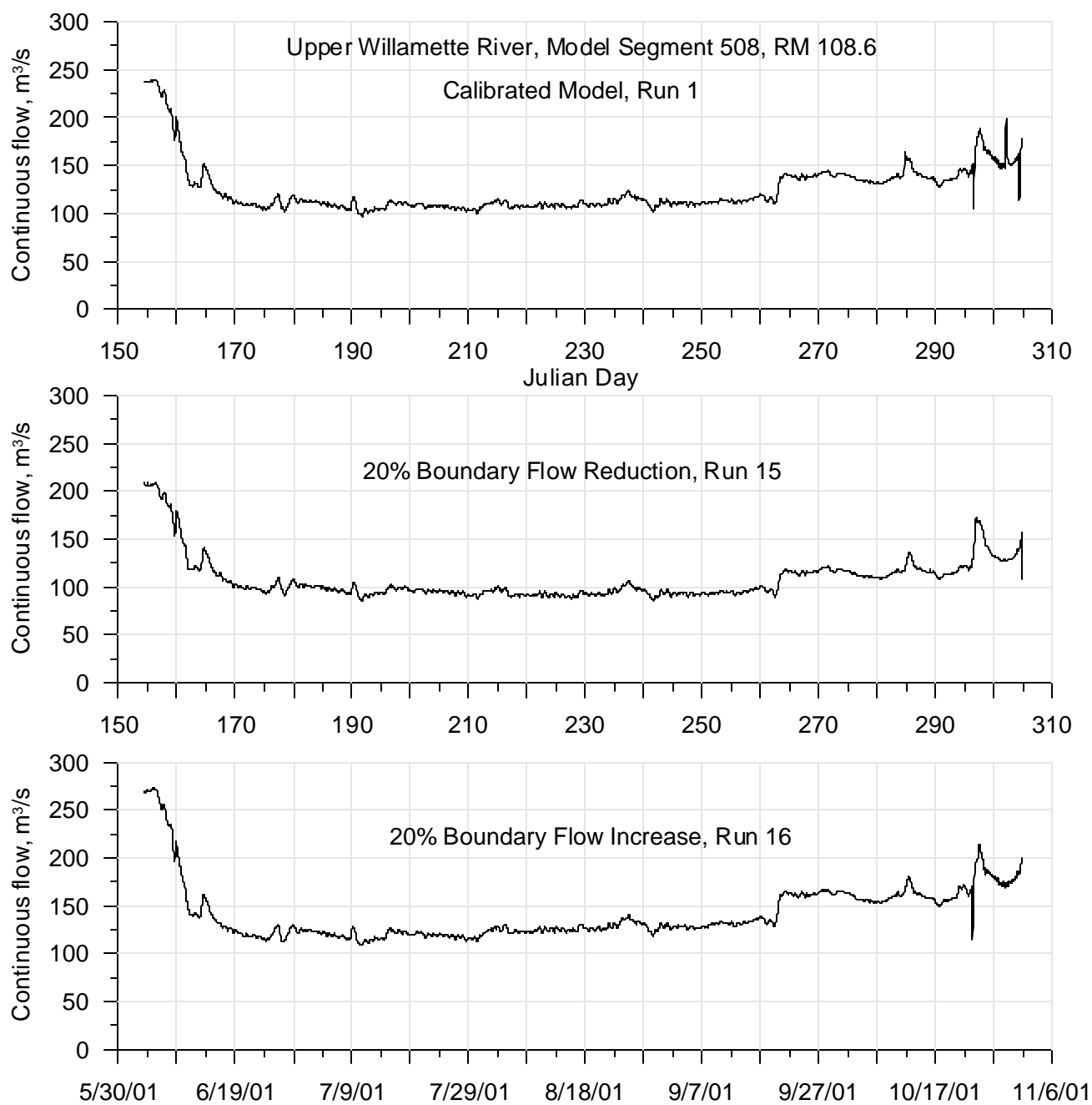


**Figure 460: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 133**

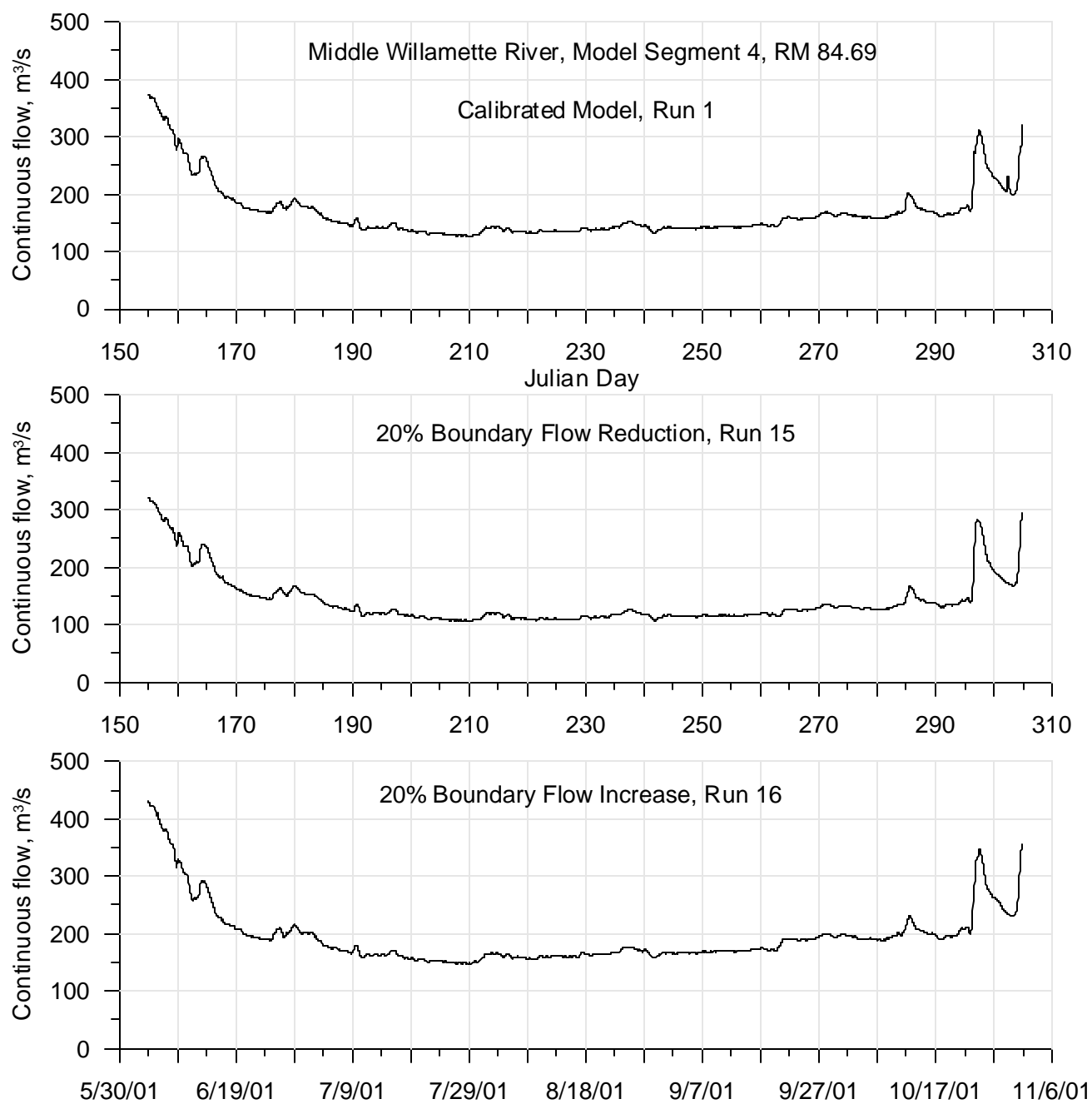


**Figure 461: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 120.11**

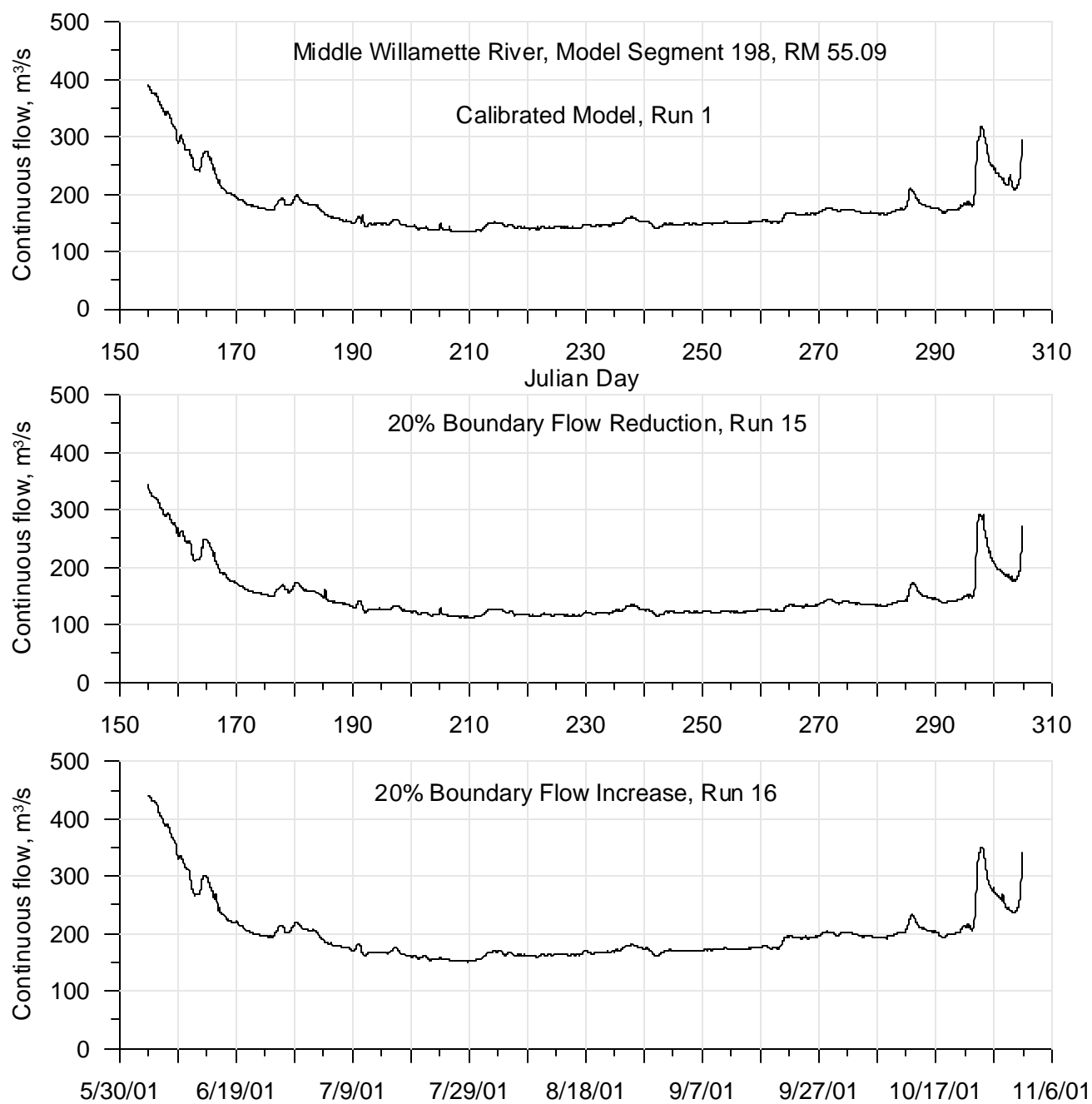




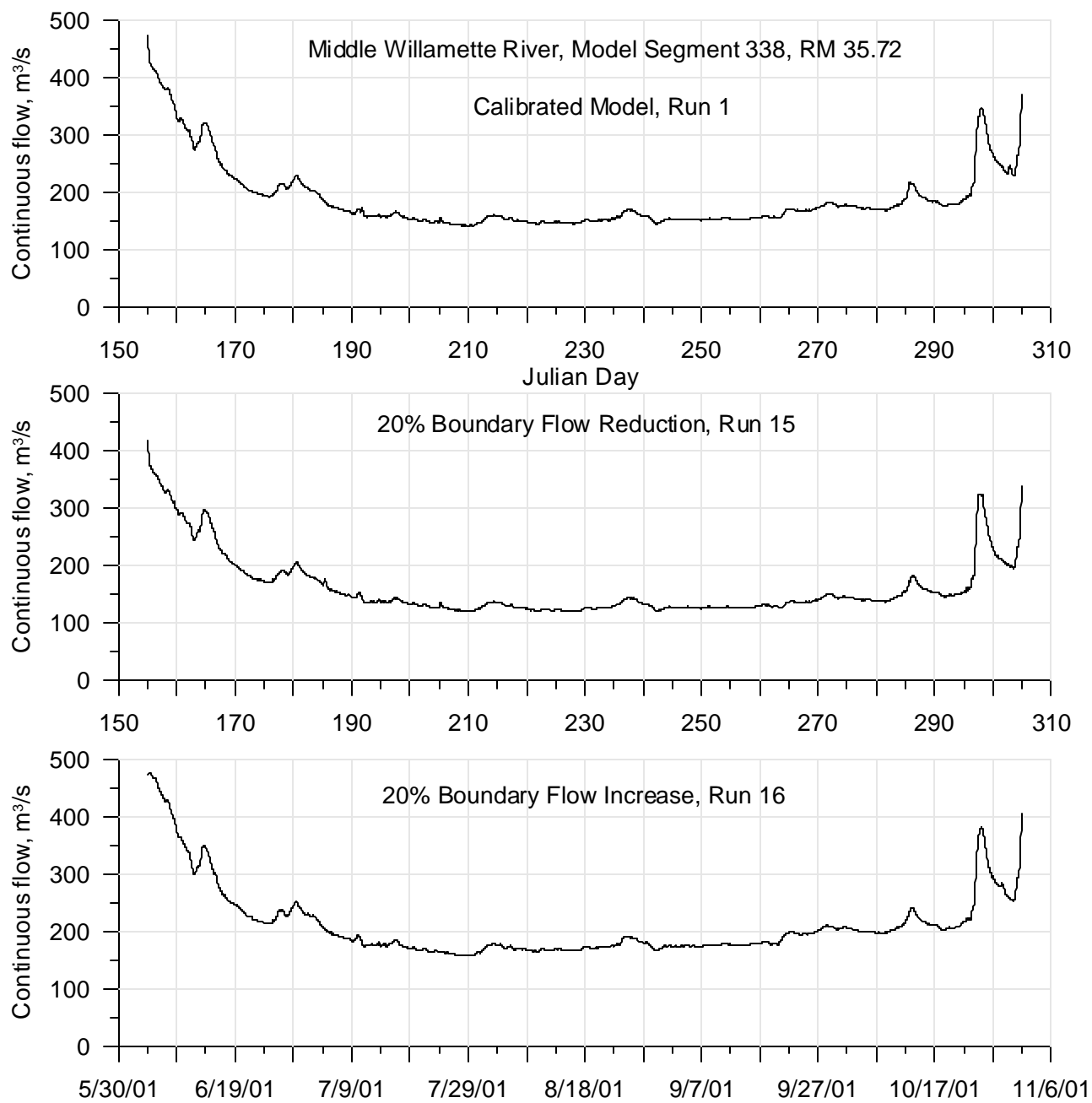
**Figure 462: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 108.6**



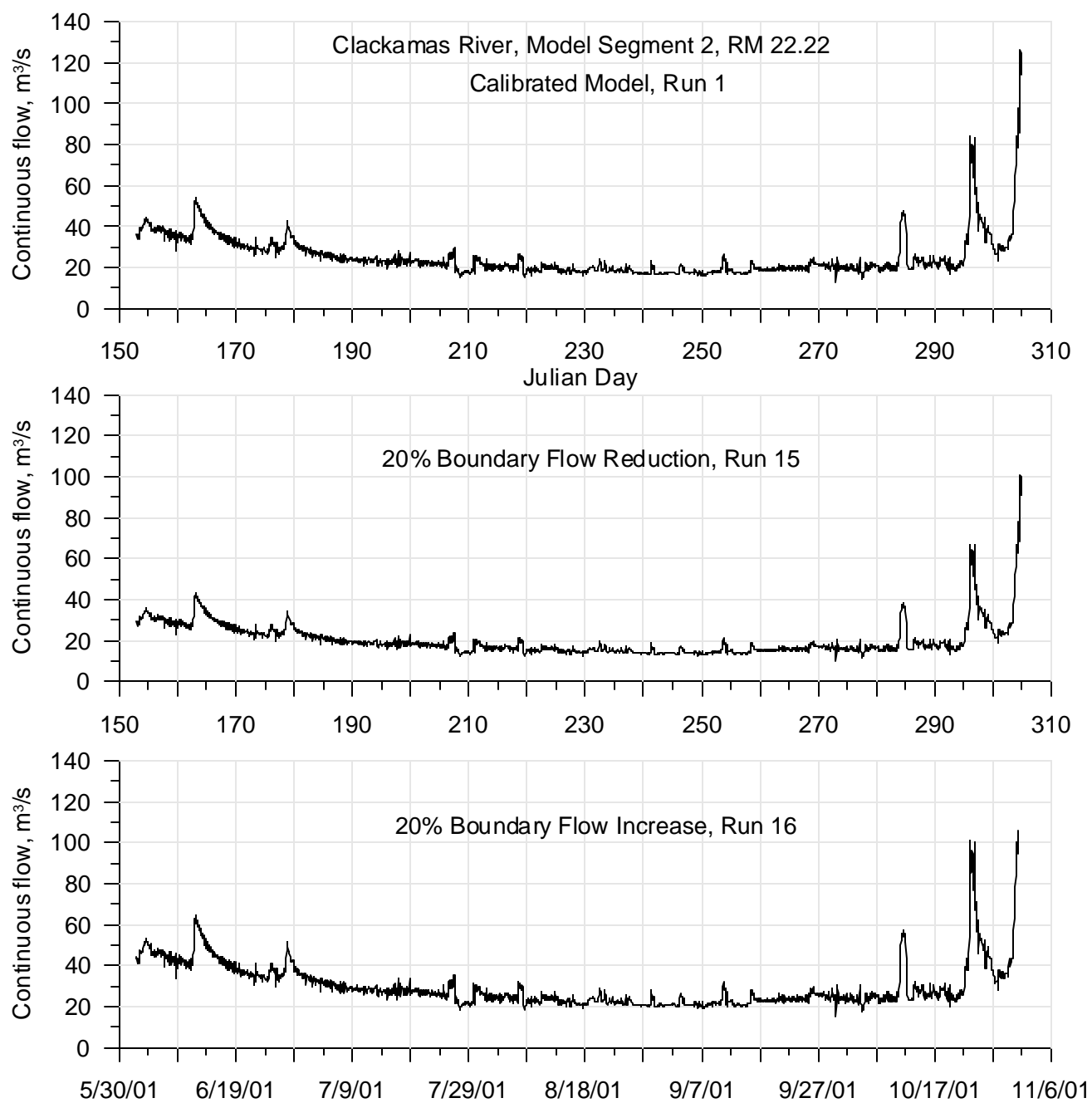
**Figure 463: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 84.69**



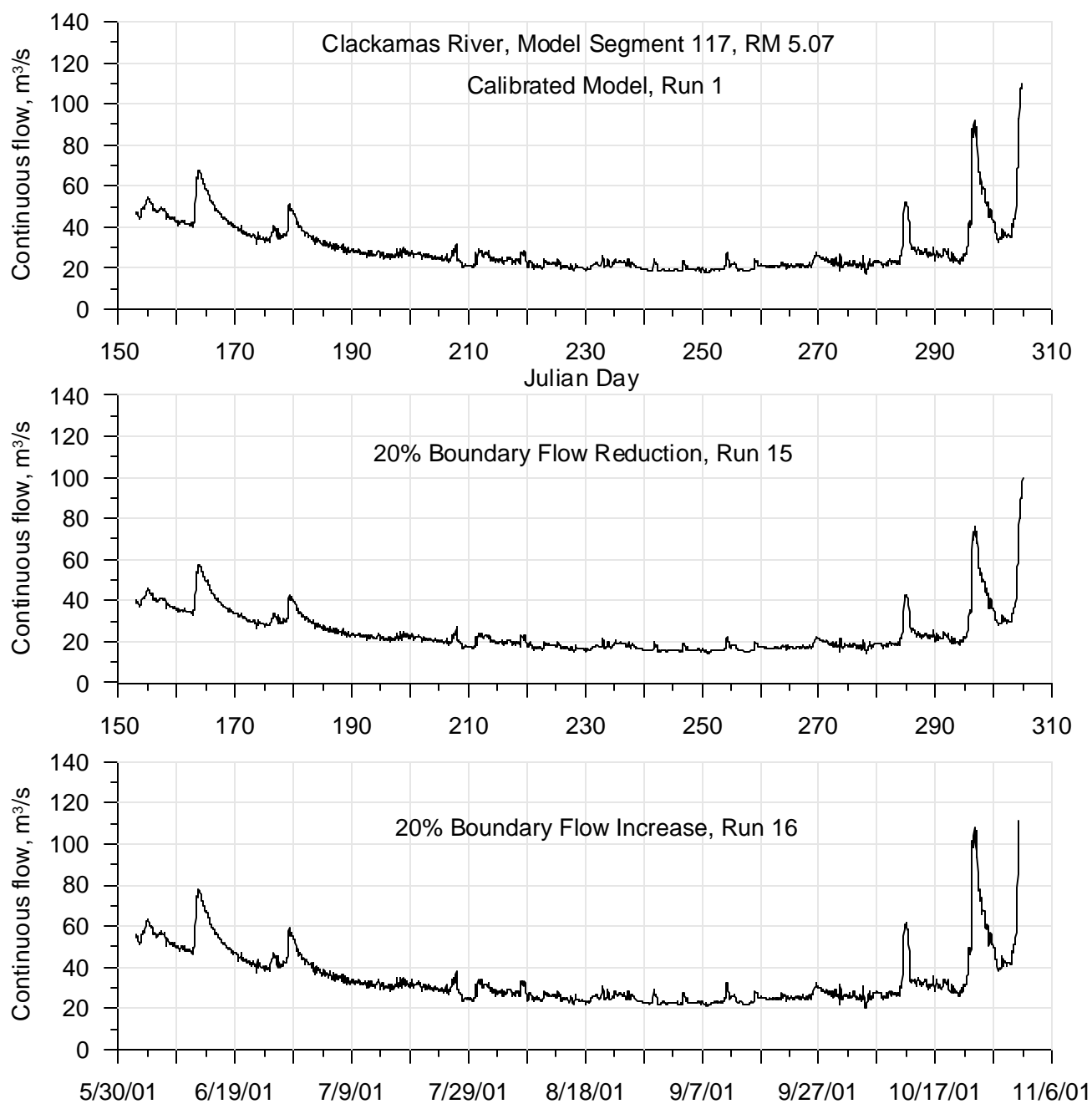
**Figure 464: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 55.09**



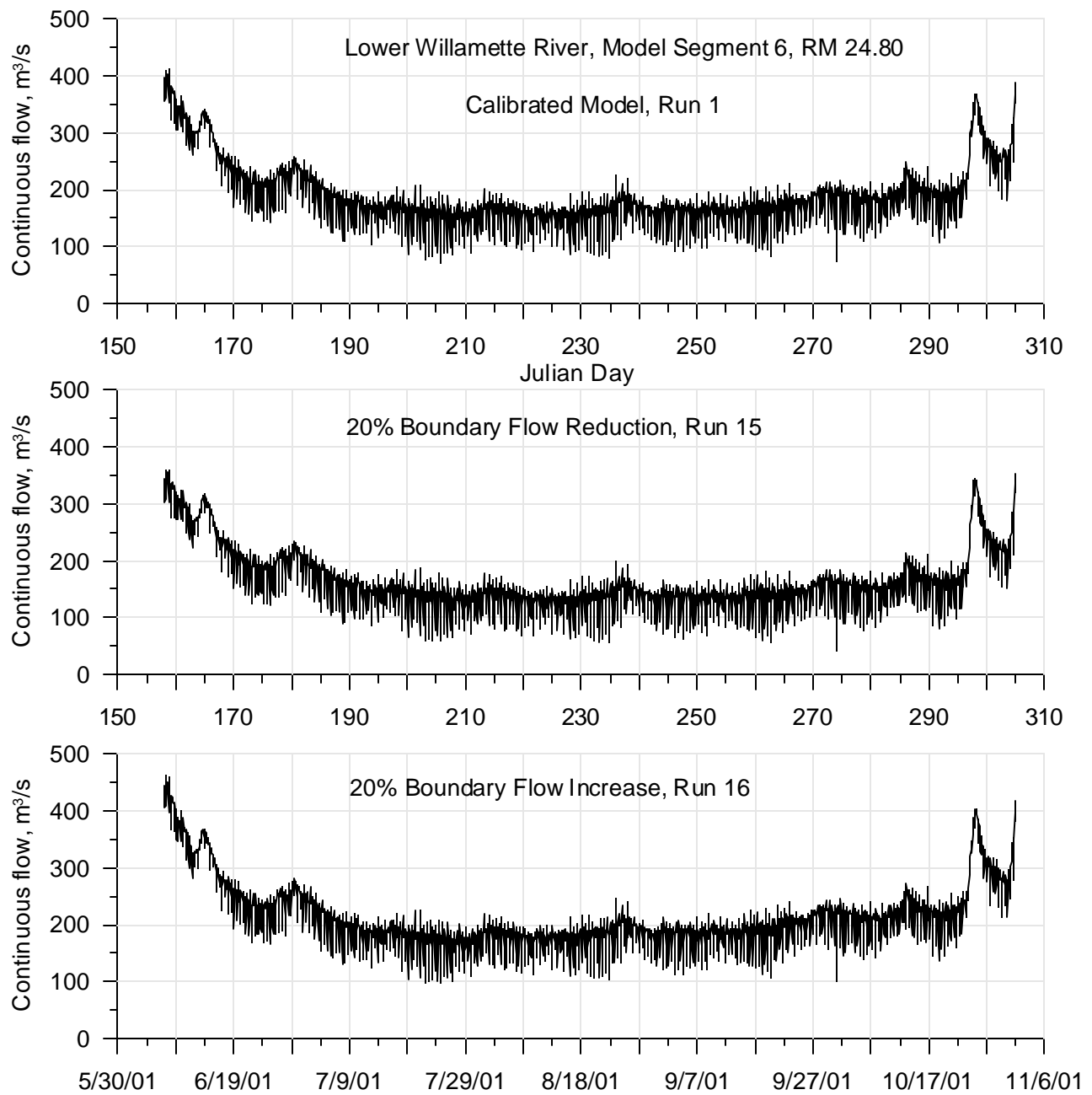
**Figure 465: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 35.72**



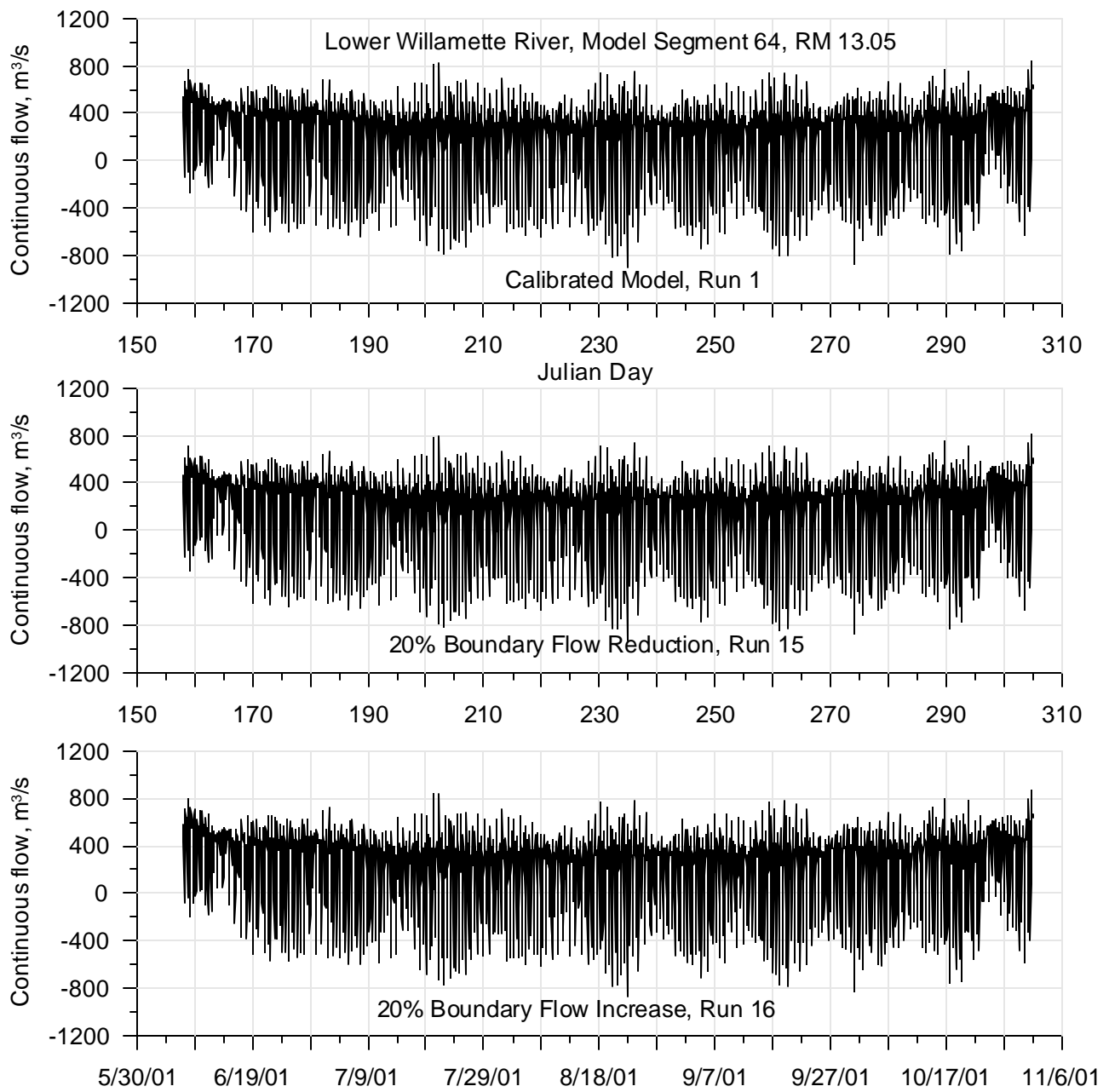
**Figure 466: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Clackamas River at RM 22.22**



**Figure 467: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Clackamas River at RM 5.07**

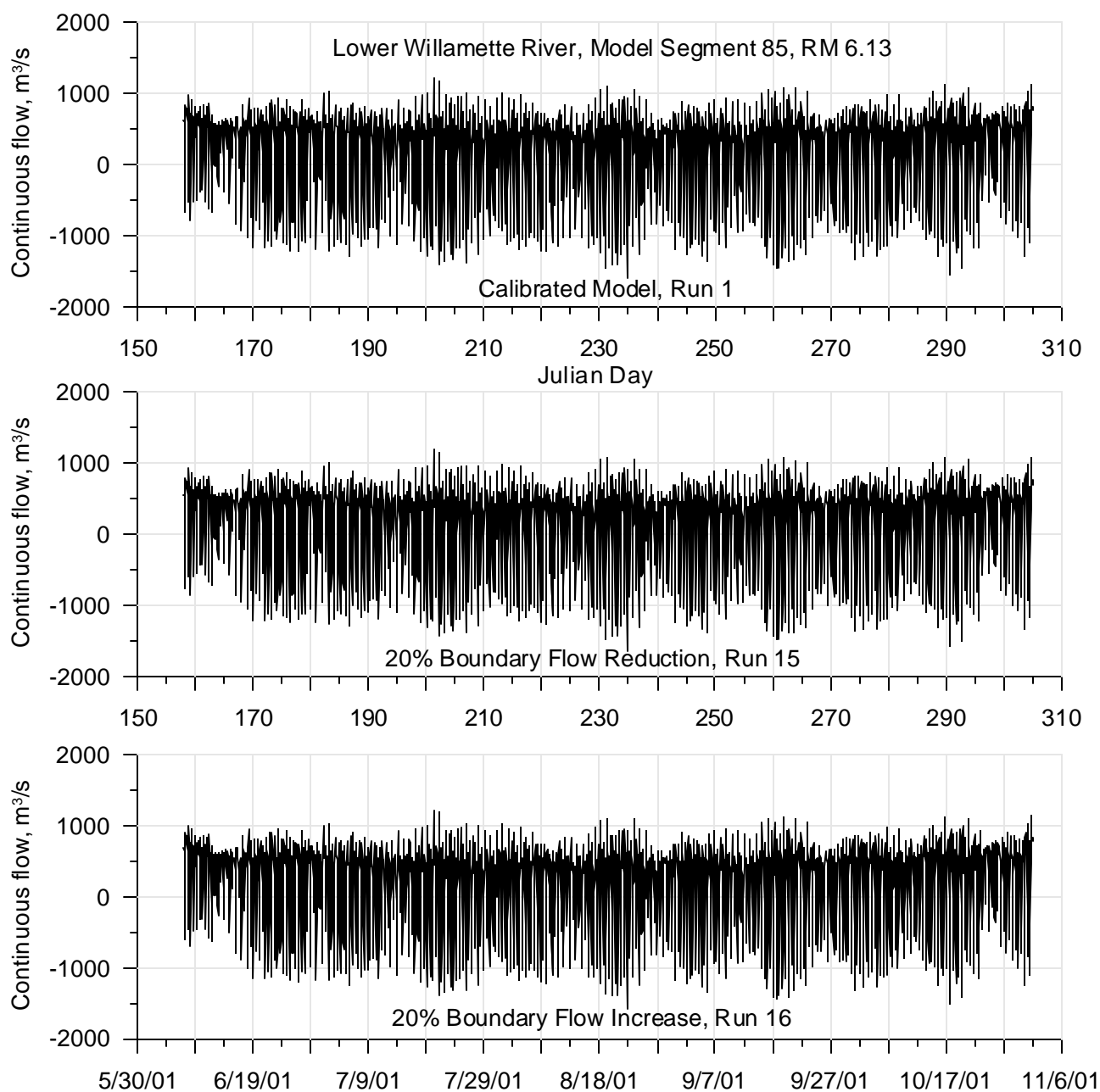


**Figure 468: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 24.8**



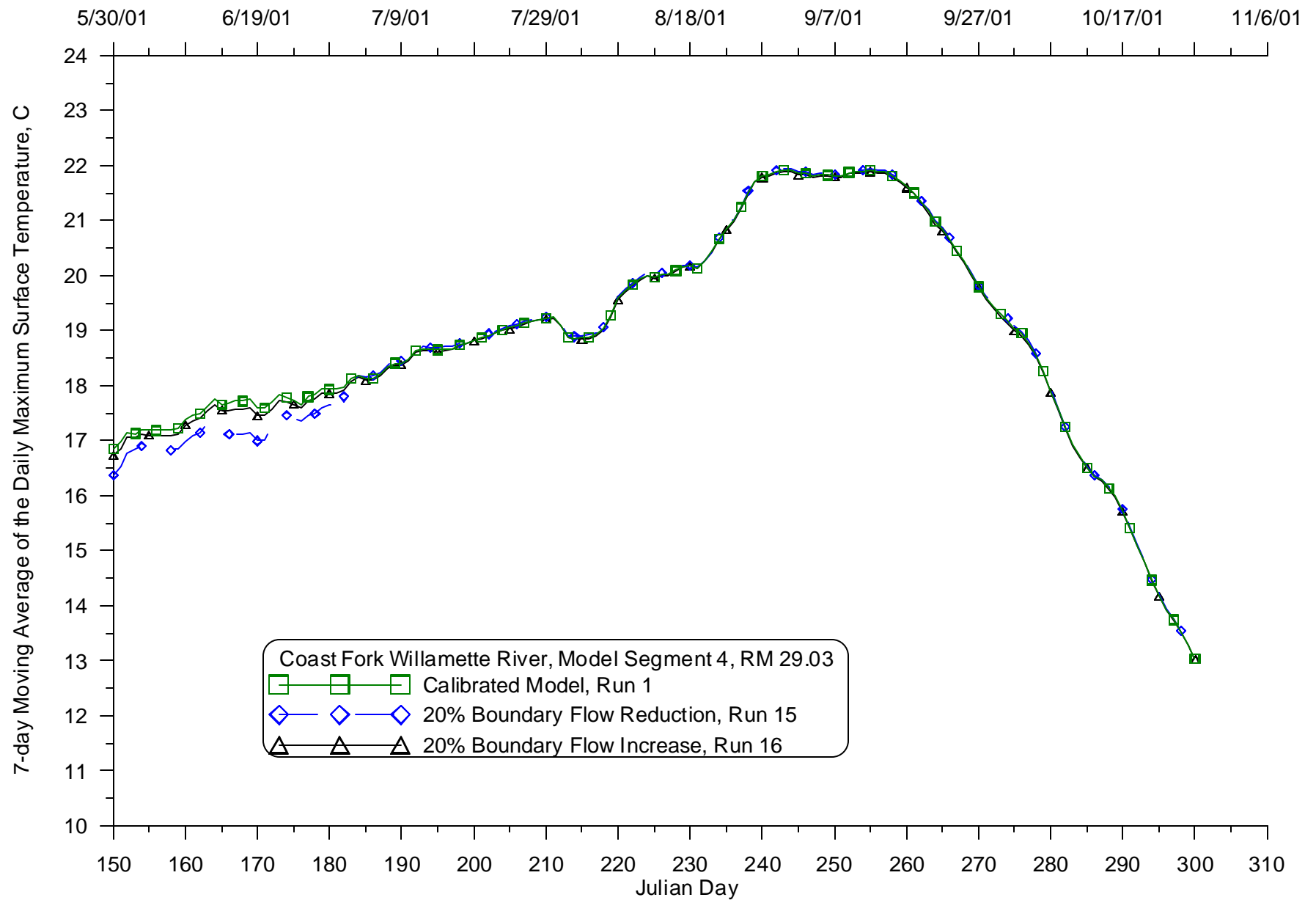
**Figure 469: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 13.05**



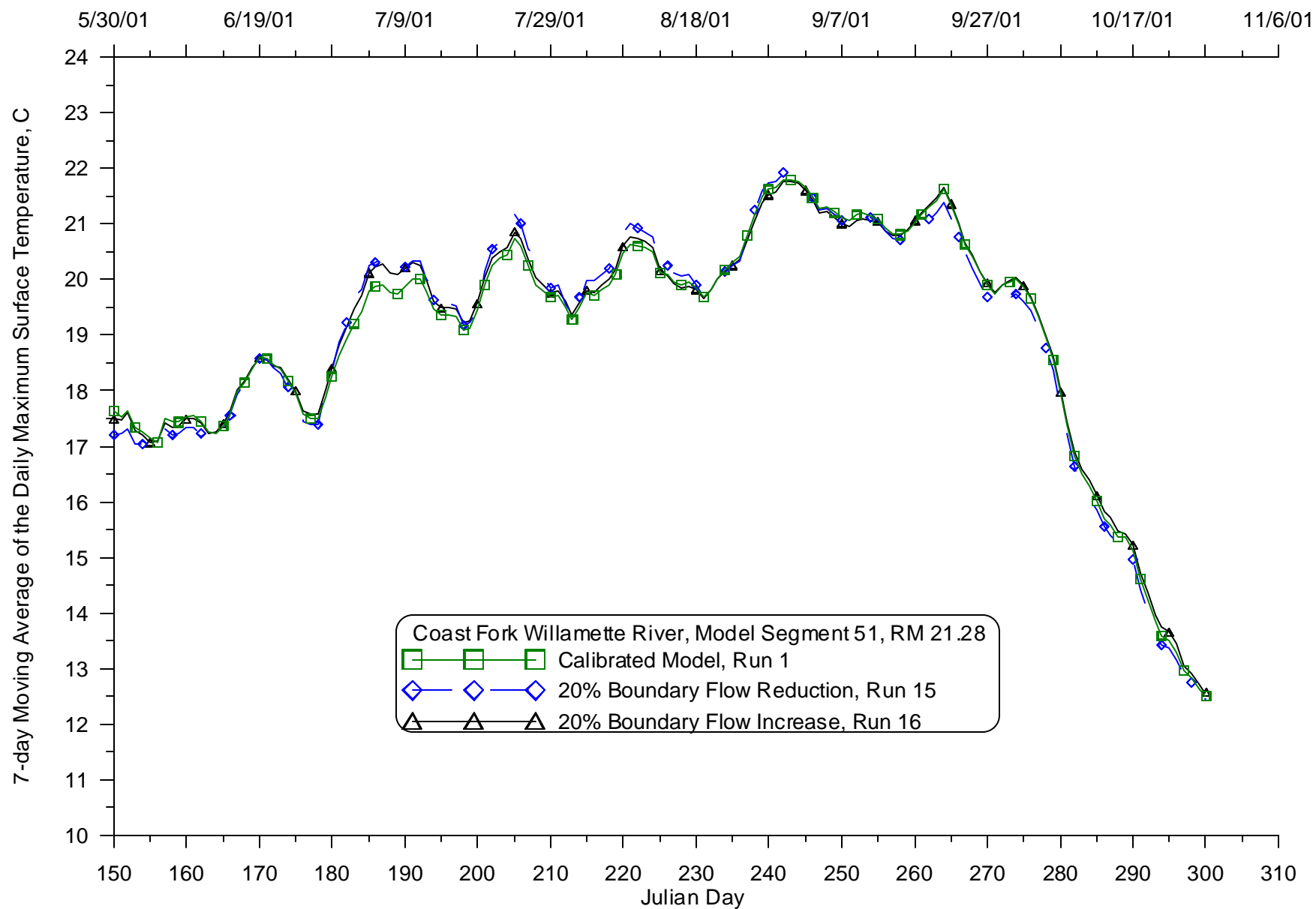


**Figure 470: Calibrated model compared with varying boundary flow (+/- 20%) continuous flow for 2001 for the Willamette River at RM 6.13**

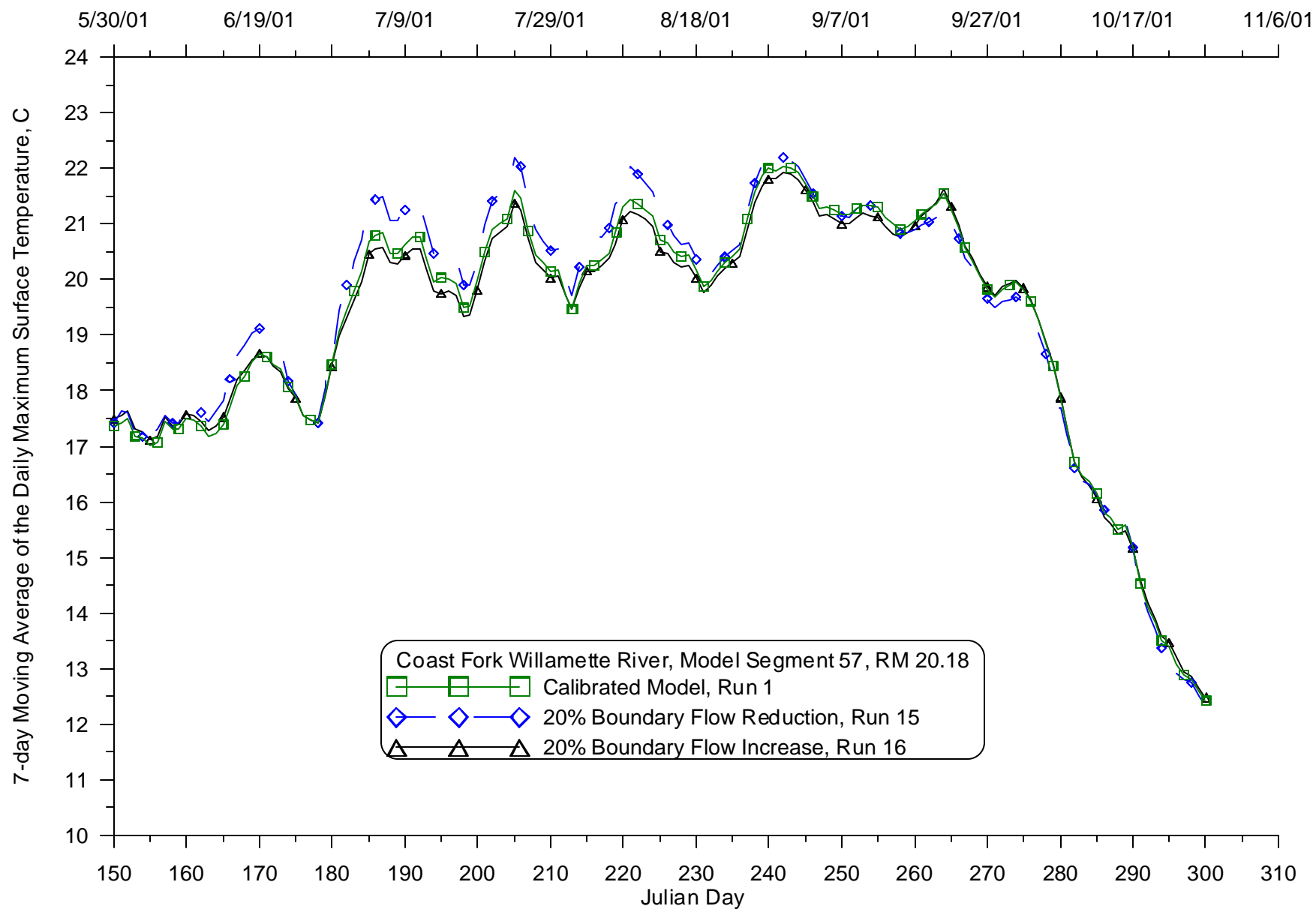
**Daily seven day moving average of daily maximum temperature**



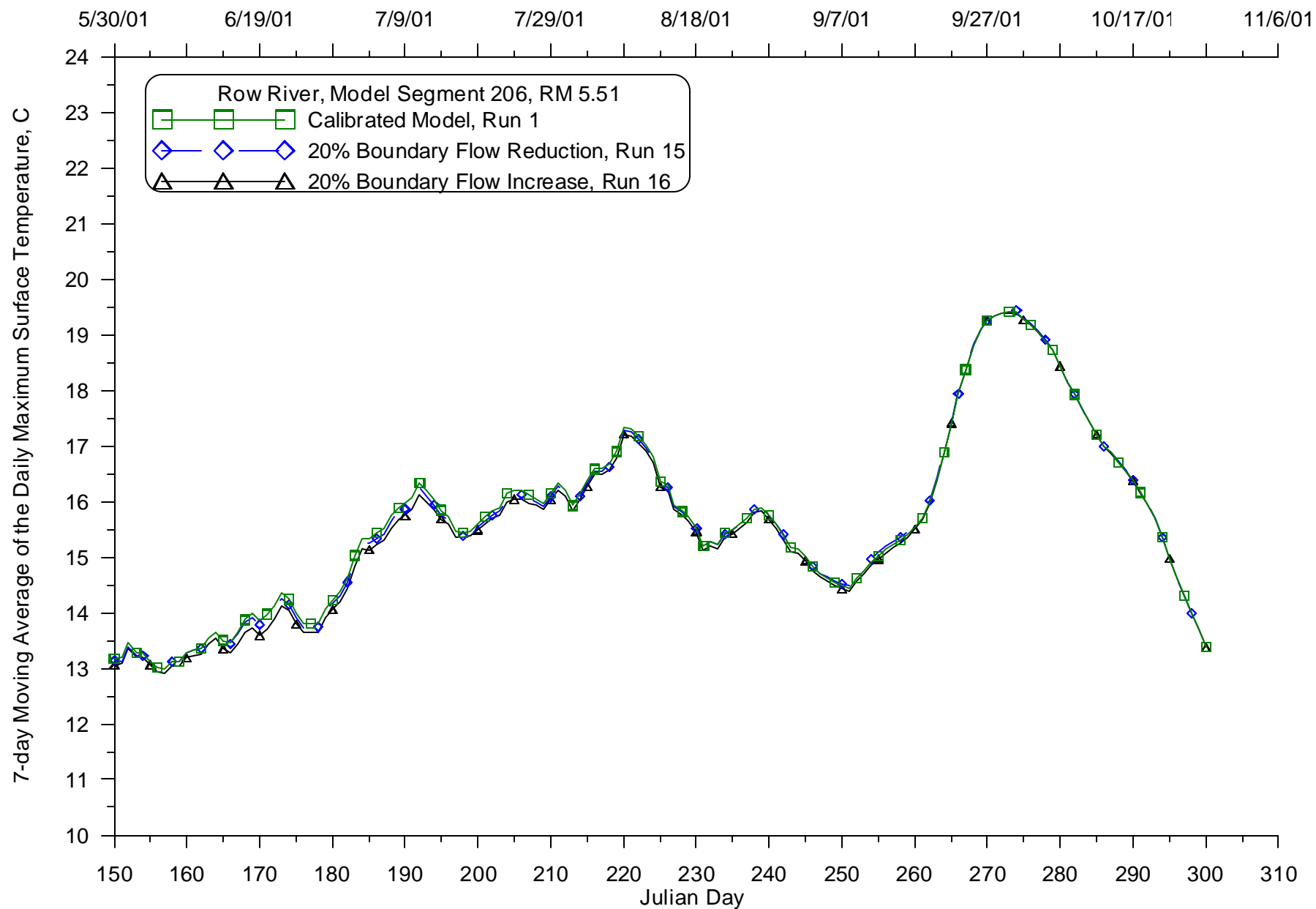
**Figure 471: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 29.03**



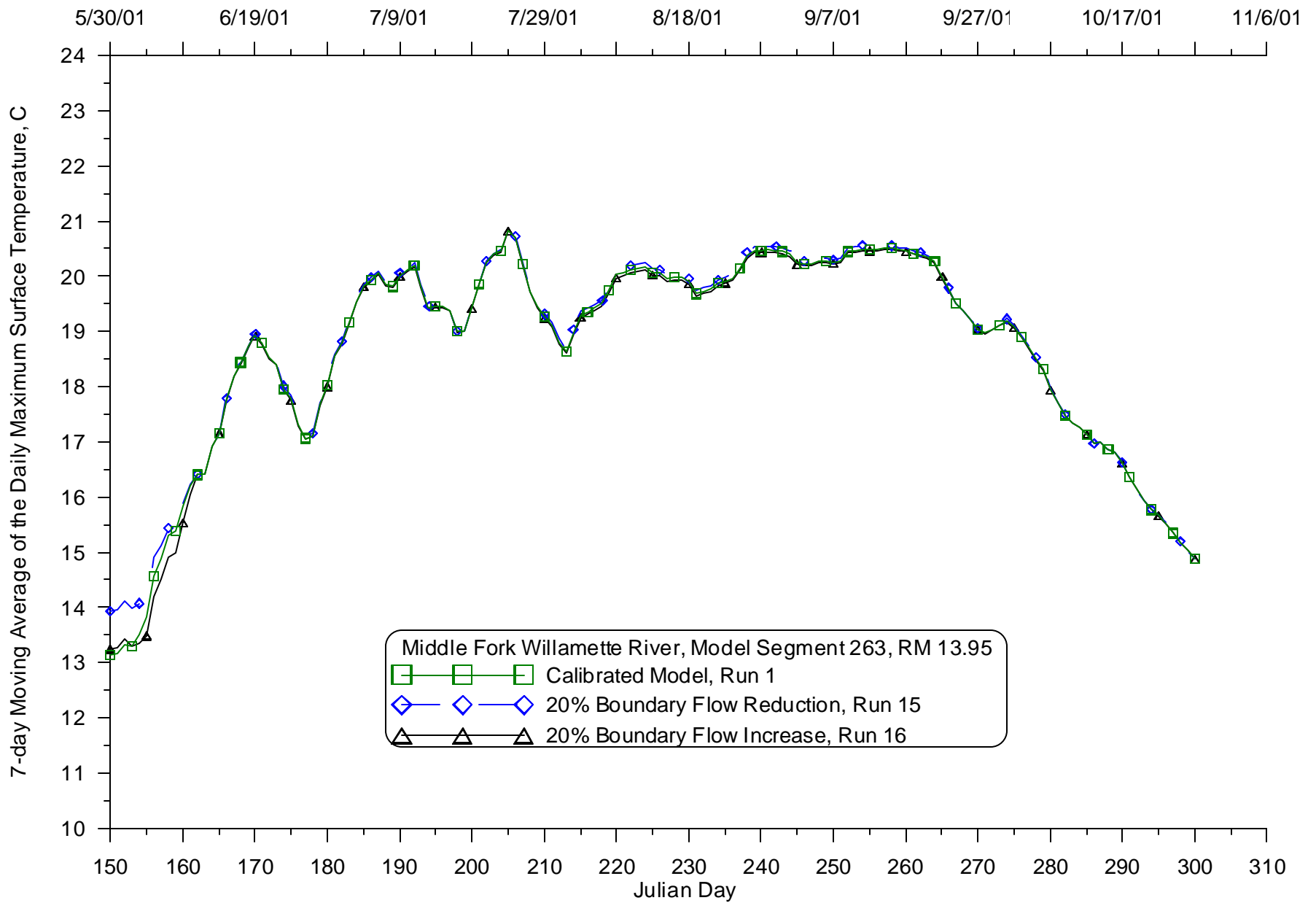
**Figure 472: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 21.28**



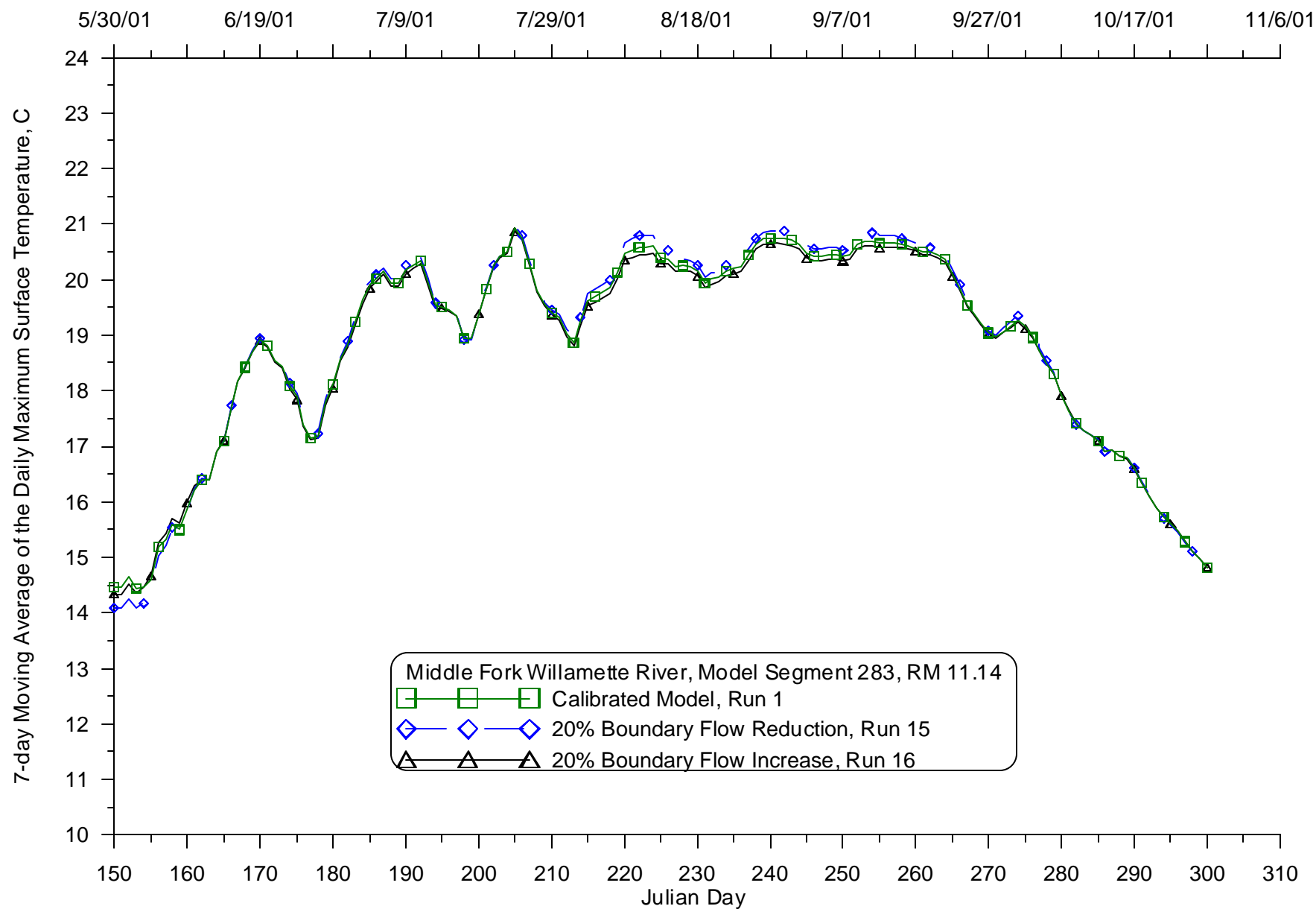
**Figure 473: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 20.18**



**Figure 474: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Row River at RM 5.51**

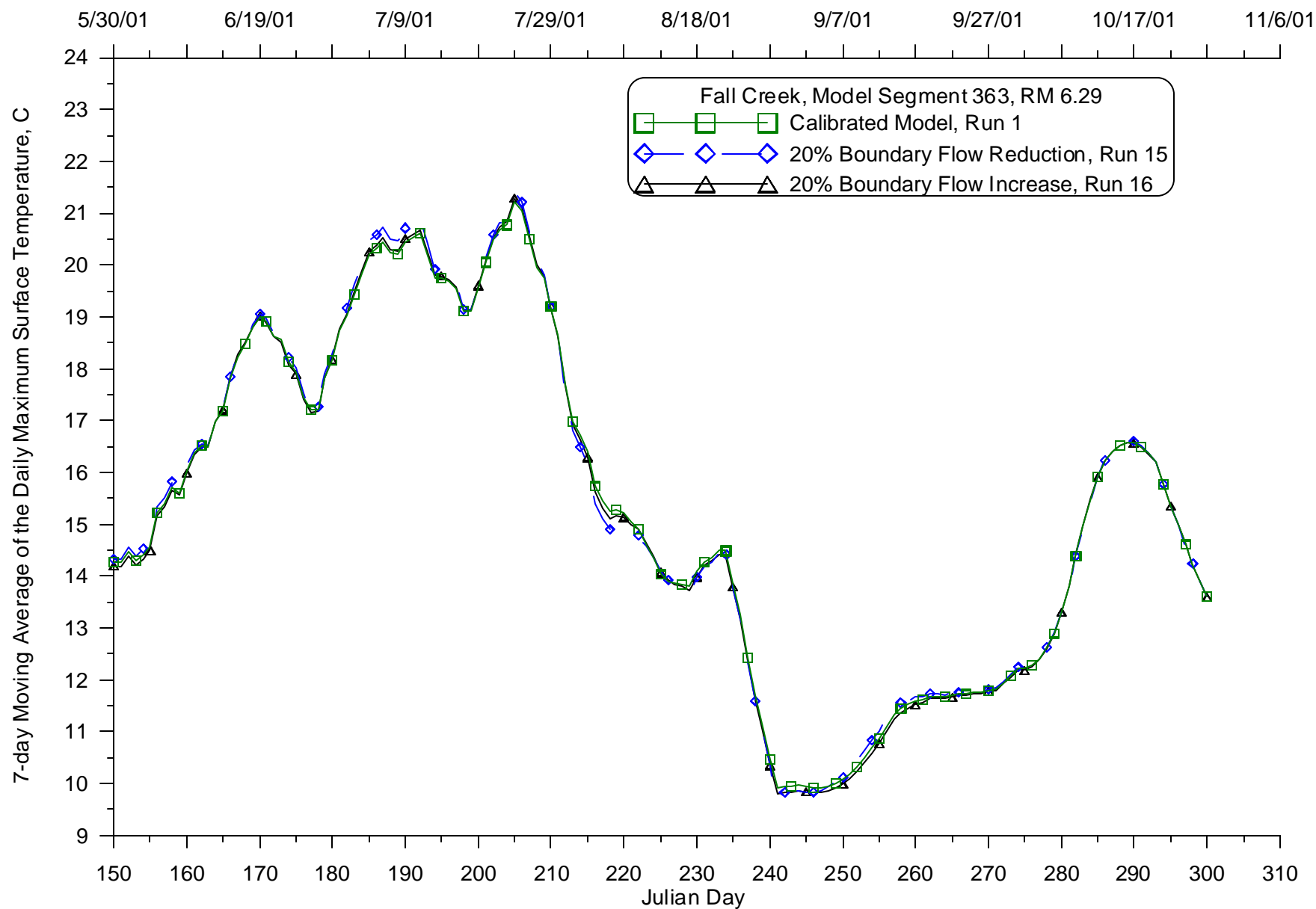


**Figure 475: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Middle Fork Willamette River at RM 13.95**

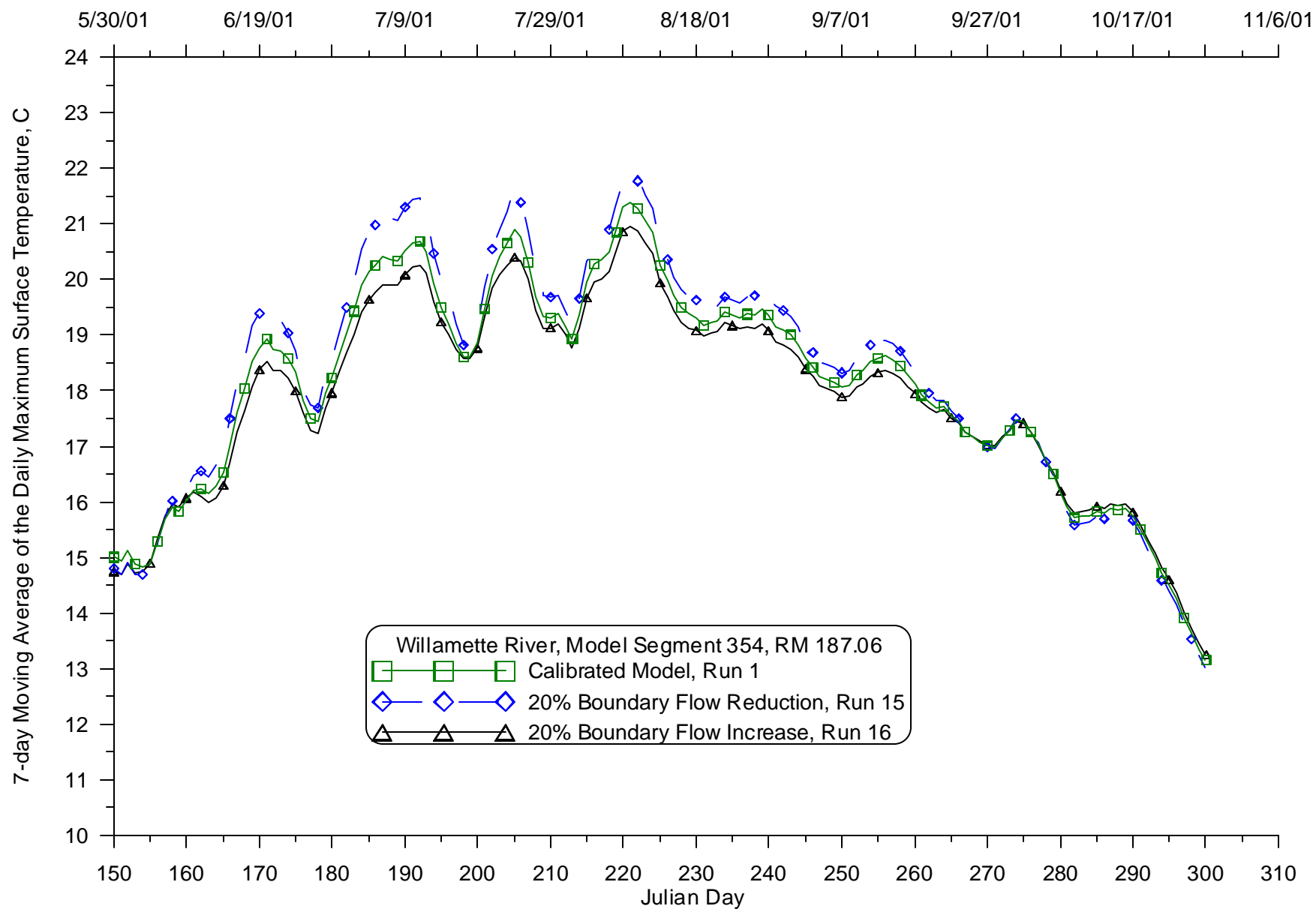


**Figure 476: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Middle Fork Willamette River at RM 11.14**

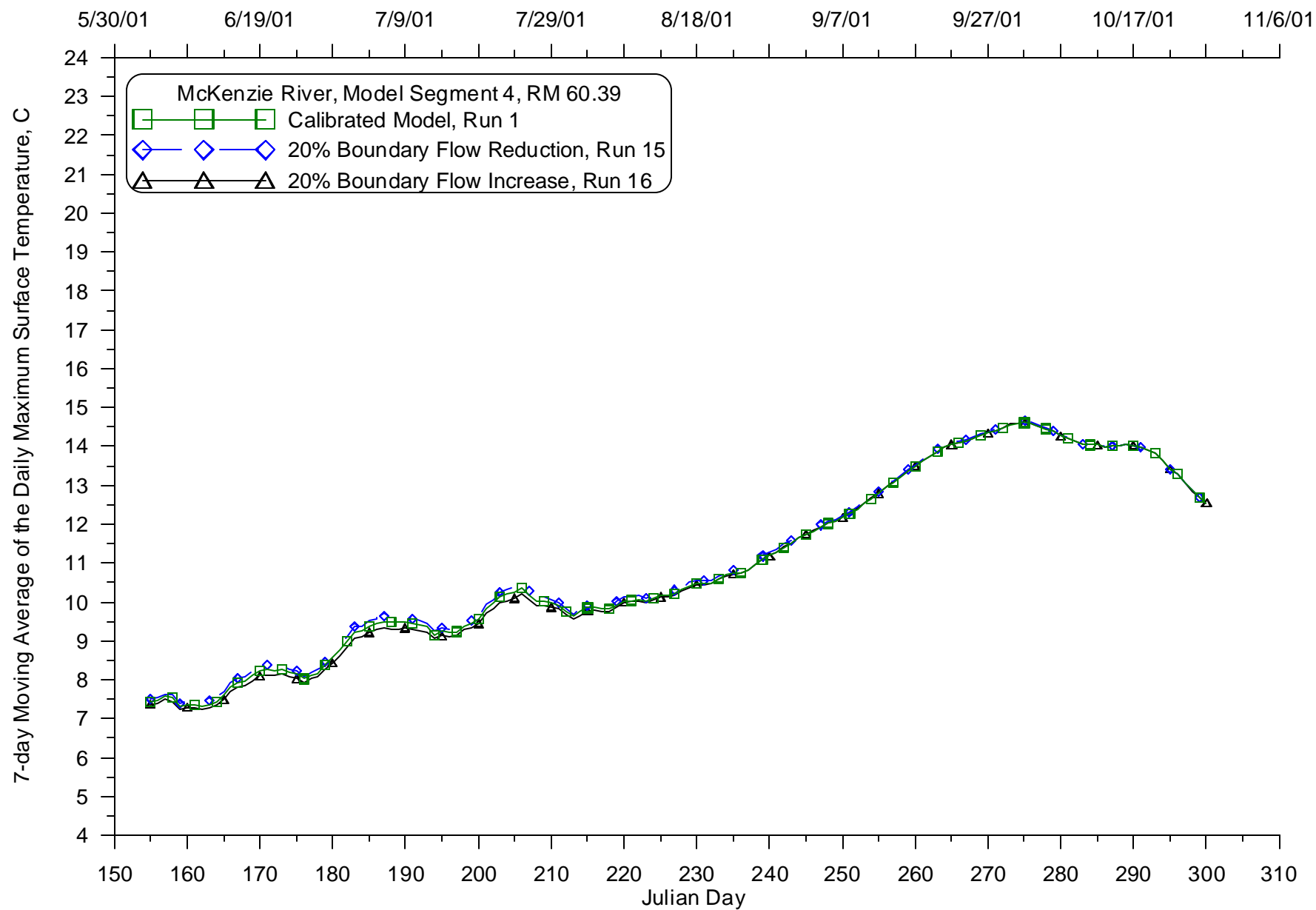




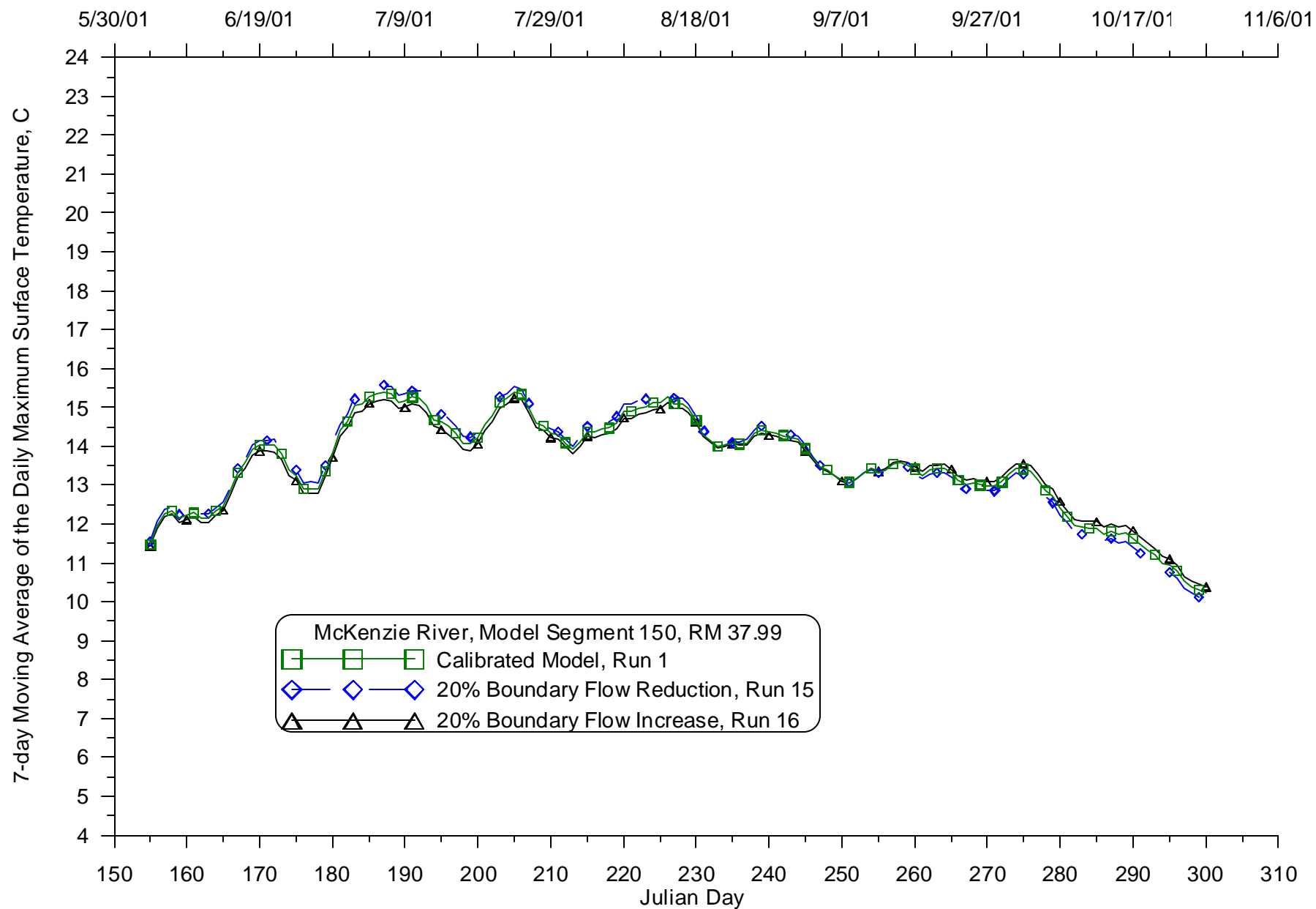
**Figure 477: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for Fall Creek at RM 6.29**



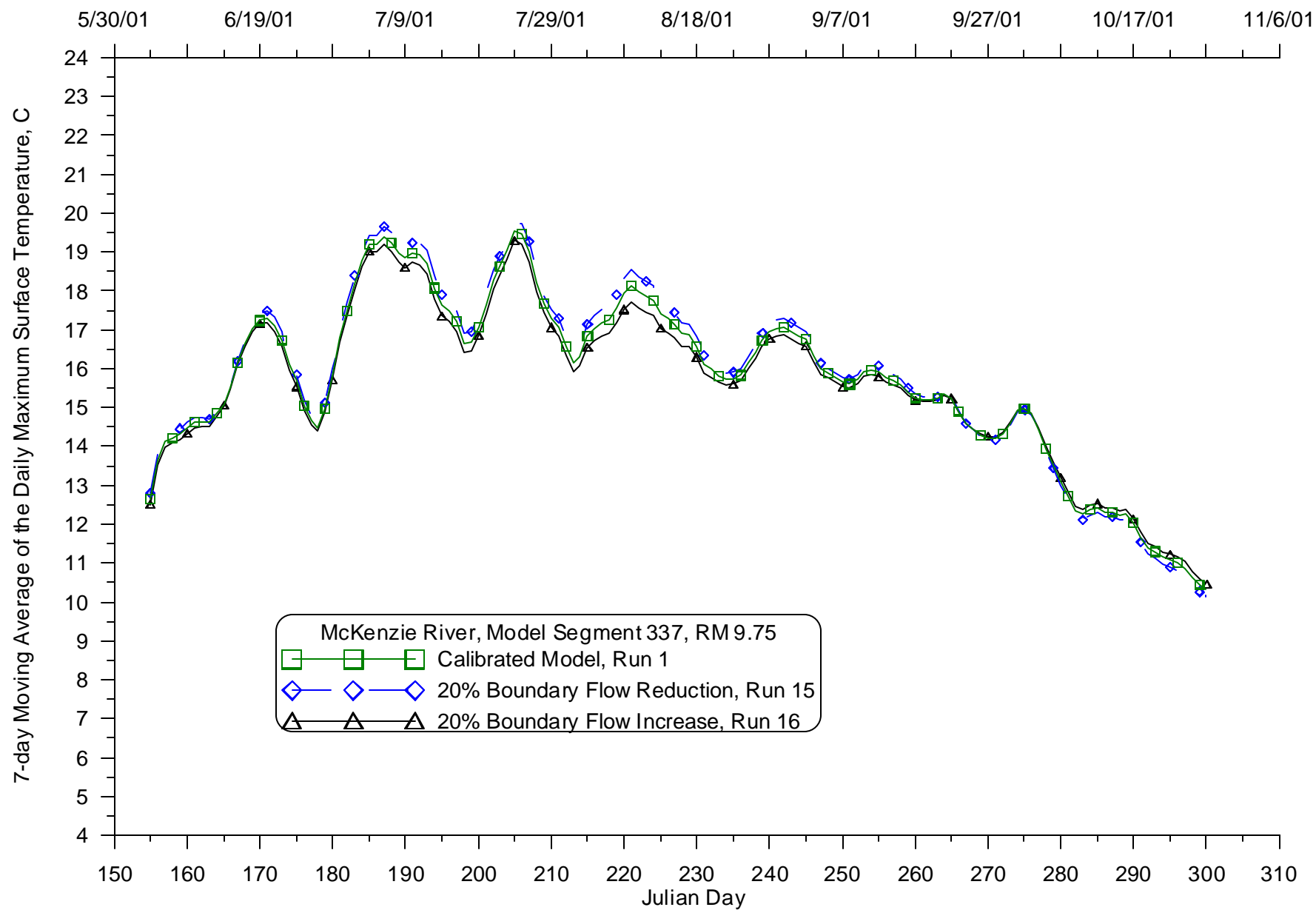
**Figure 478: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 187.06**



**Figure 479: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the McKenzie River at RM 60.39**



**Figure 480: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the McKenzie River at RM 37.99**



**Figure 481: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the McKenzie River at RM 9.75**

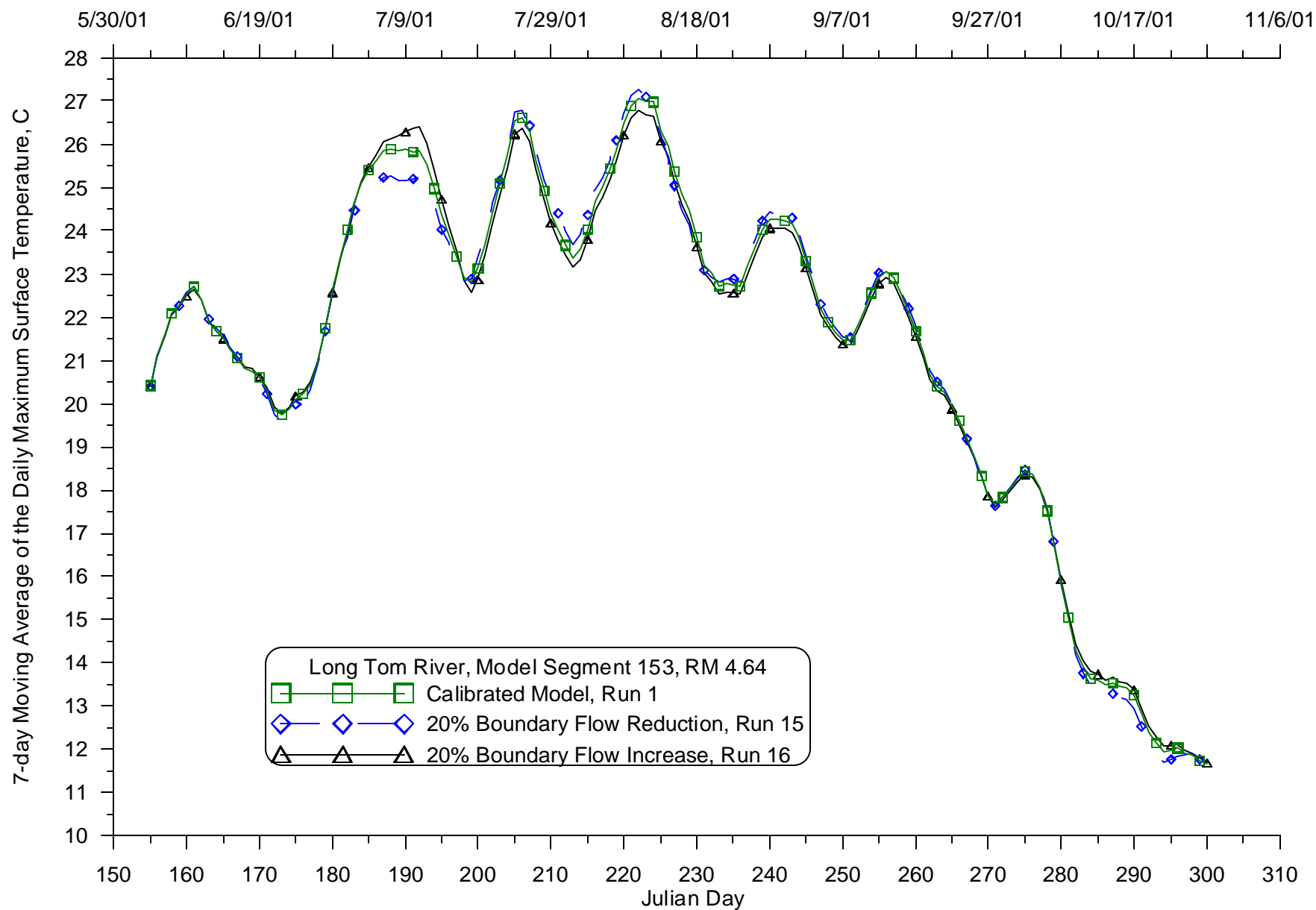
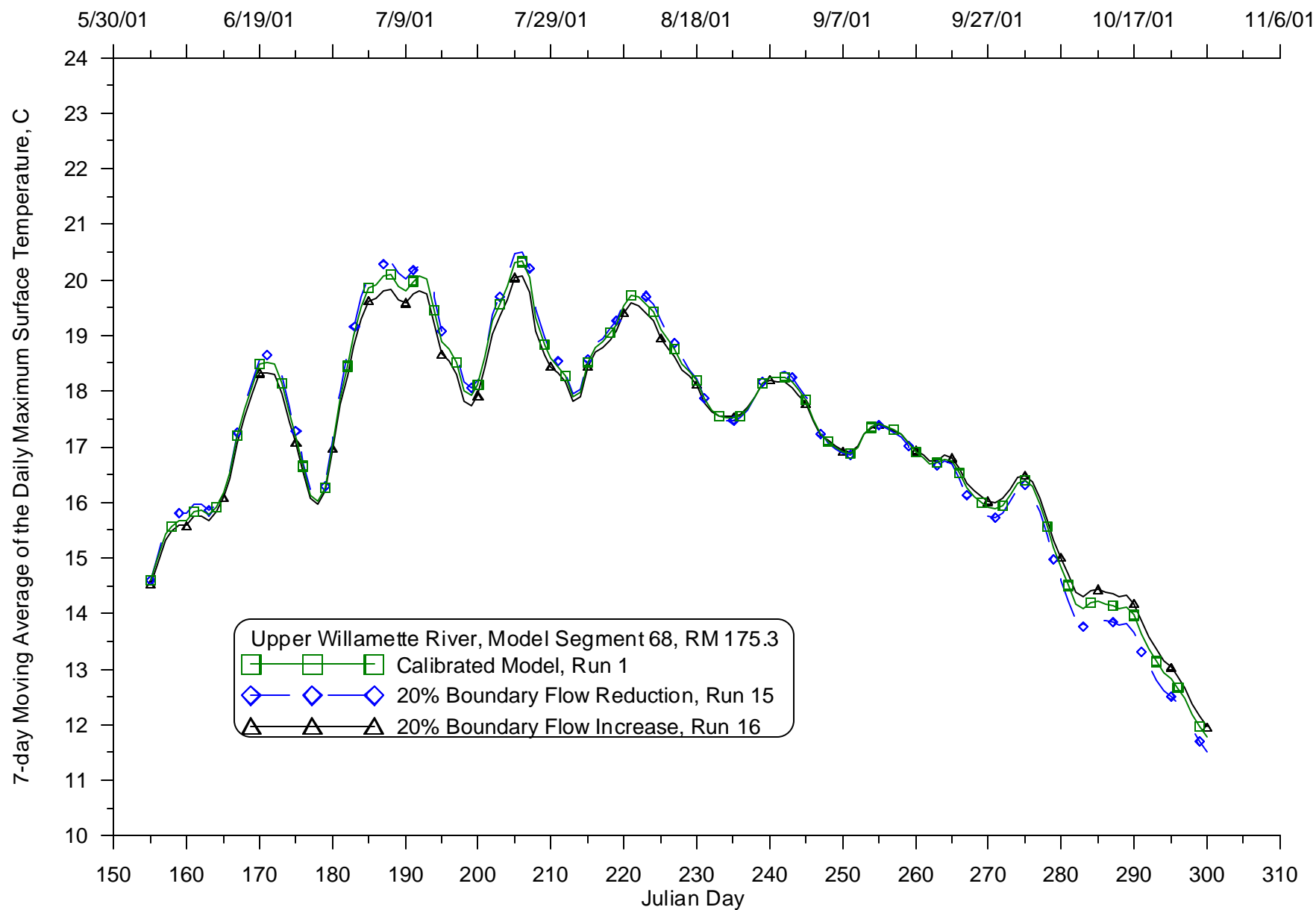


Figure 482: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Long Tom River at RM 9.75



**Figure 483: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 175.3**

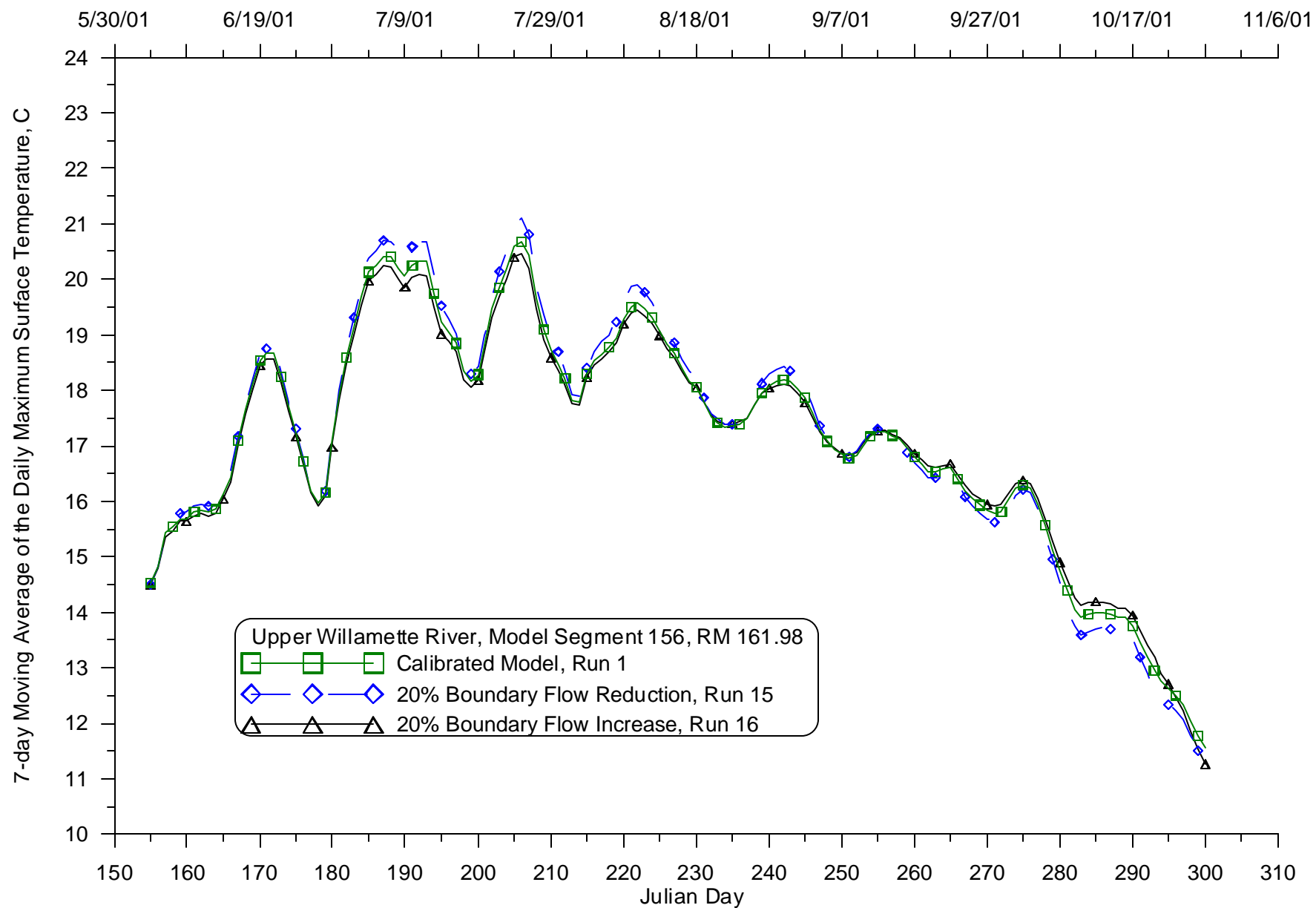


Figure 484: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 161.98



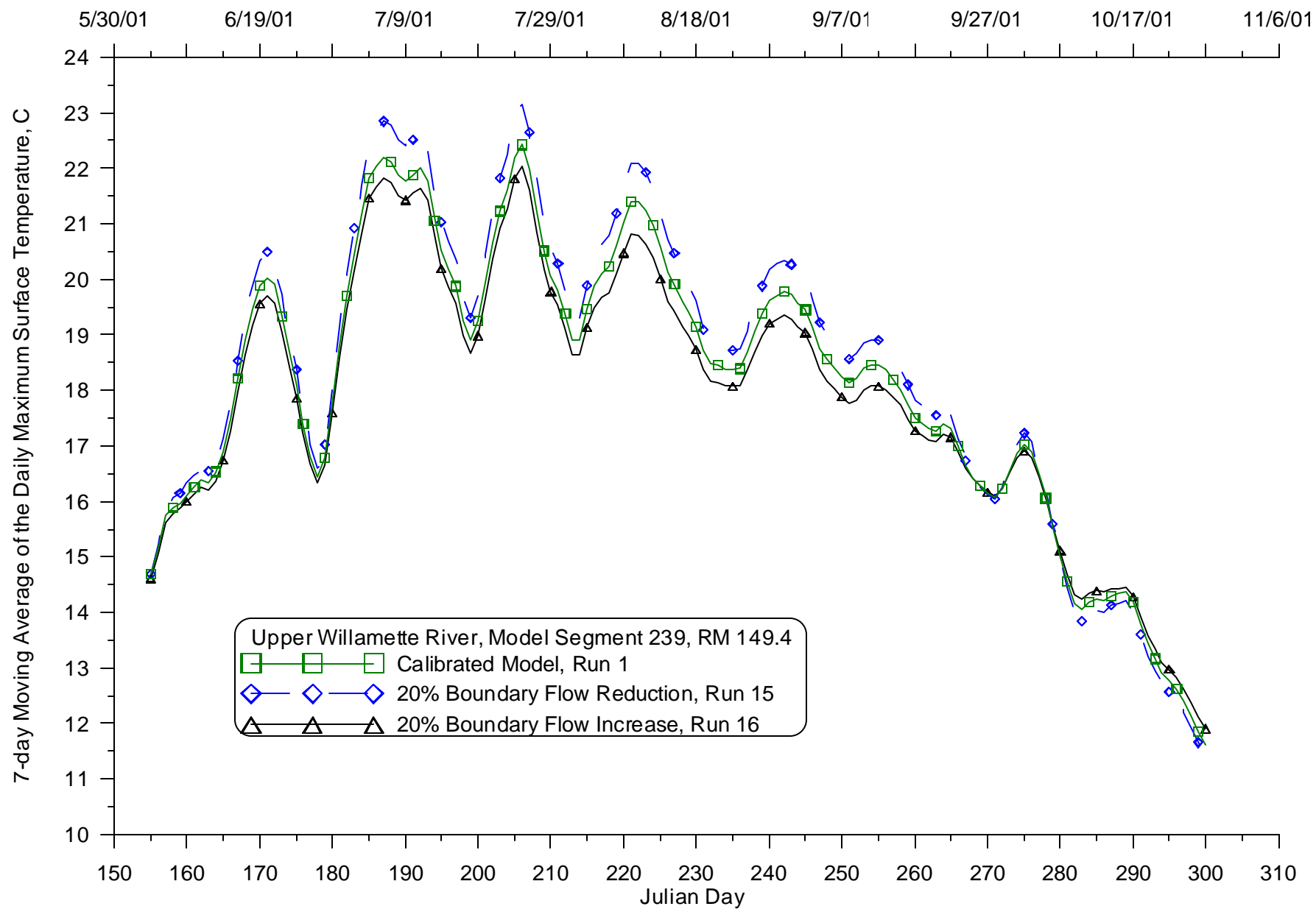
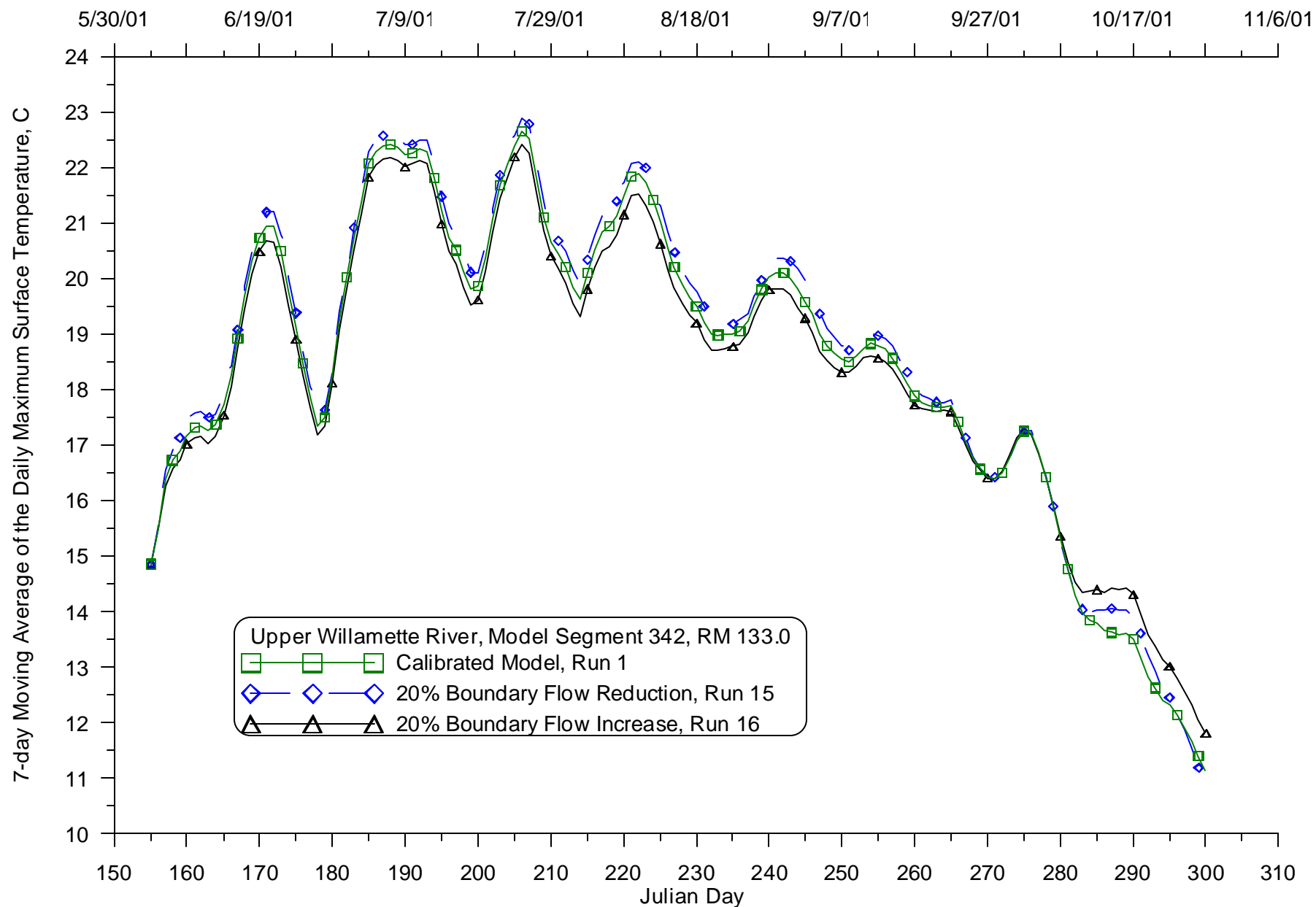


Figure 485: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 149.4



**Figure 486: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 133**

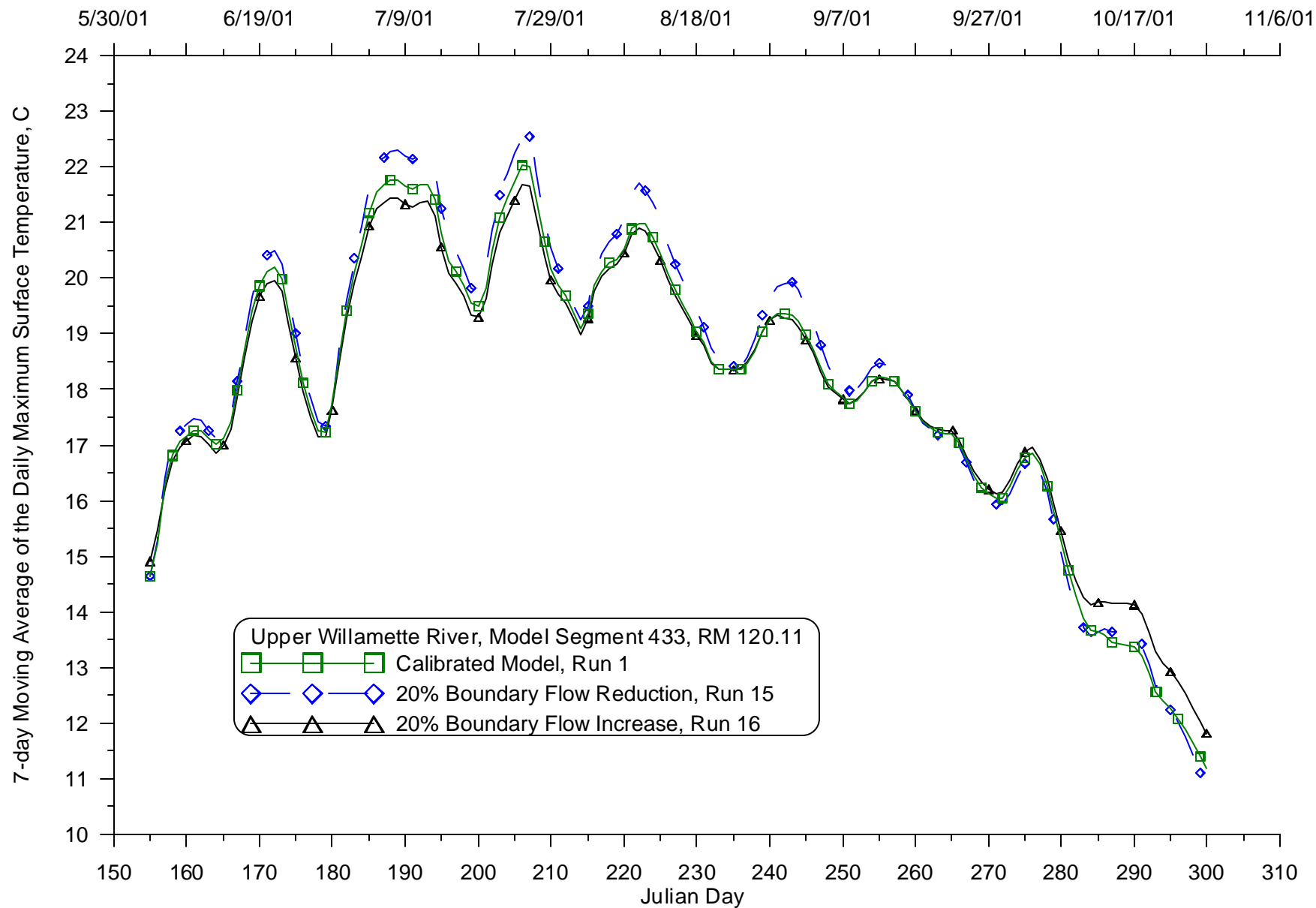


Figure 487: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 120.11

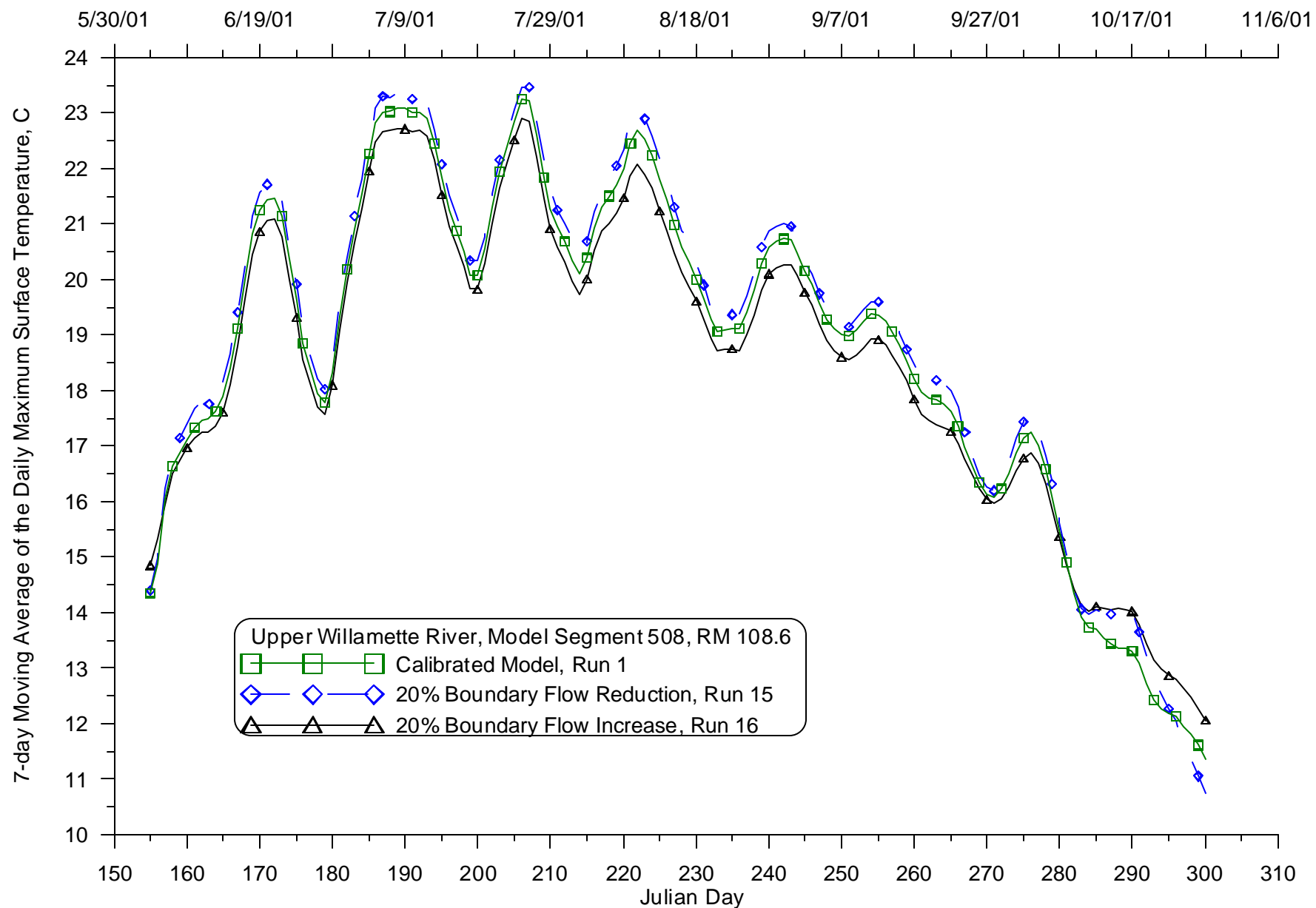
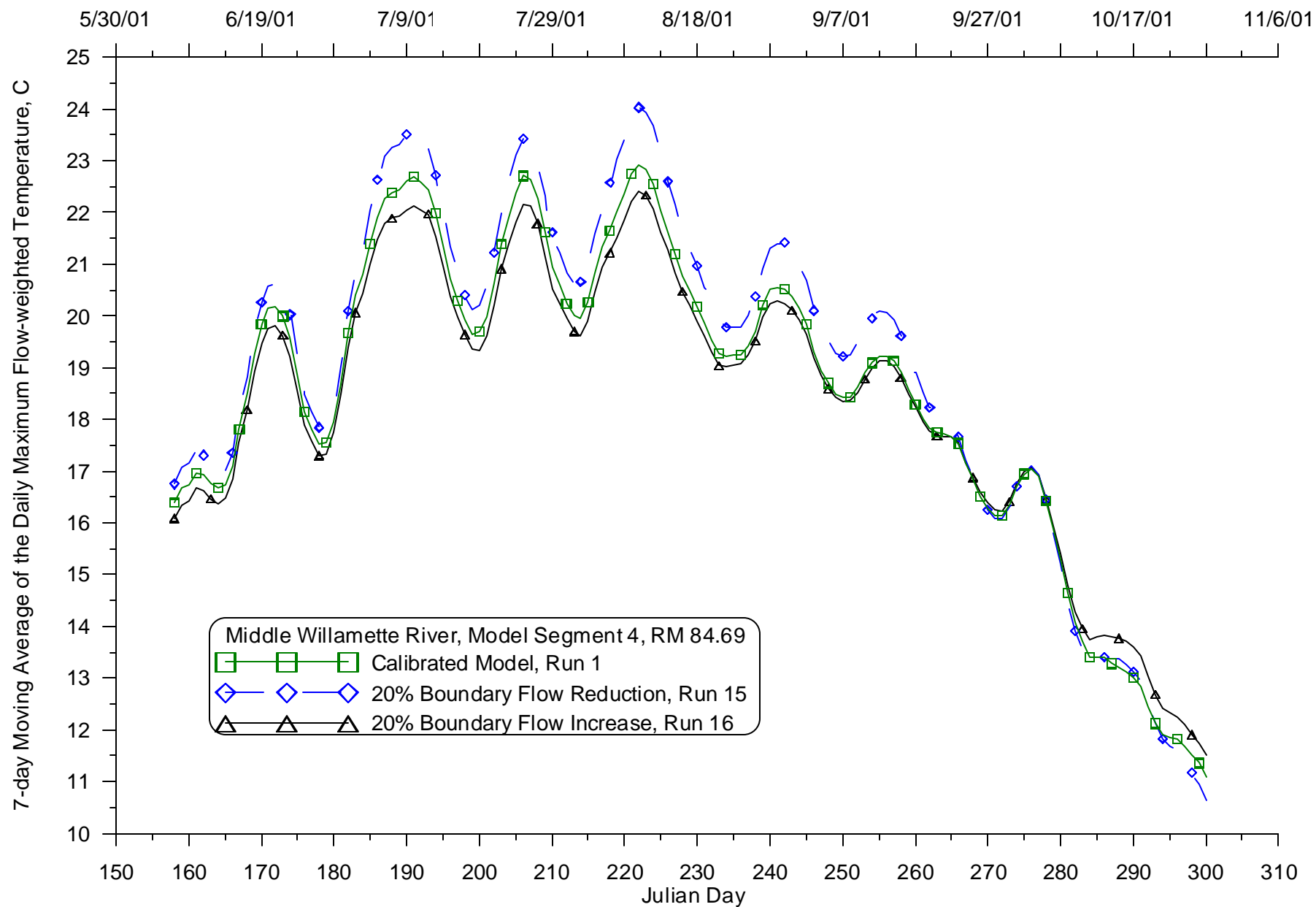
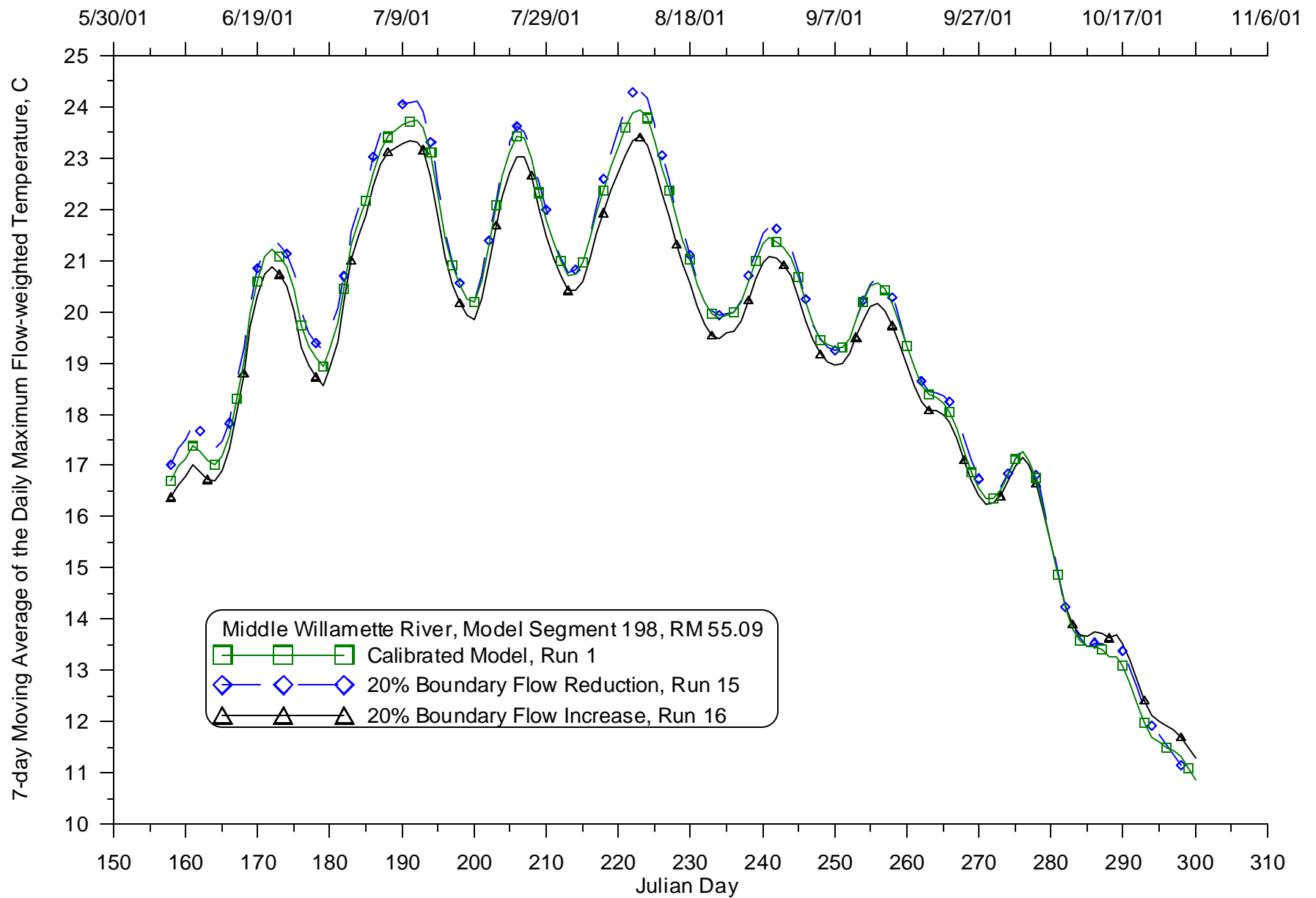


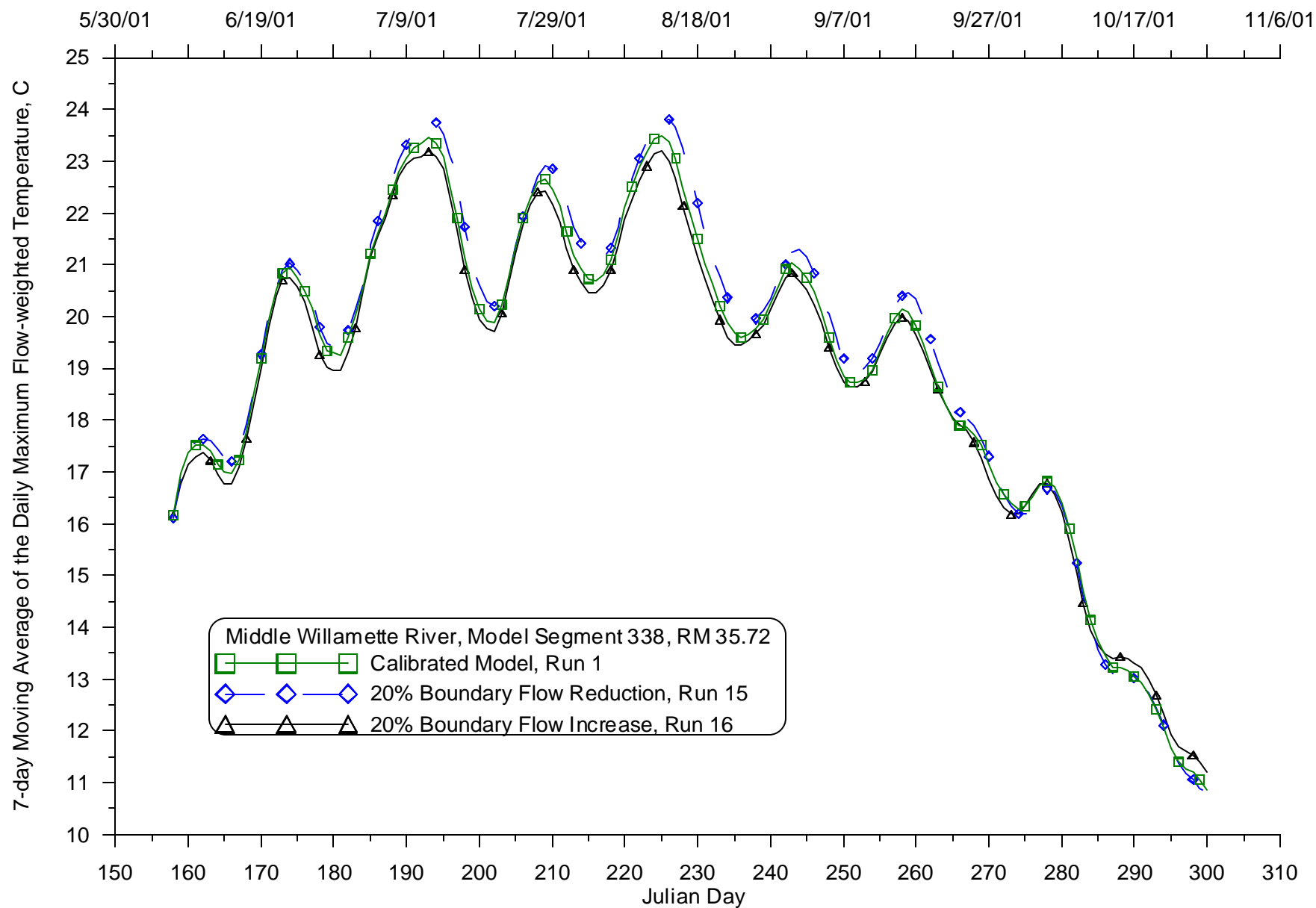
Figure 488: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 108.6



**Figure 489: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 84.69**



**Figure 490: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 55.09**



**Figure 491: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 35.72**

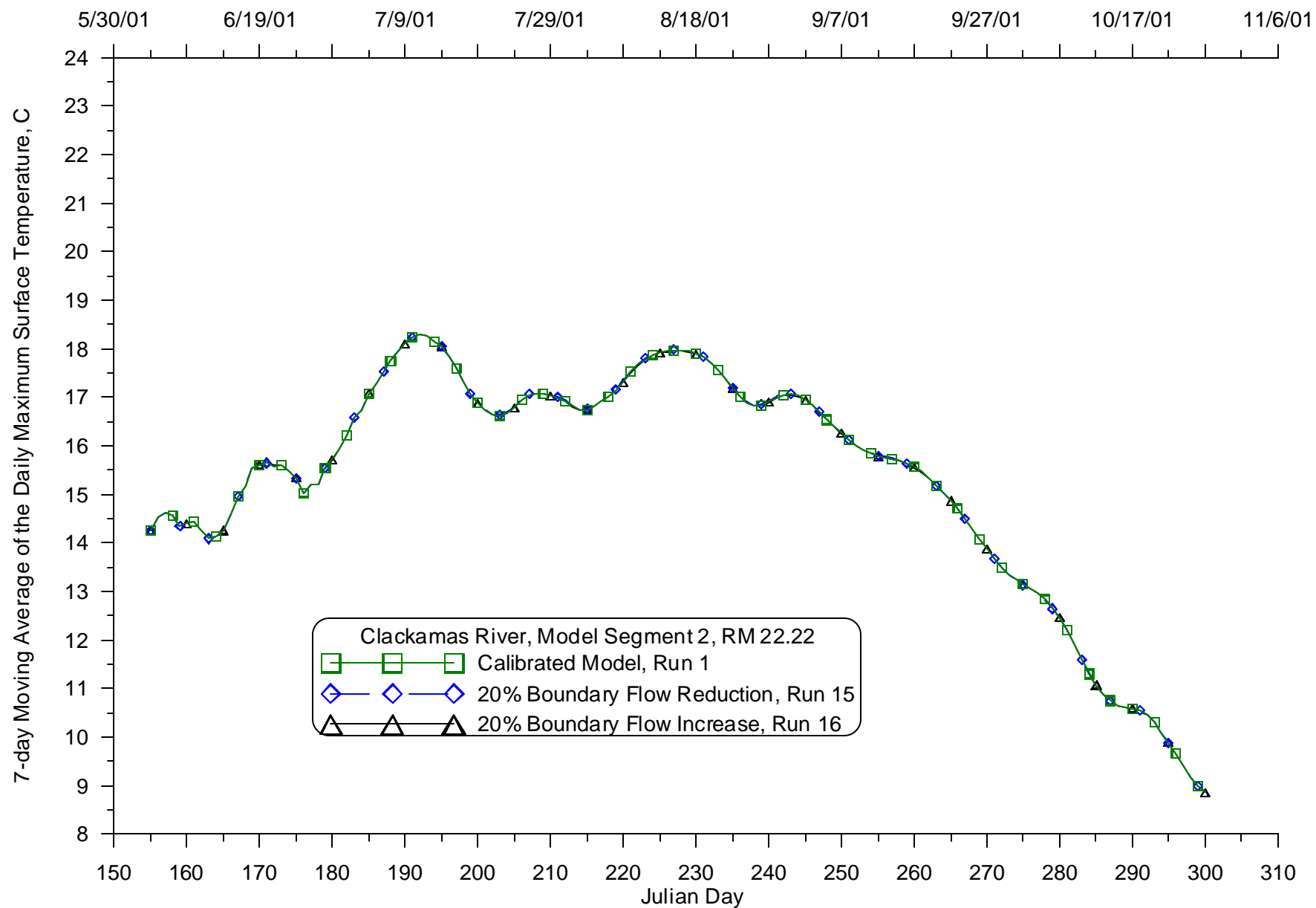
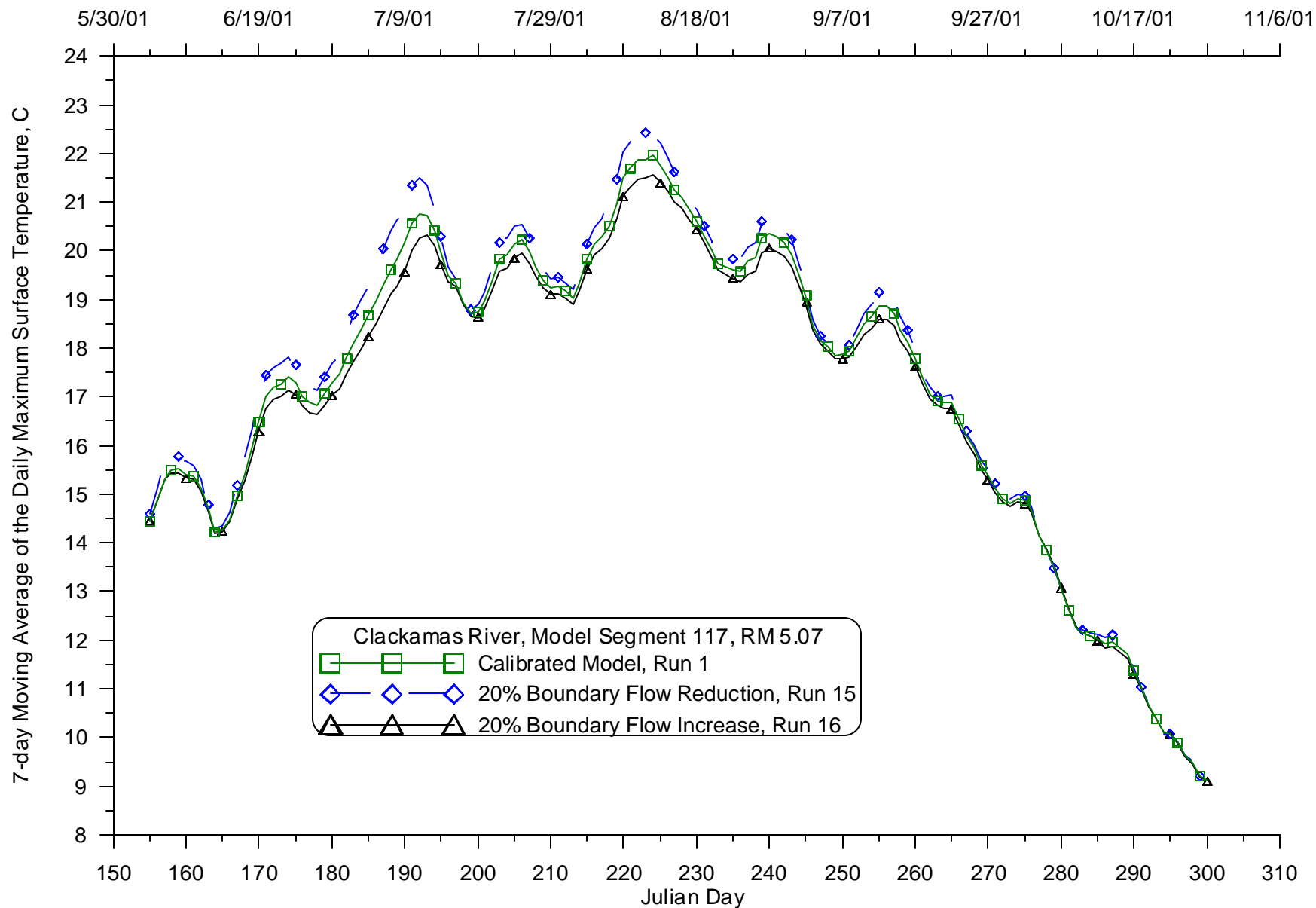
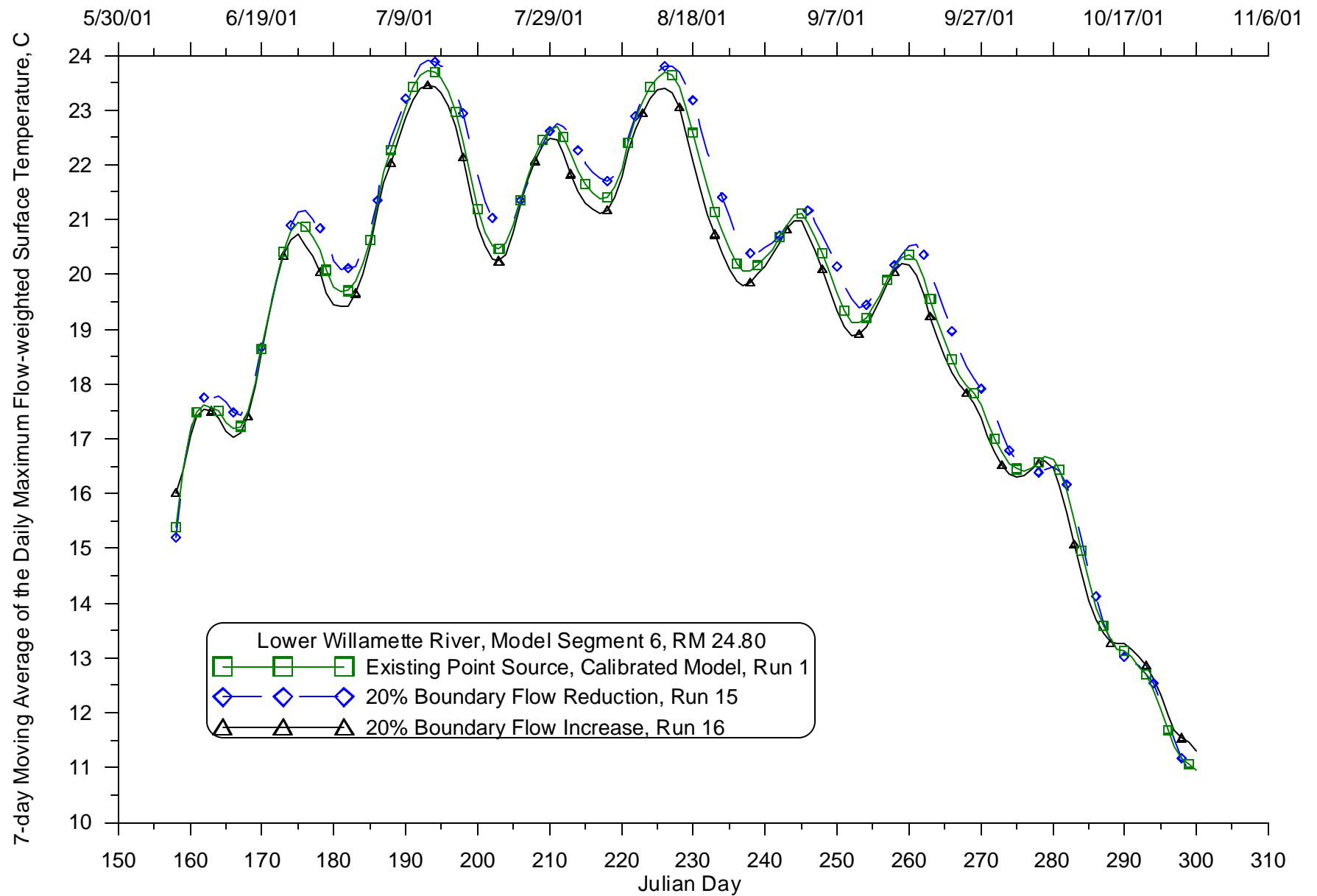


Figure 492: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Clackamas River at RM 22.22





**Figure 493: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Clackamas River at RM 5.07**



**Figure 494: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 24.8**

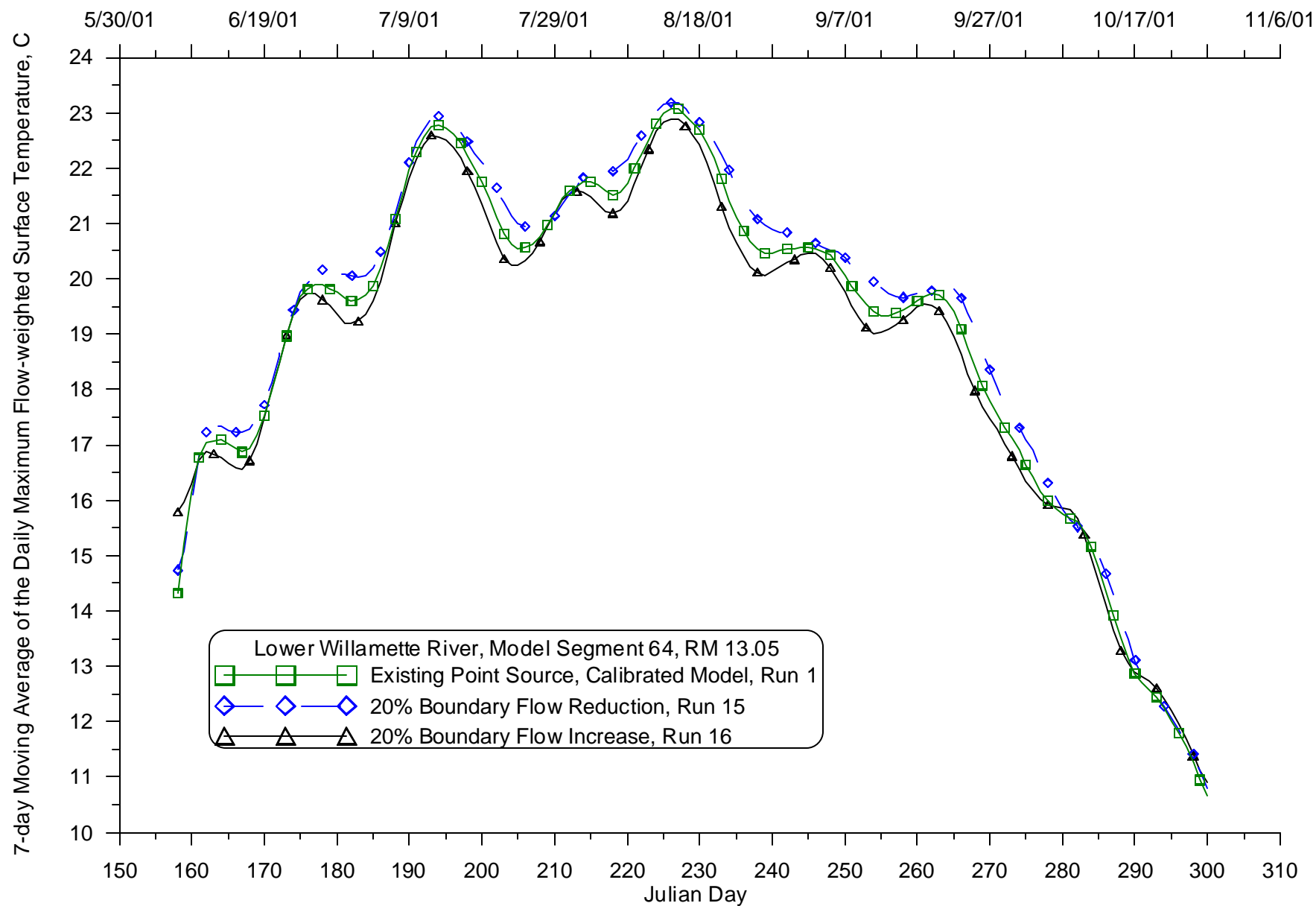
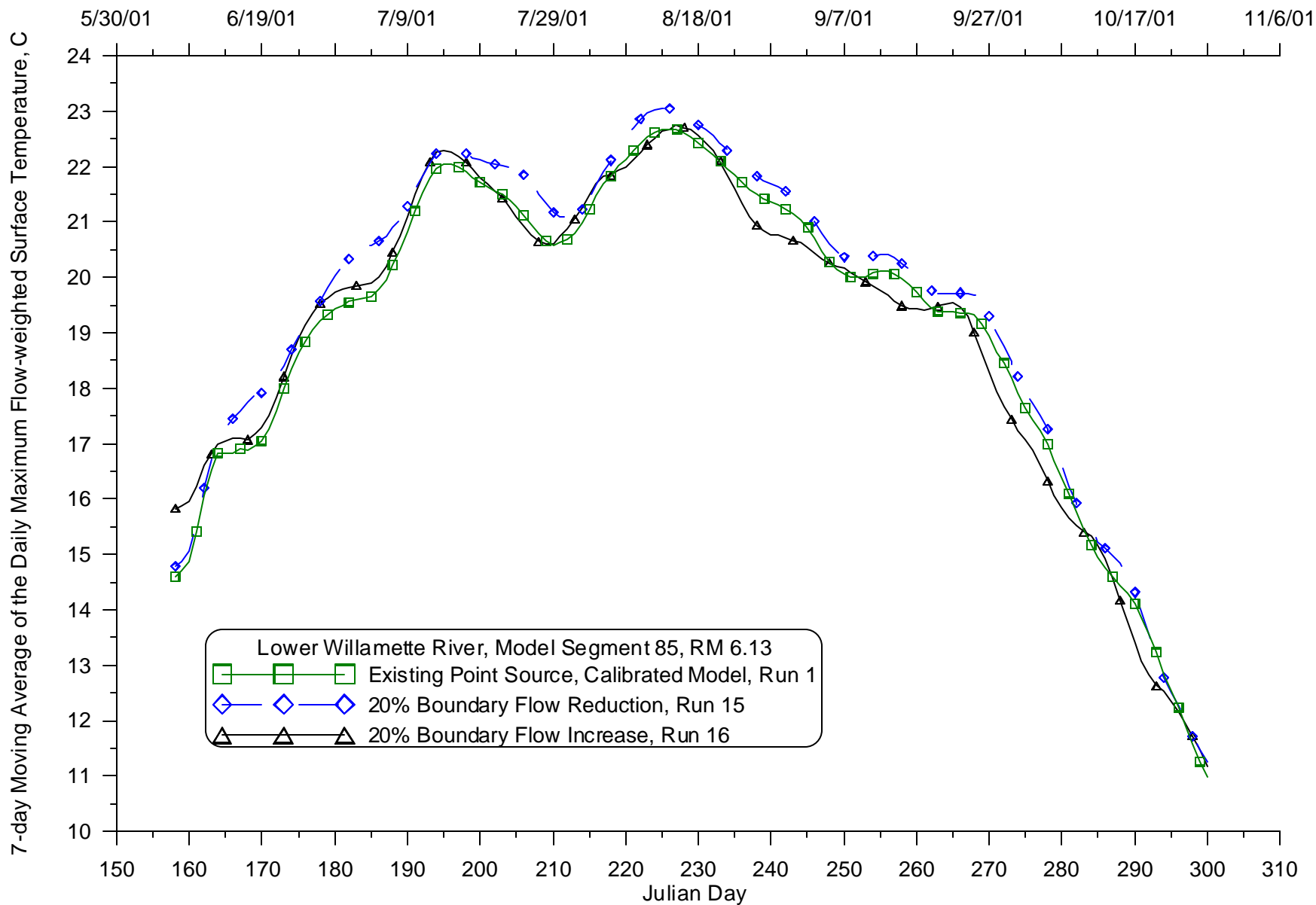


Figure 495: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 13.05



**Figure 496: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily maximum temperature for 2001 for the Willamette River at RM 6.13**

**Daily seven day average flow**

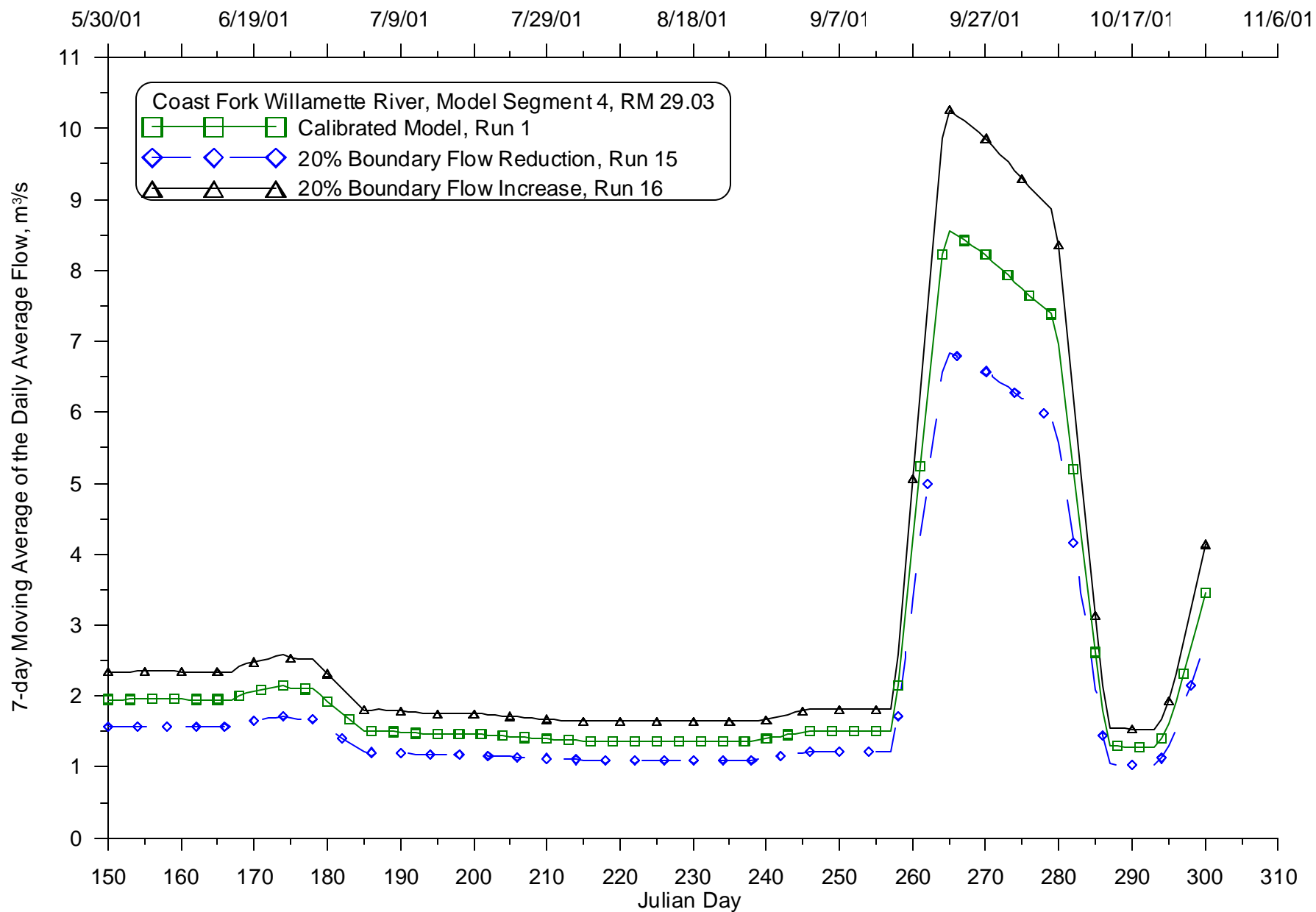
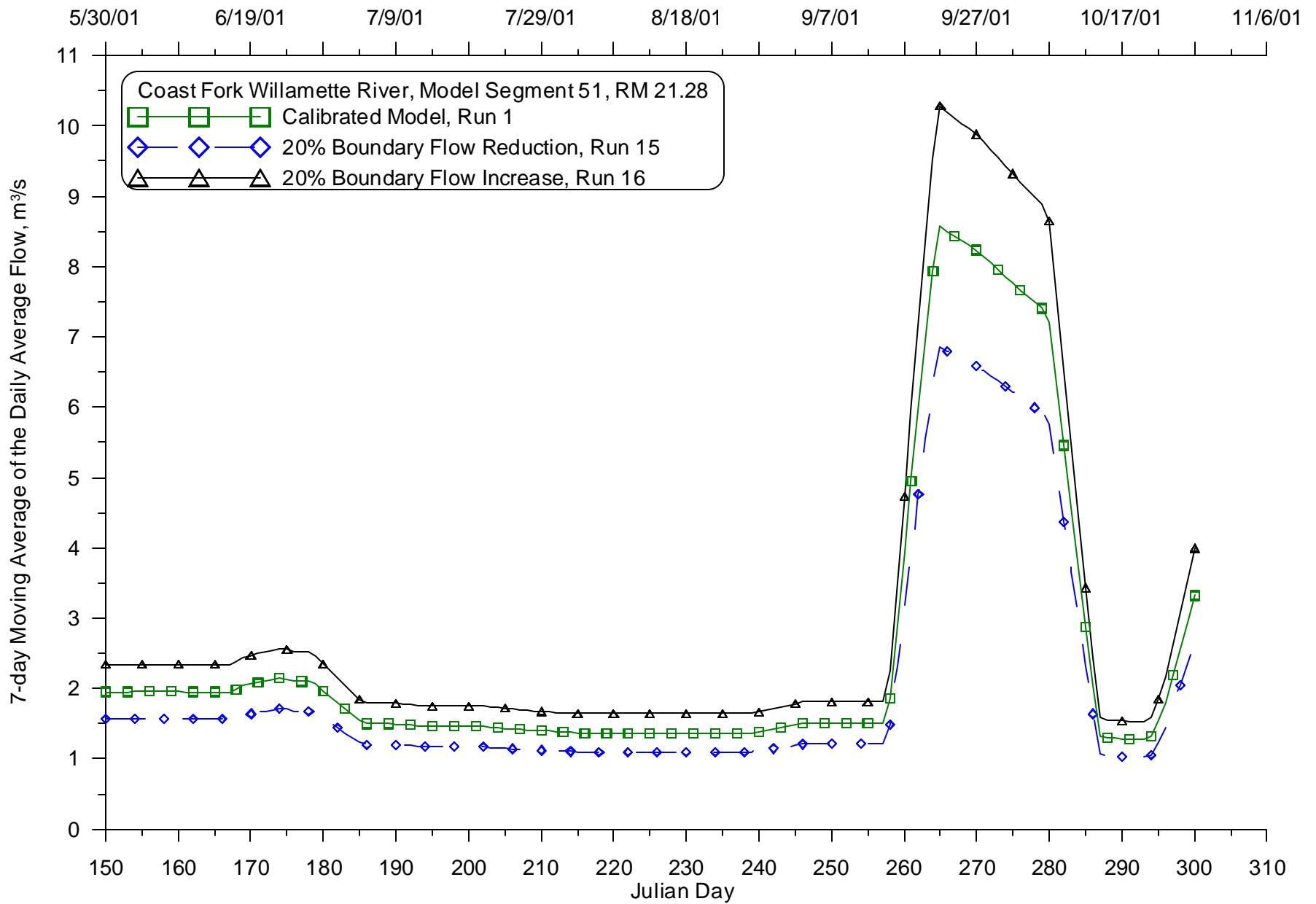


Figure 497: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 29.03



**Figure 498: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 21.28**

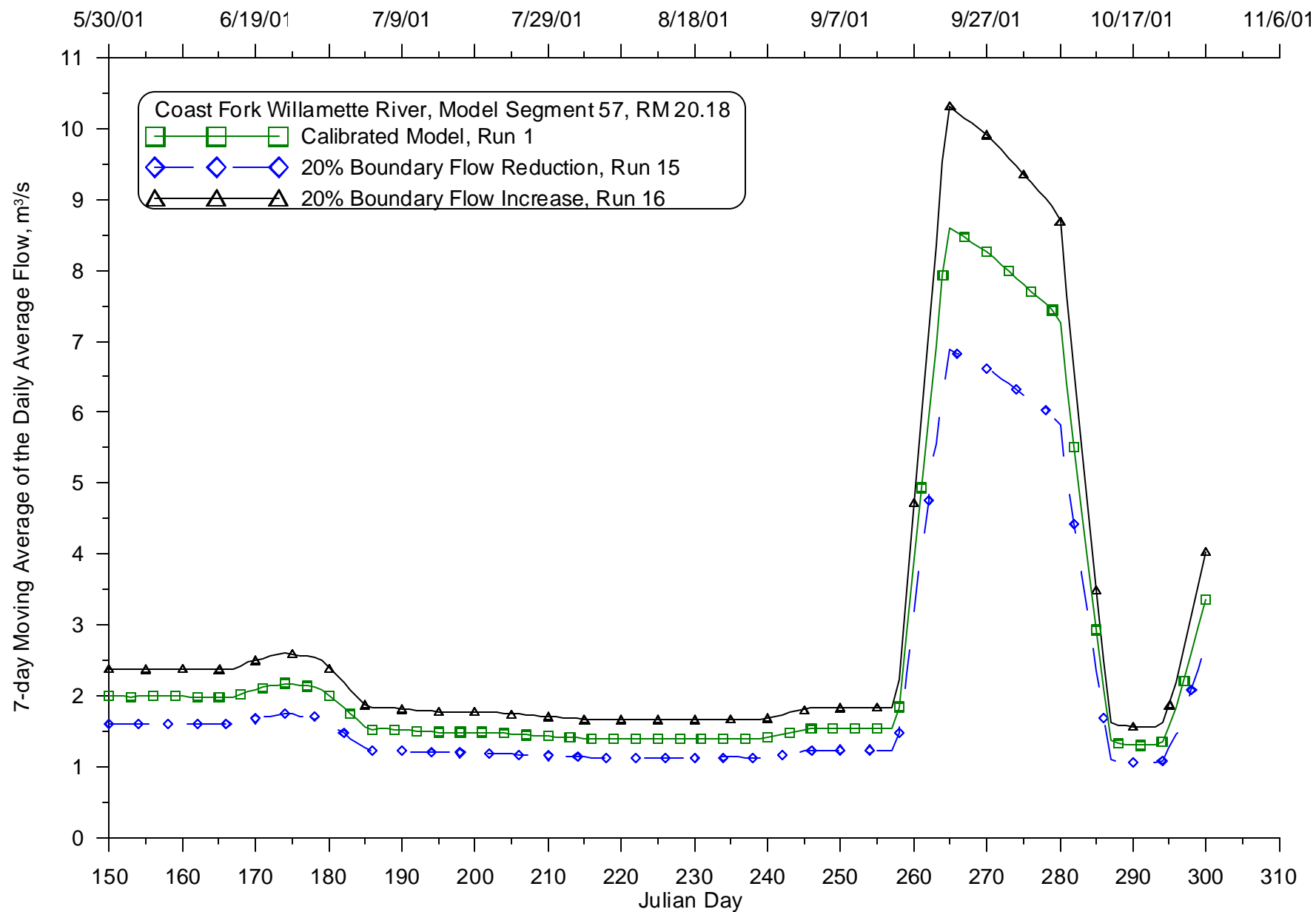


Figure 499: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 20.18



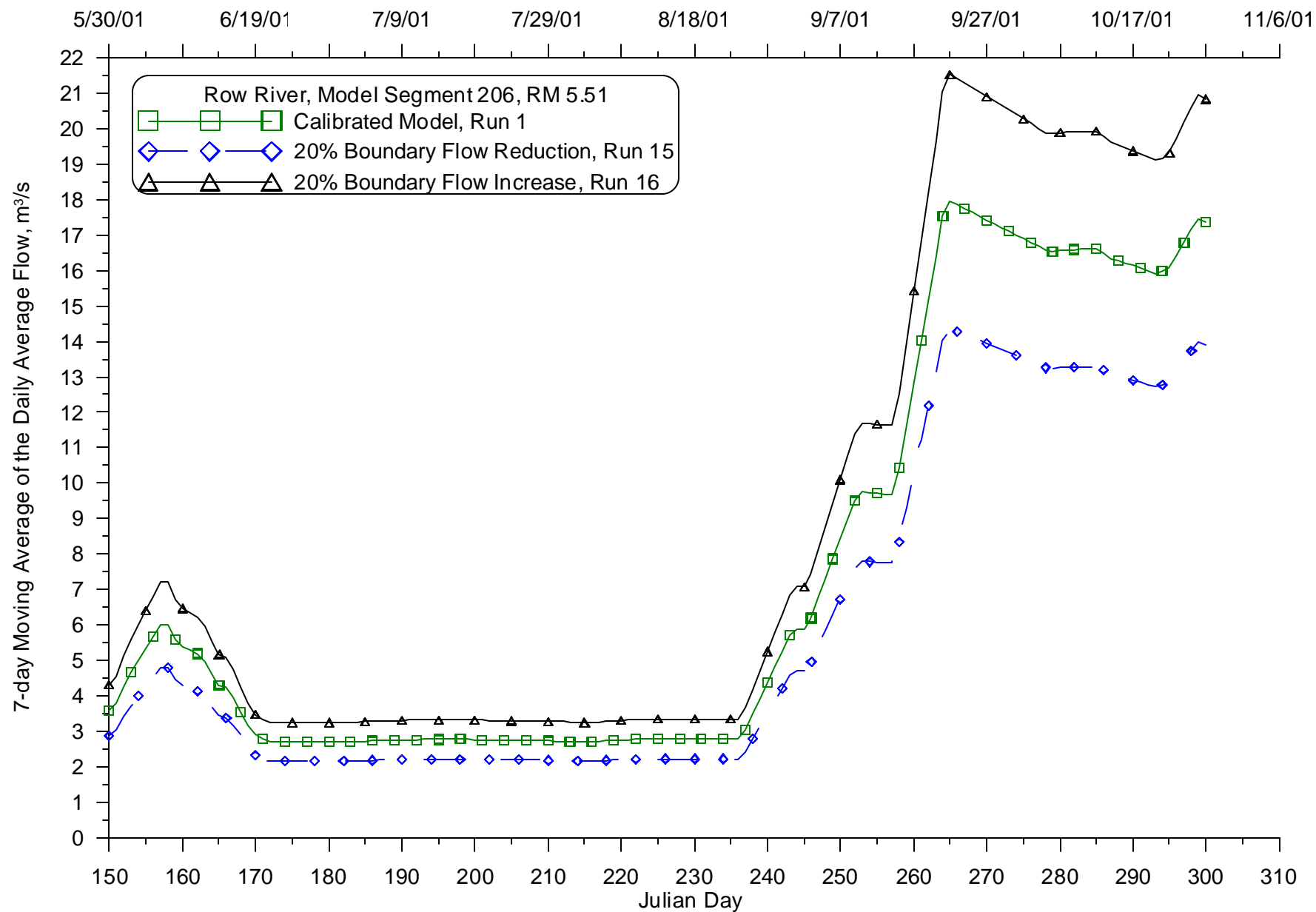
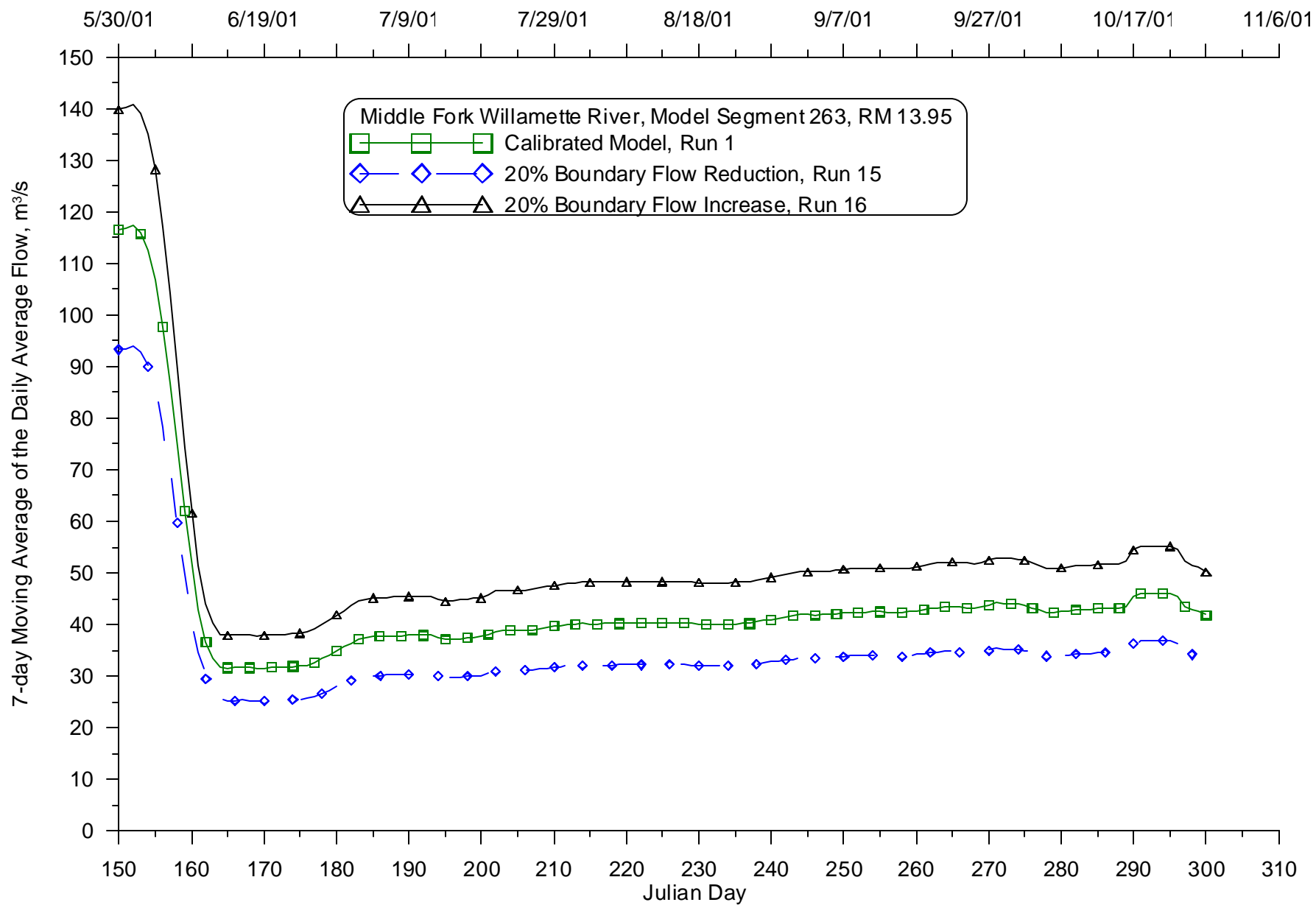
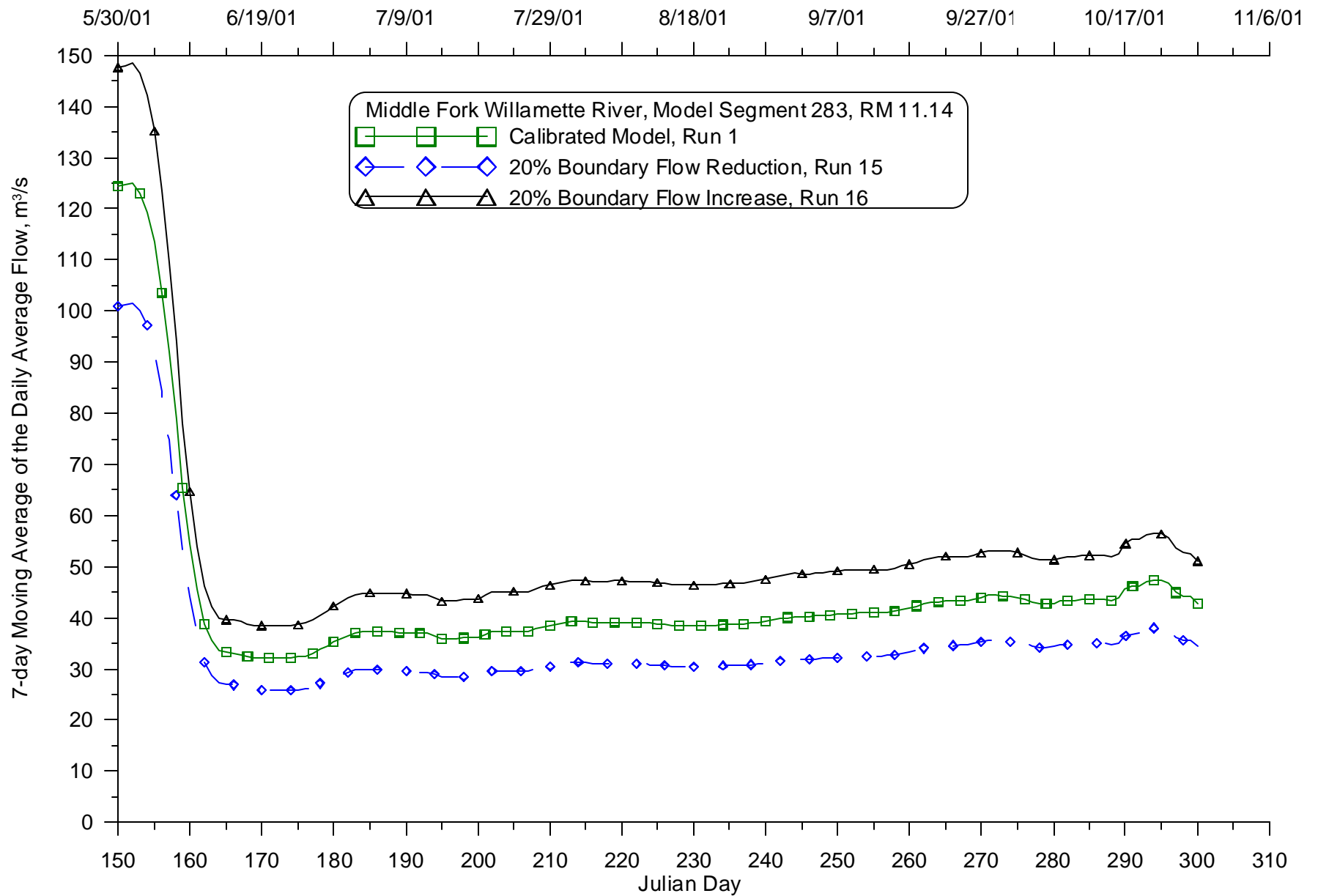


Figure 500: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Row River at RM 5.51



**Figure 501: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 502: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Middle Fork Willamette River at RM 11.14**

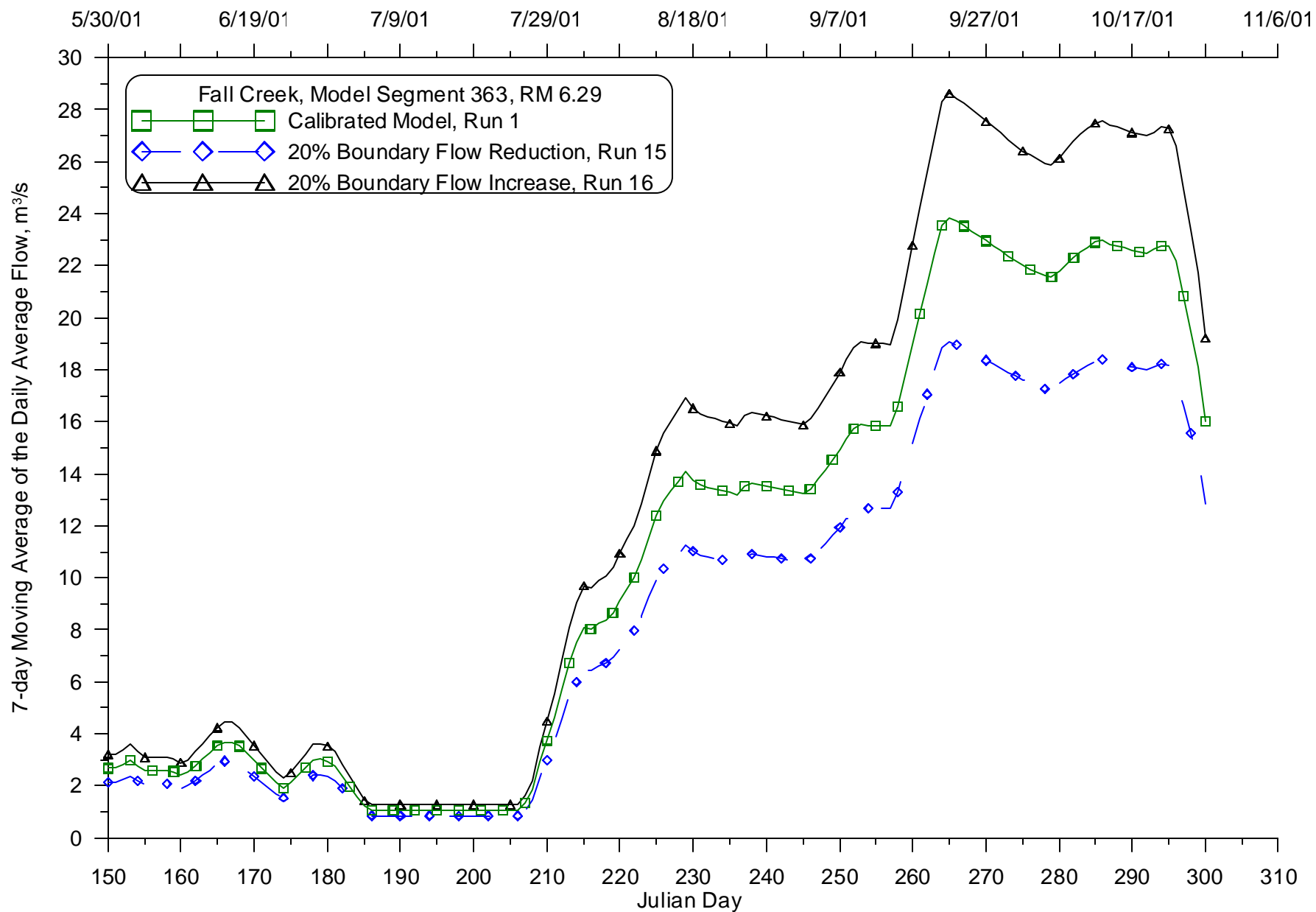
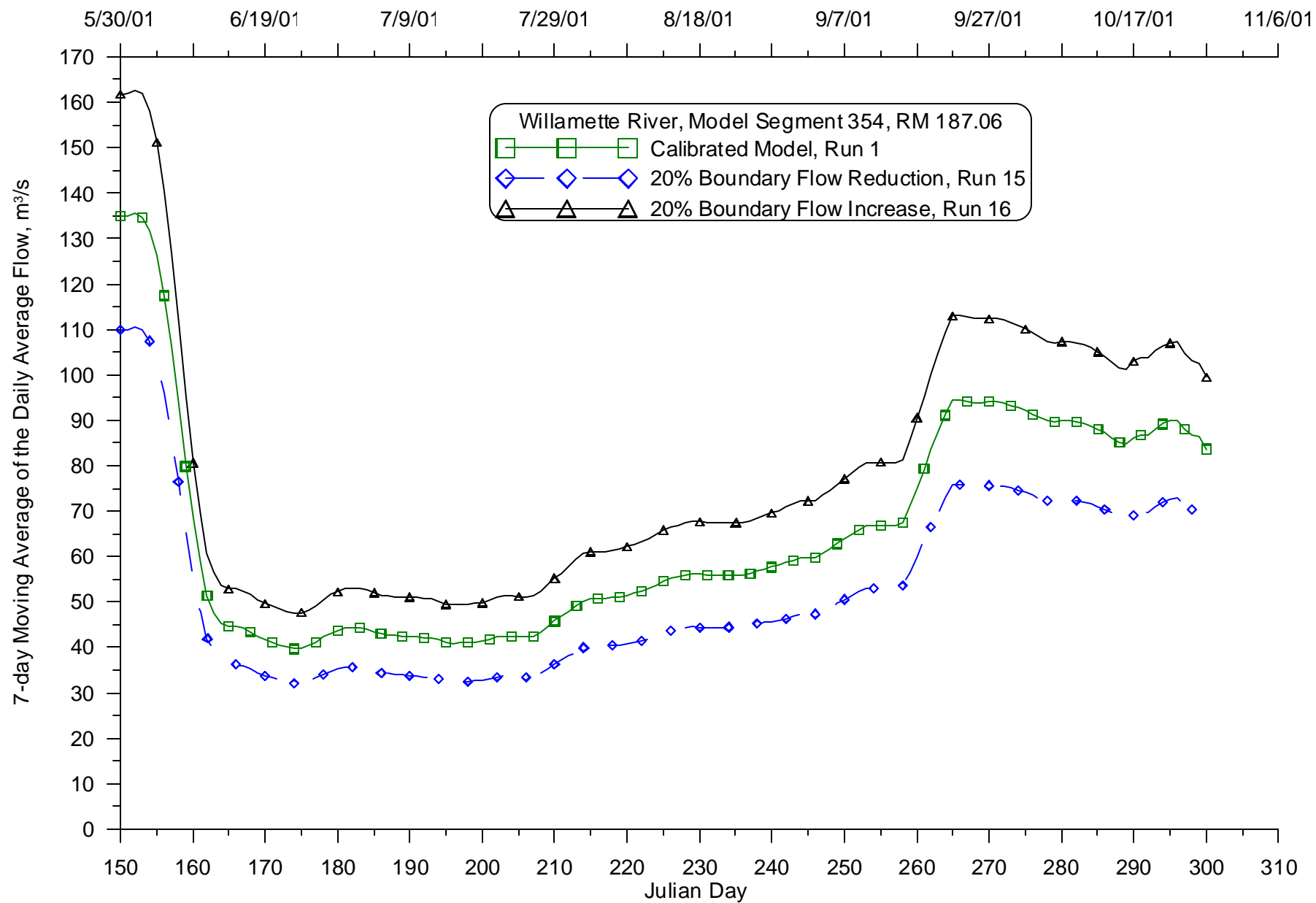


Figure 503: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for Fall Creek at RM 6.29



**Figure 504: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 187.06**

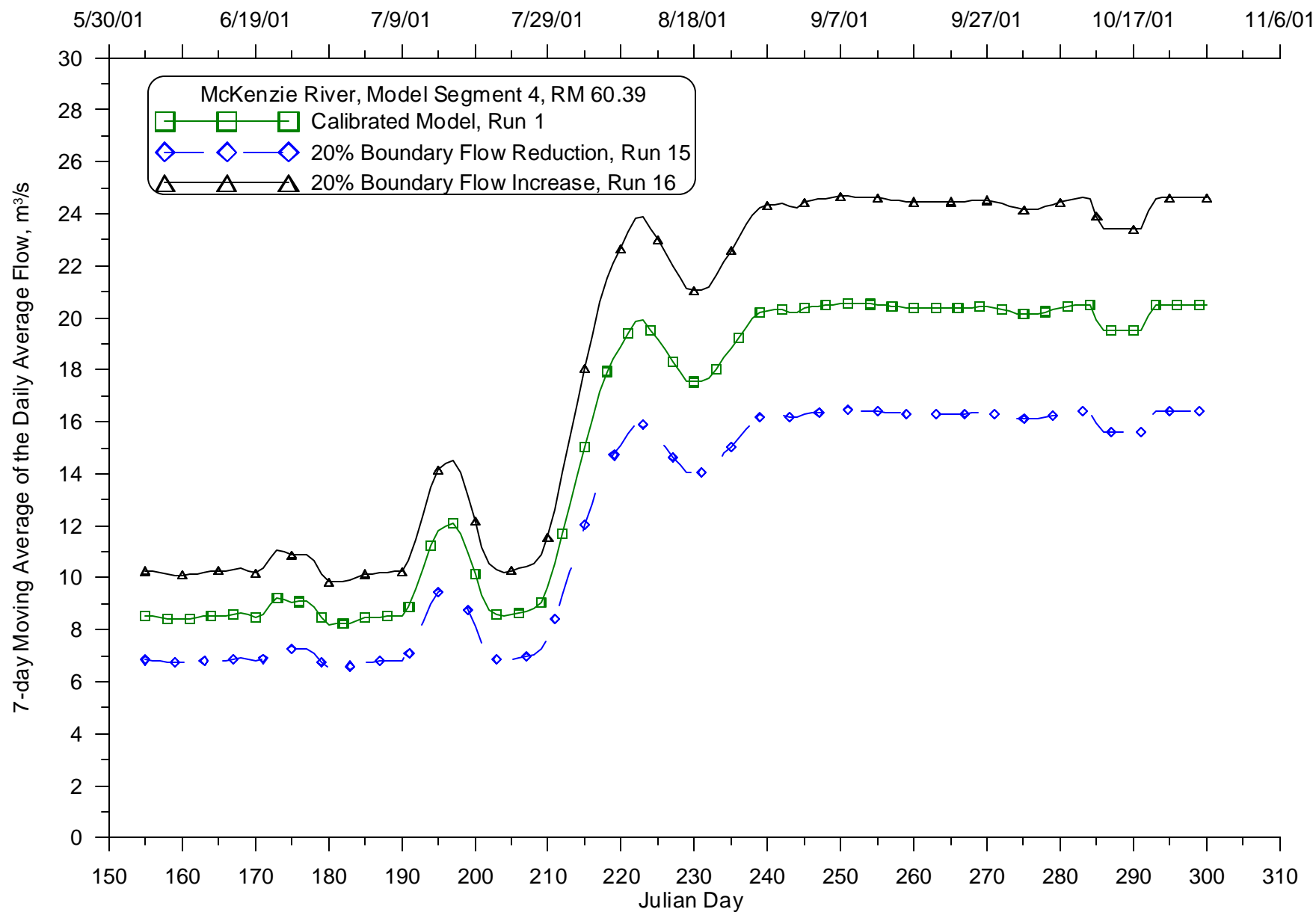
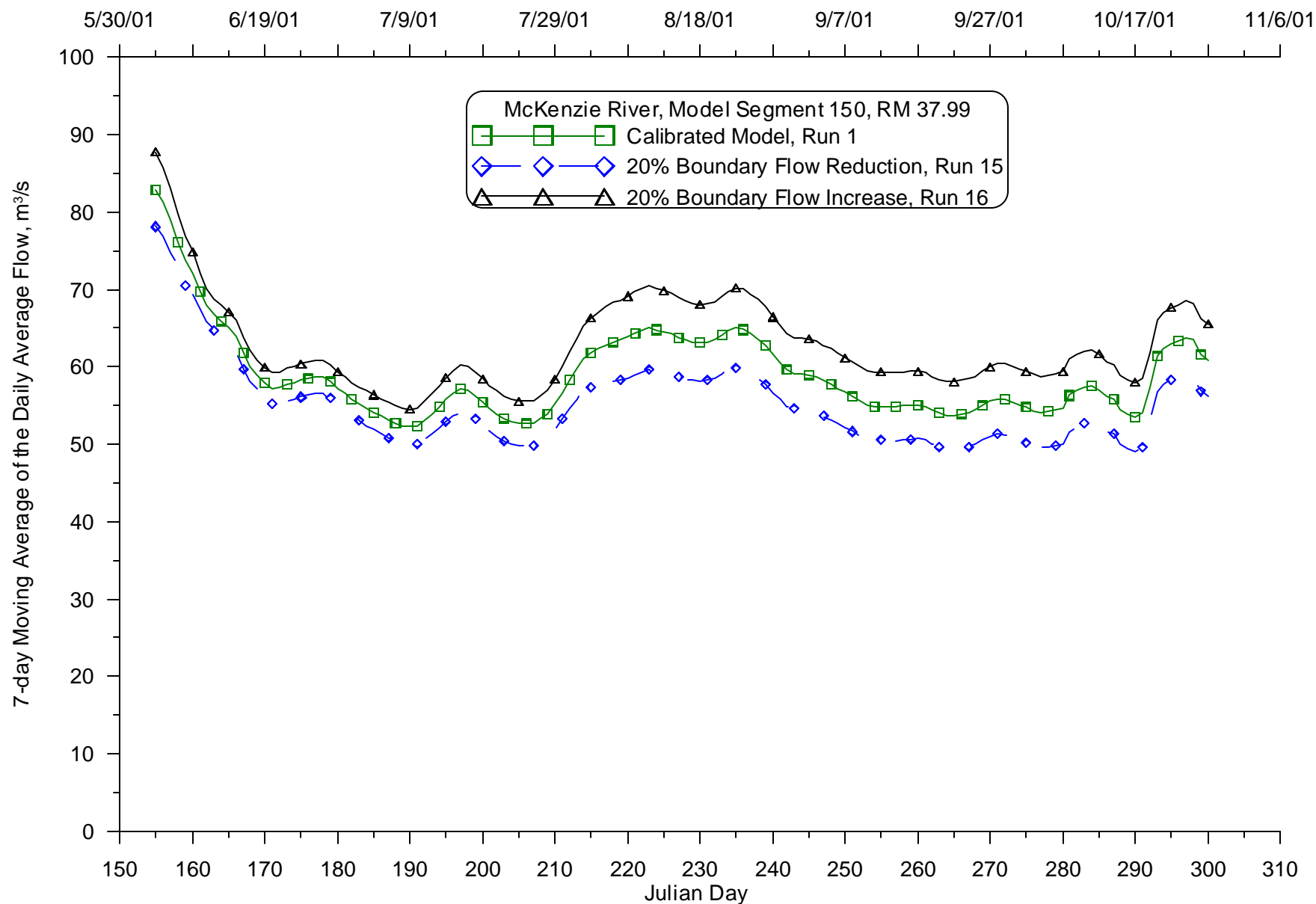


Figure 505: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the McKenzie River at RM 60.39



**Figure 506: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the McKenzie River at RM 37.99**

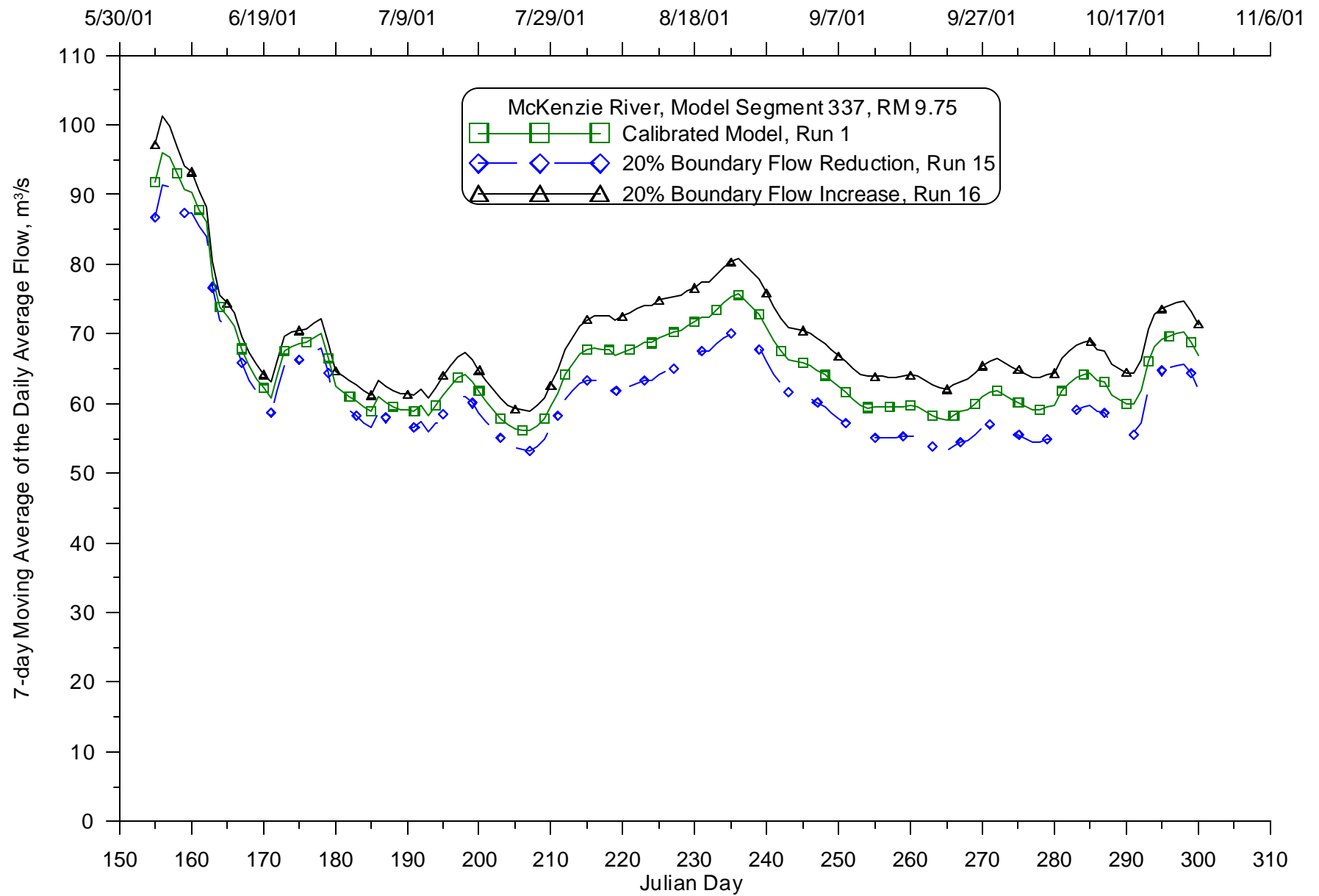


Figure 507: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the McKenzie River at RM 9.75



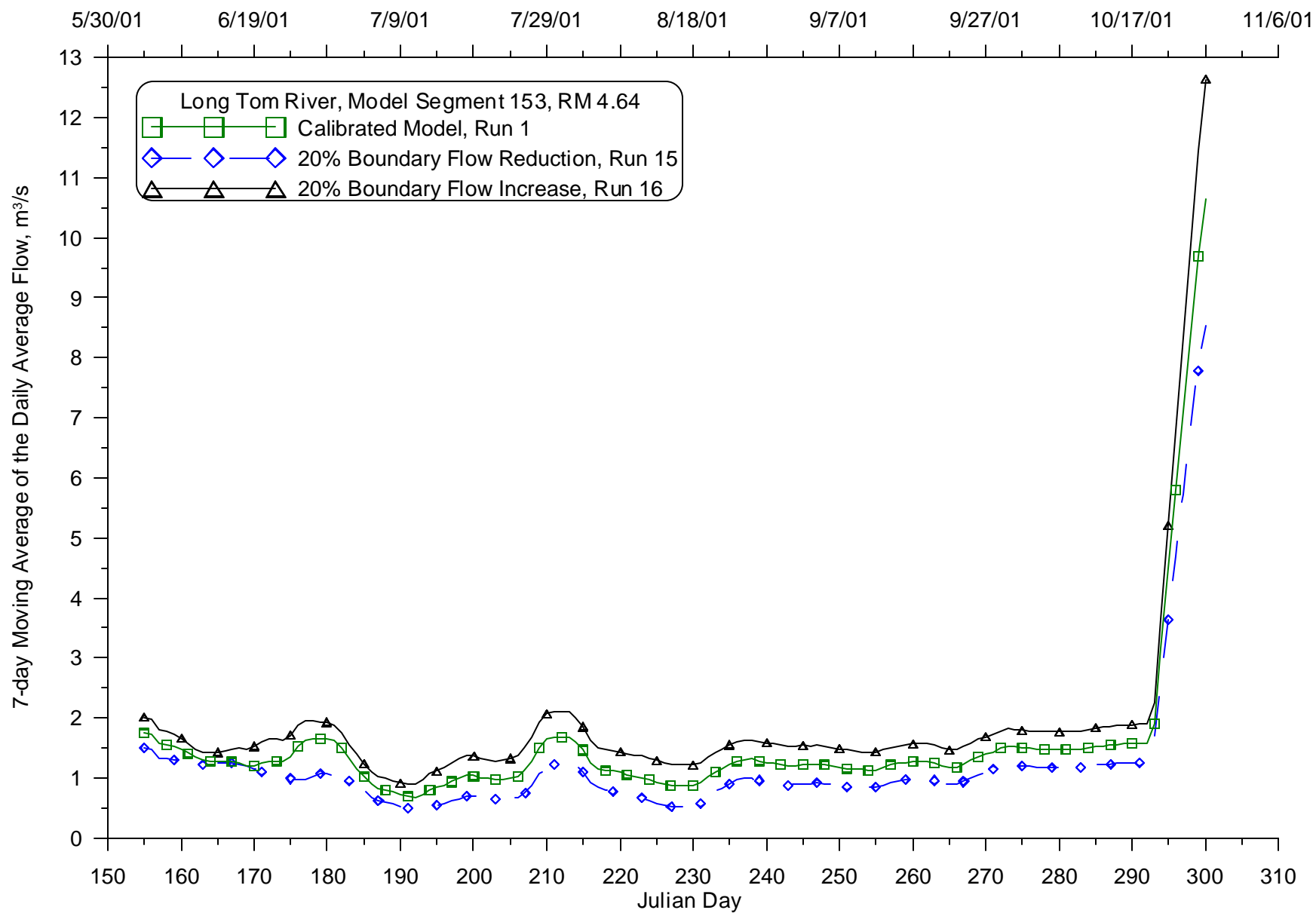
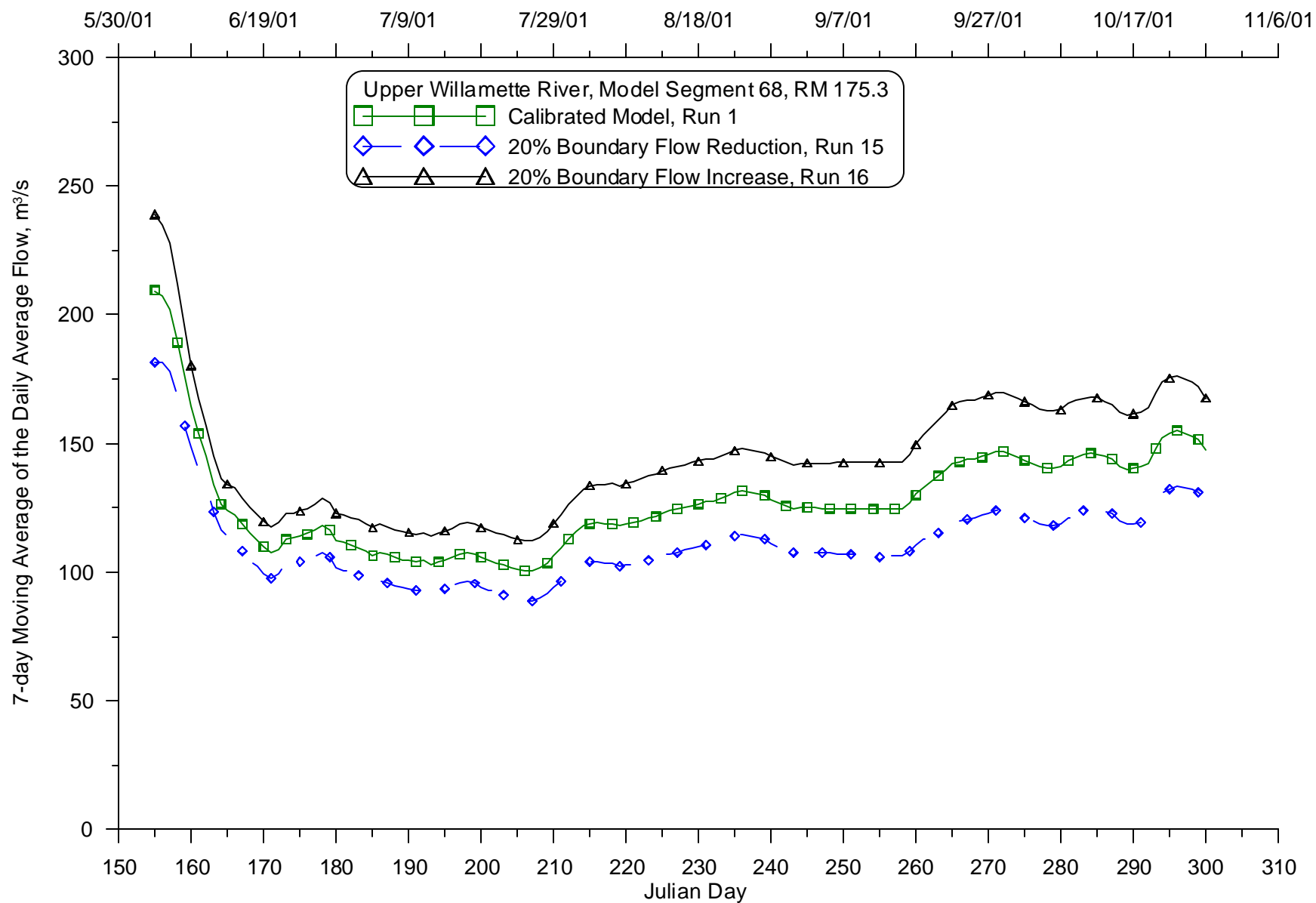
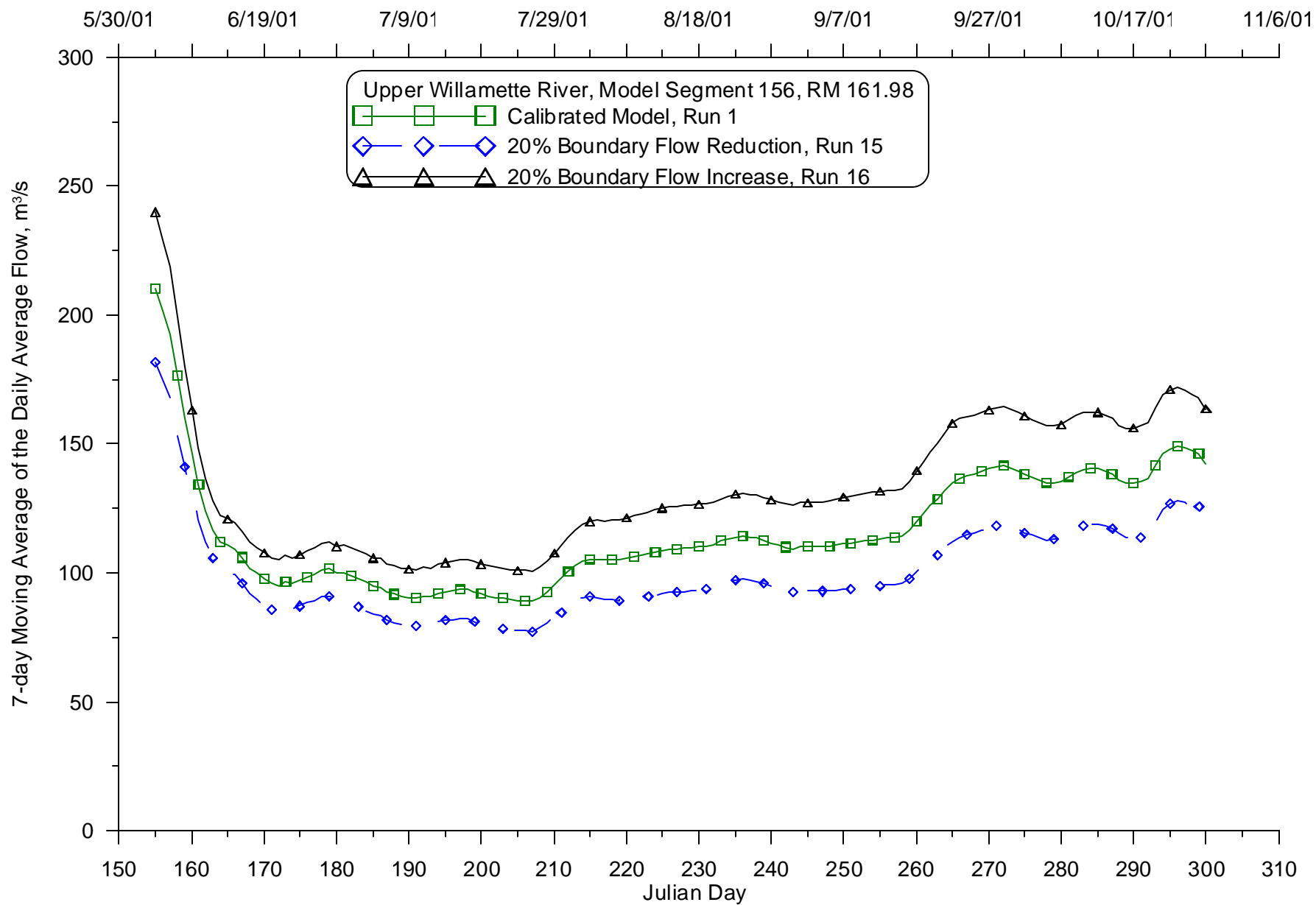


Figure 508: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Long Tom River at RM 4.64



**Figure 509: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 175.3**



**Figure 510: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 161.98**

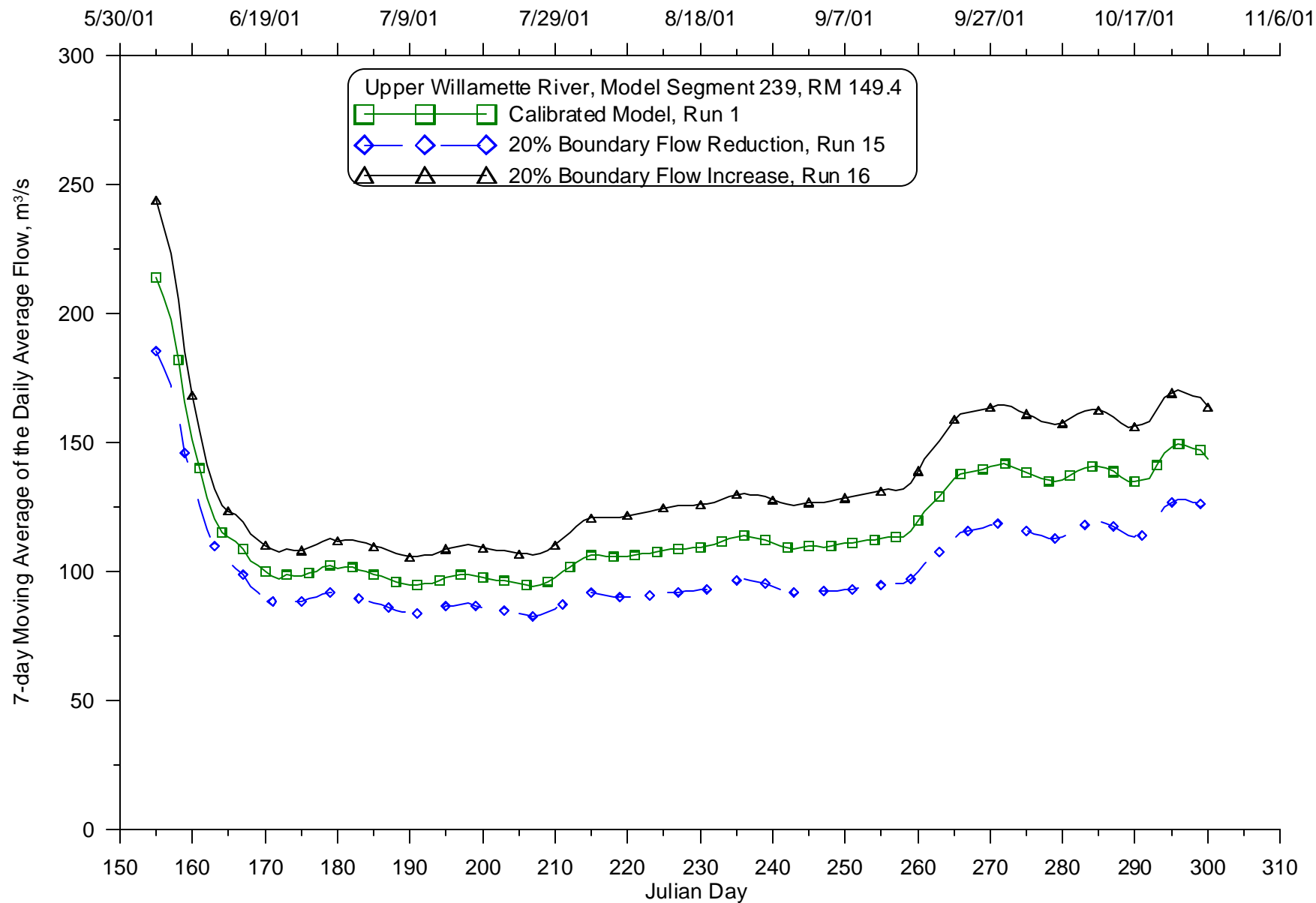
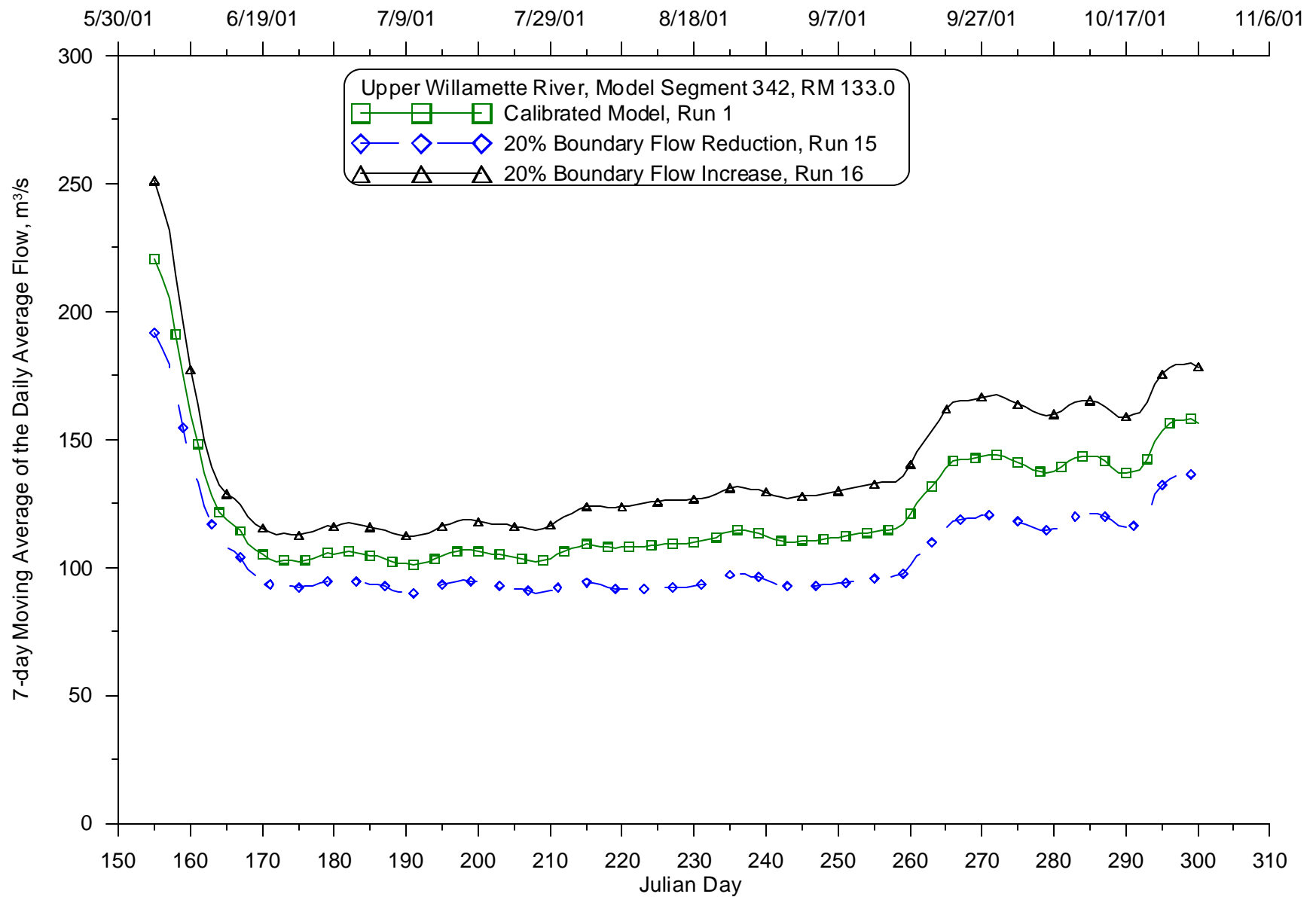


Figure 511: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 149.4



**Figure 512: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 133**

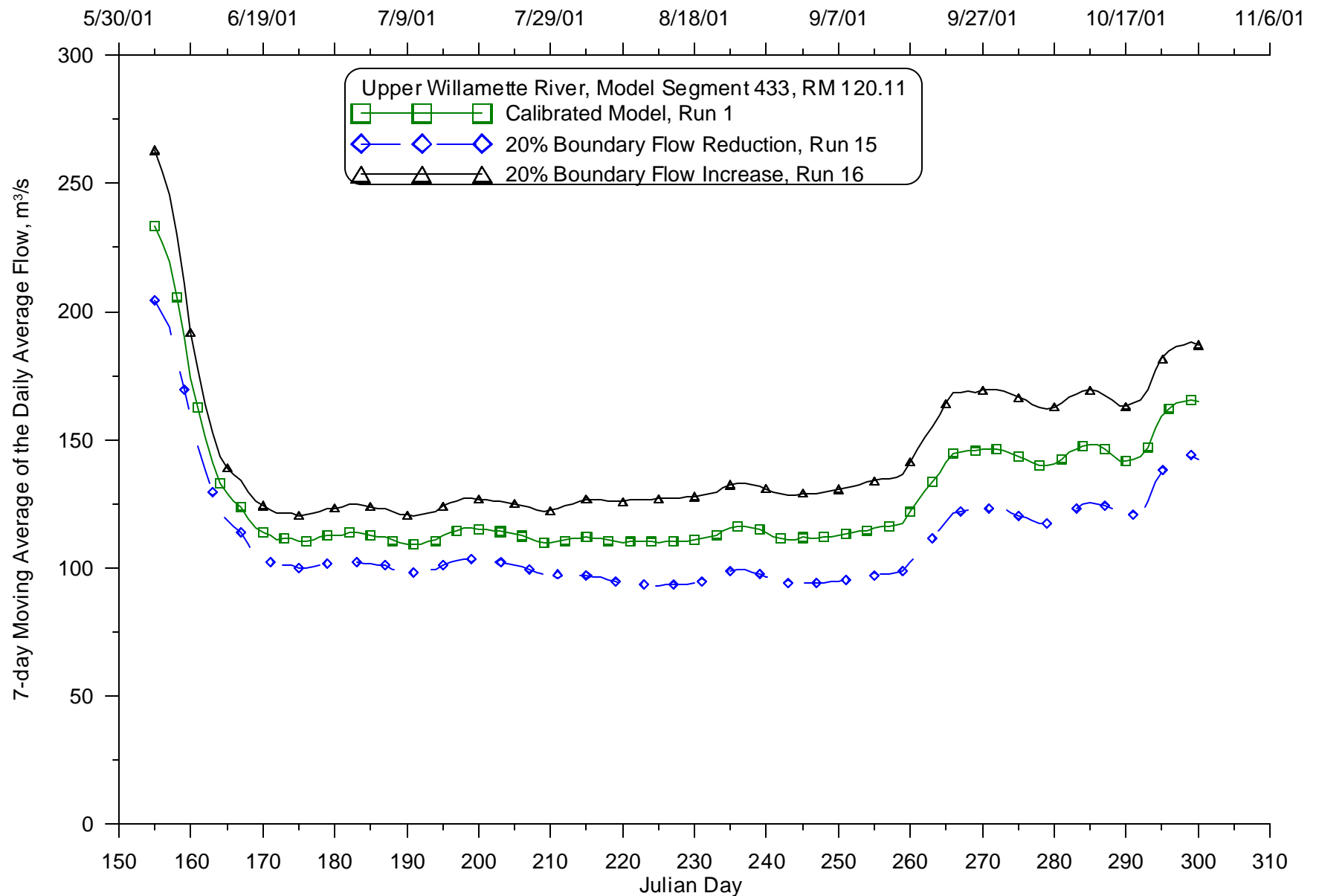


Figure 513: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 120.11

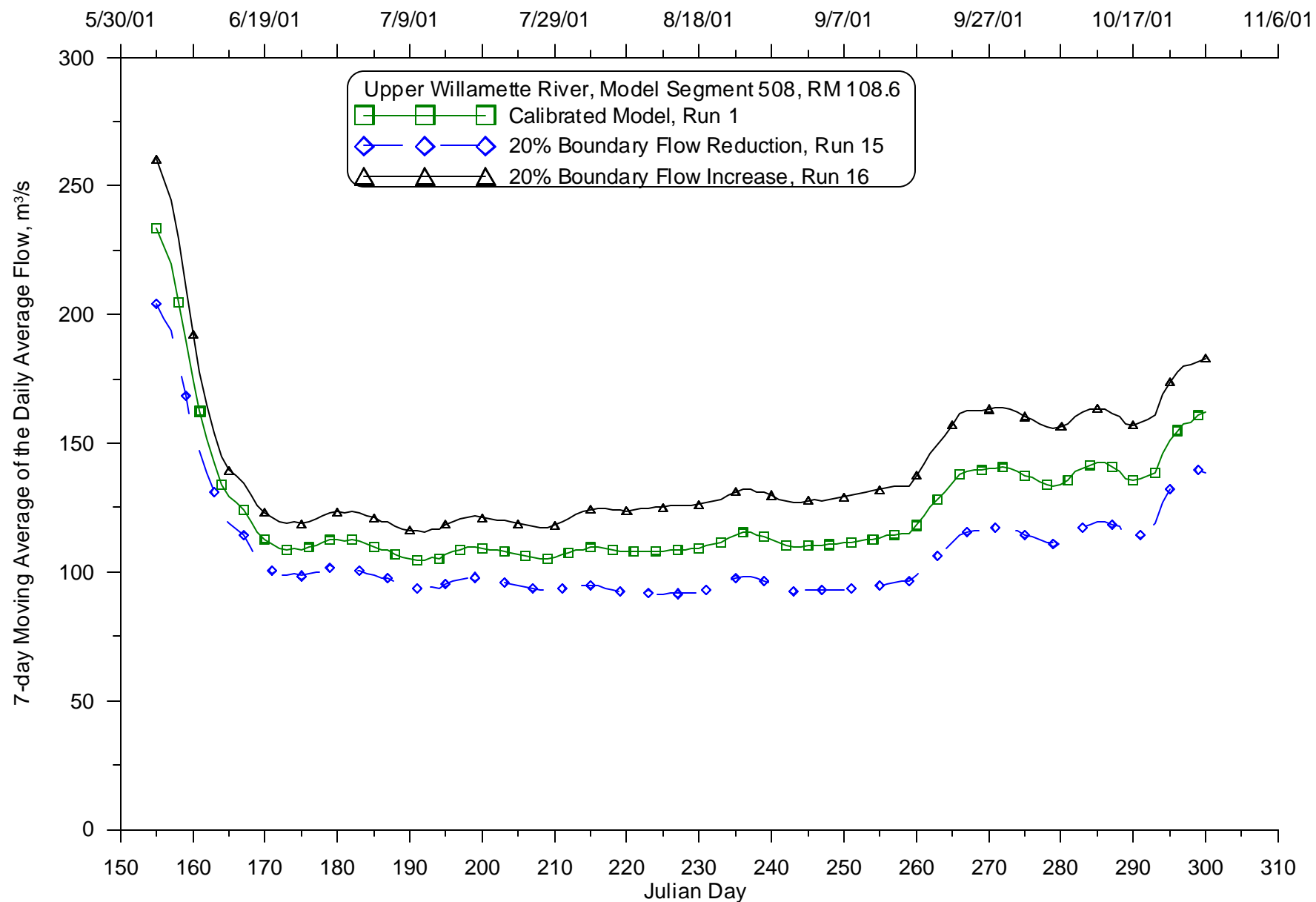
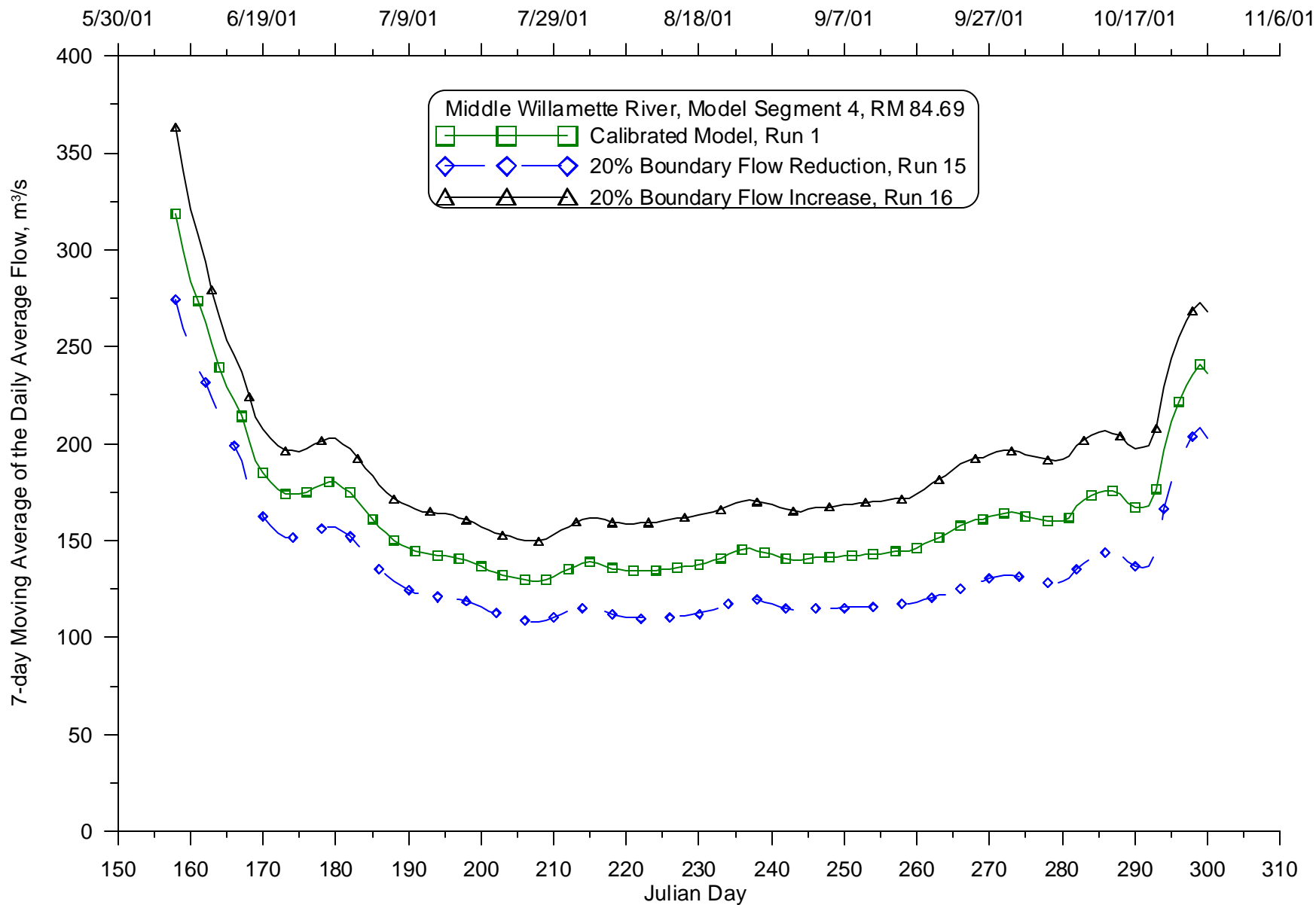
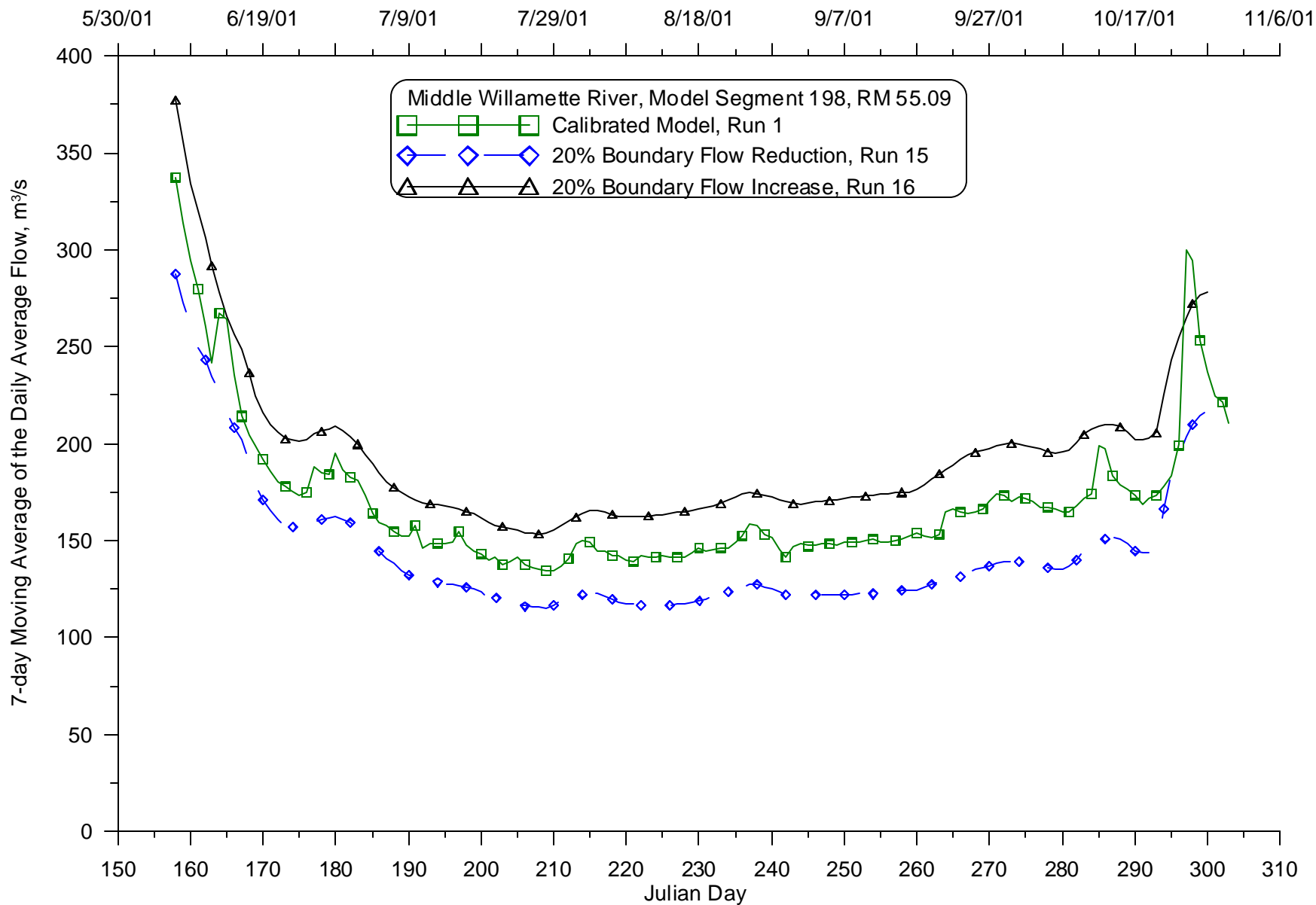


Figure 514: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 108.6



**Figure 515: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 84.69**





**Figure 516: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 55.09**

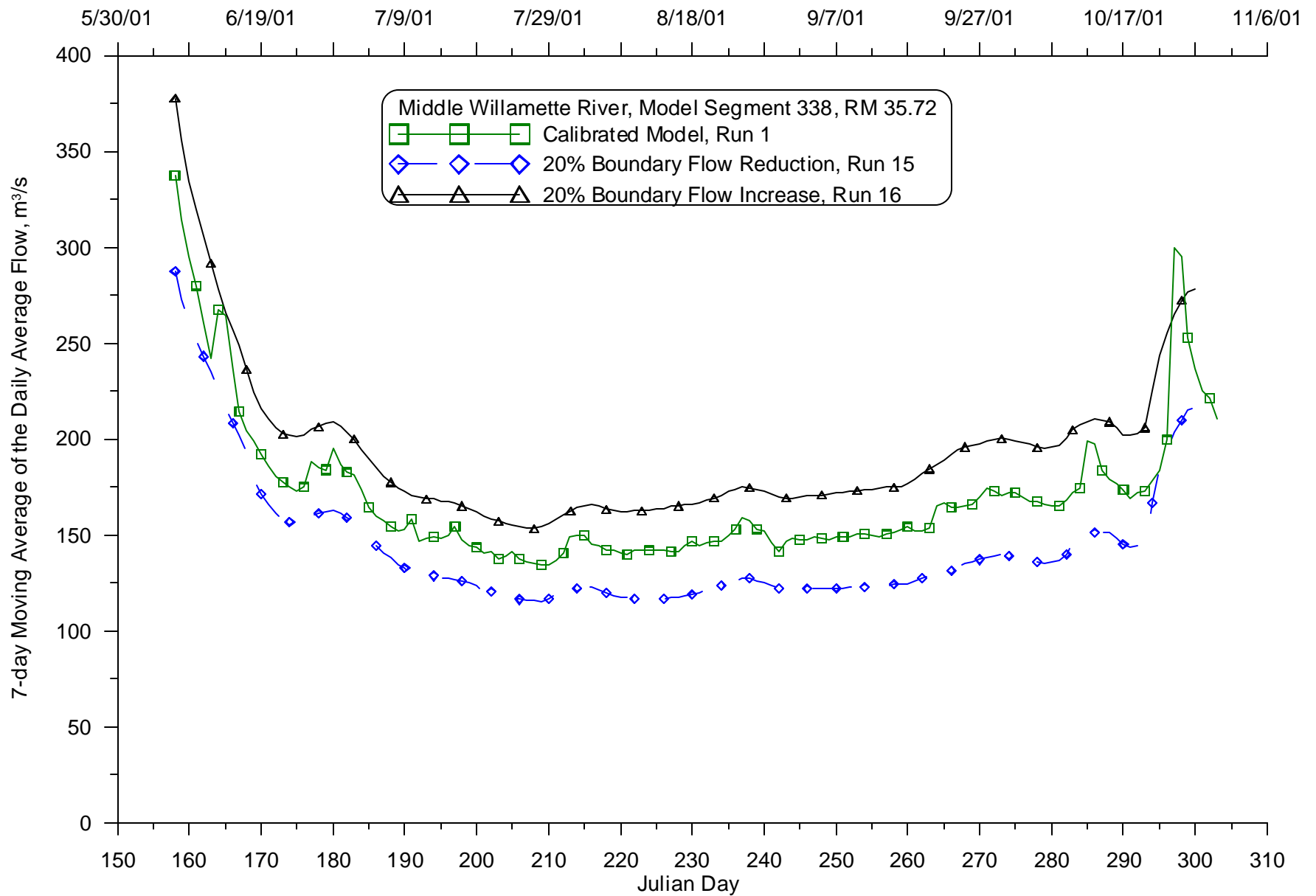


Figure 517: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 35.72

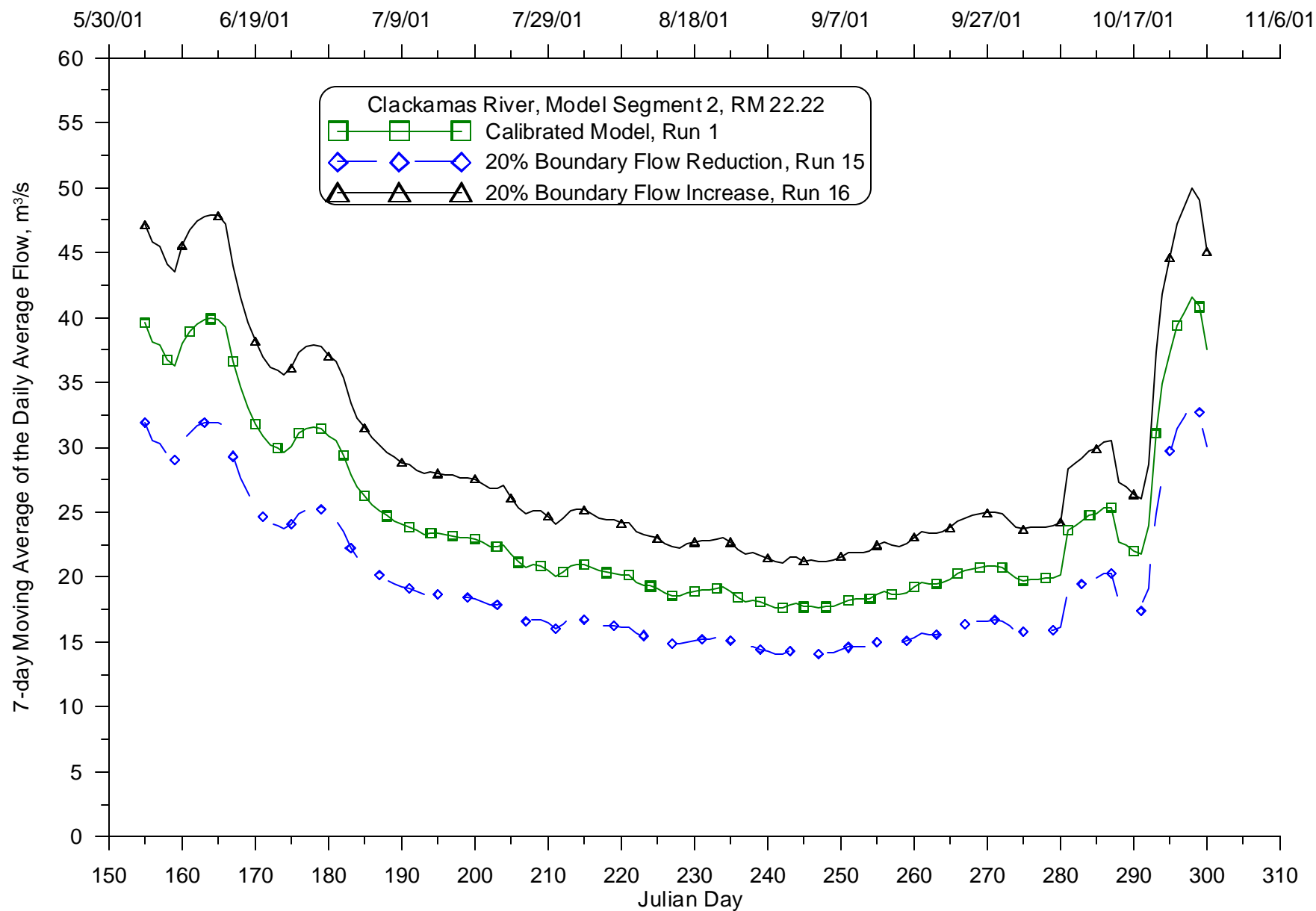
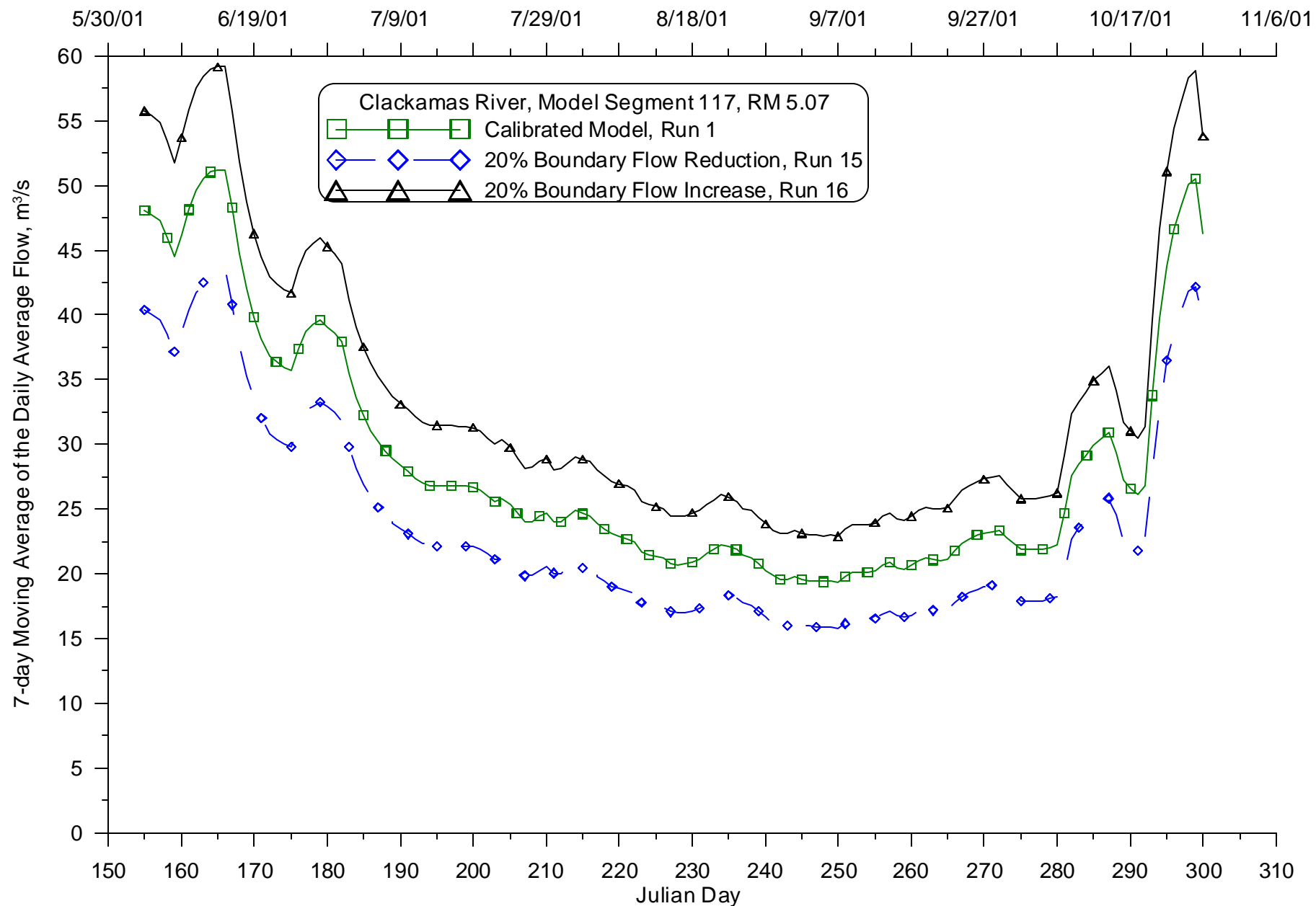


Figure 518: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Clackamas River at RM 22.22



**Figure 519: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Clackamas River at RM 5.07**

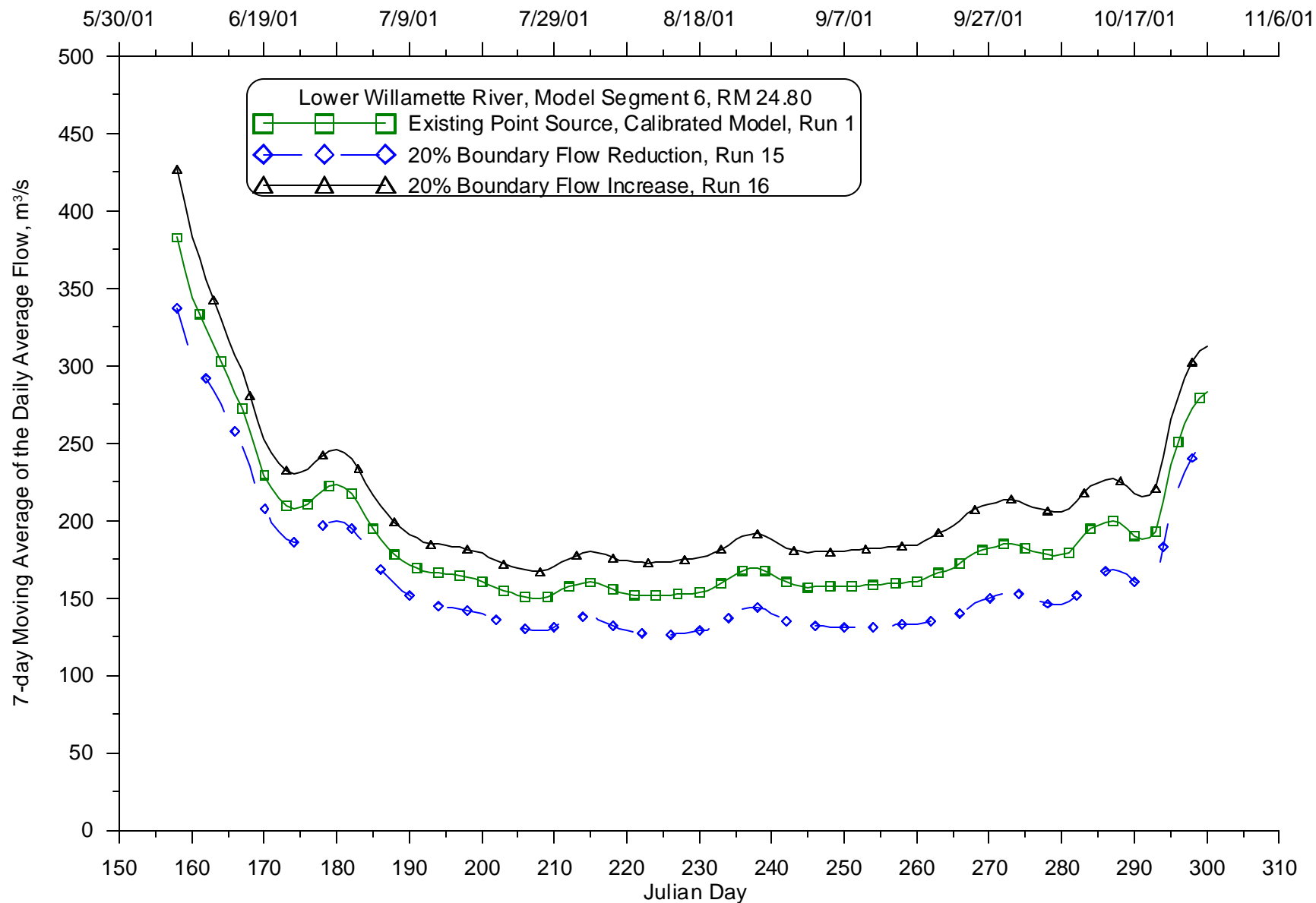
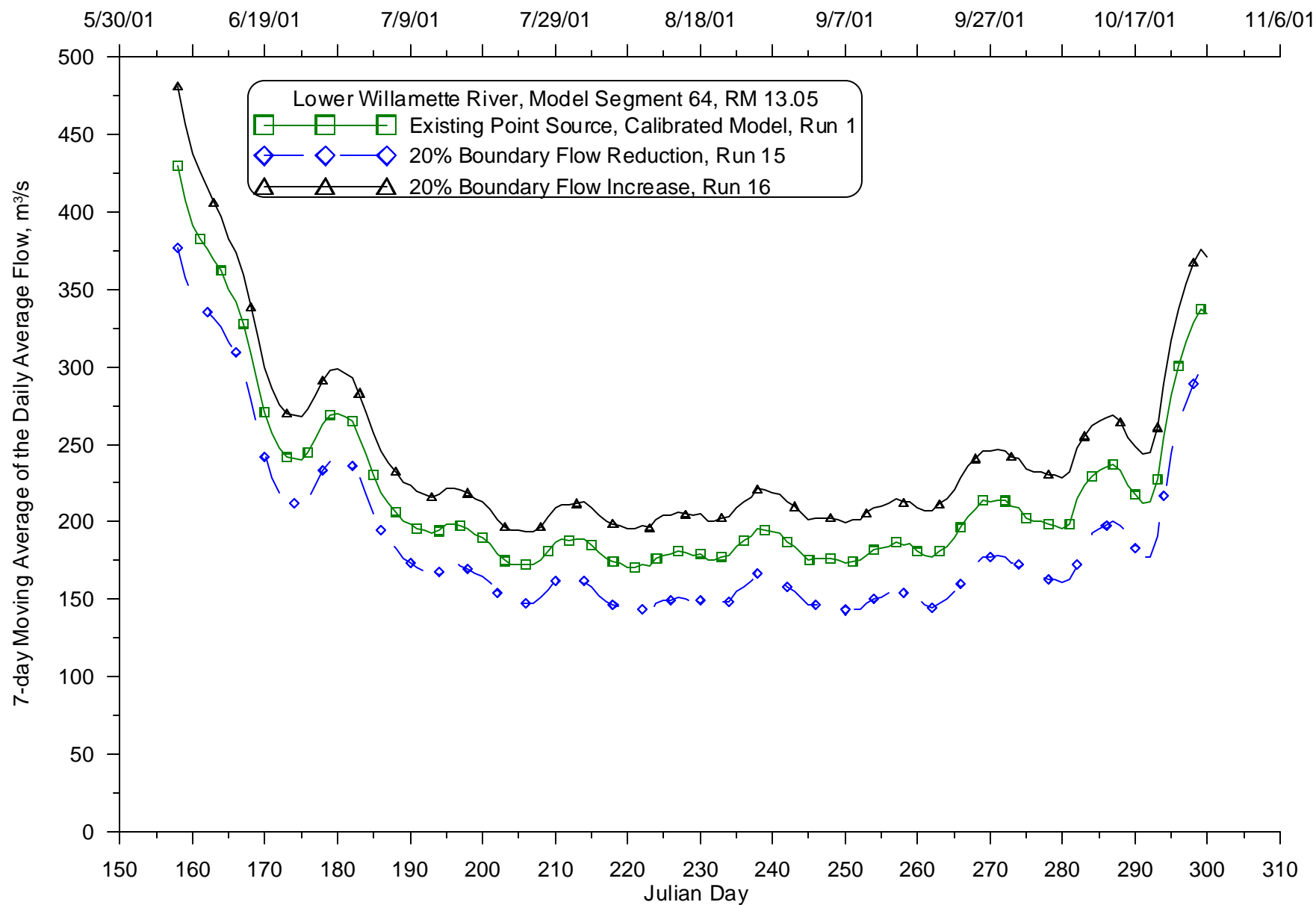


Figure 520: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 24.8



**Figure 521: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 13.05**

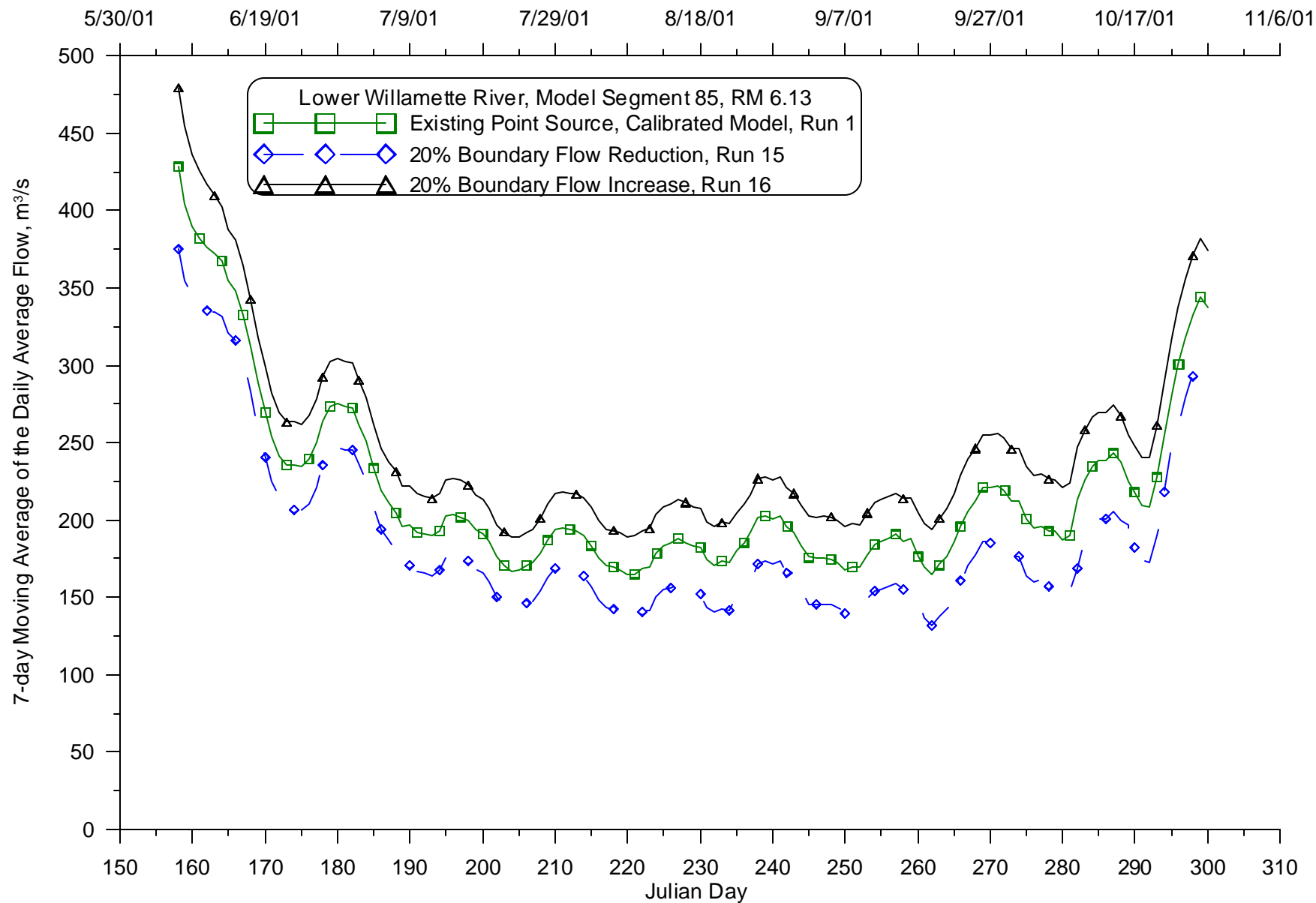


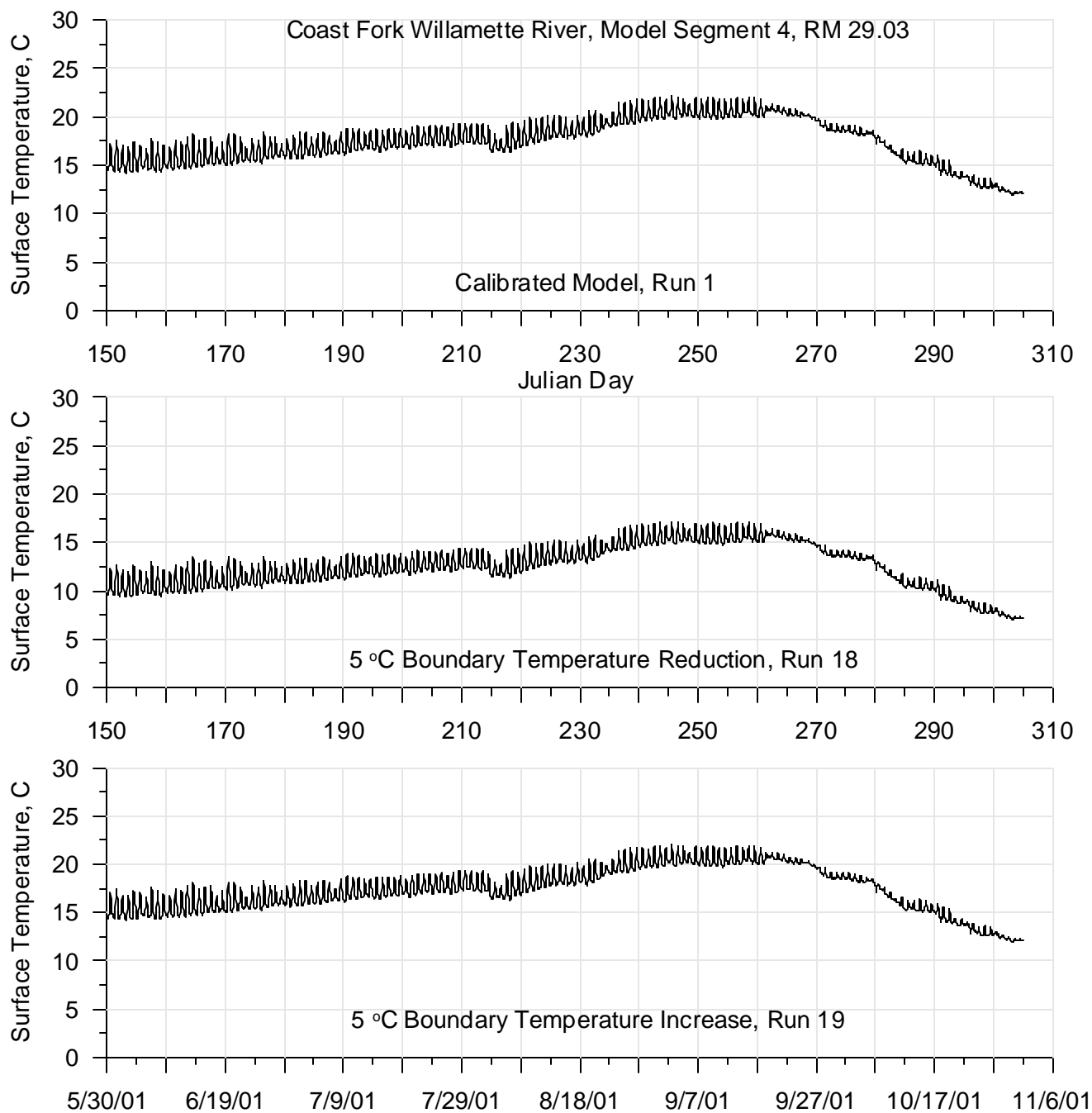
Figure 522: Calibrated model compared with varying boundary flow (+/- 20%) 7-day moving average of the daily average flow for 2001 for the Willamette River at RM 6.13

## ***Sensitivity to boundary temperature***

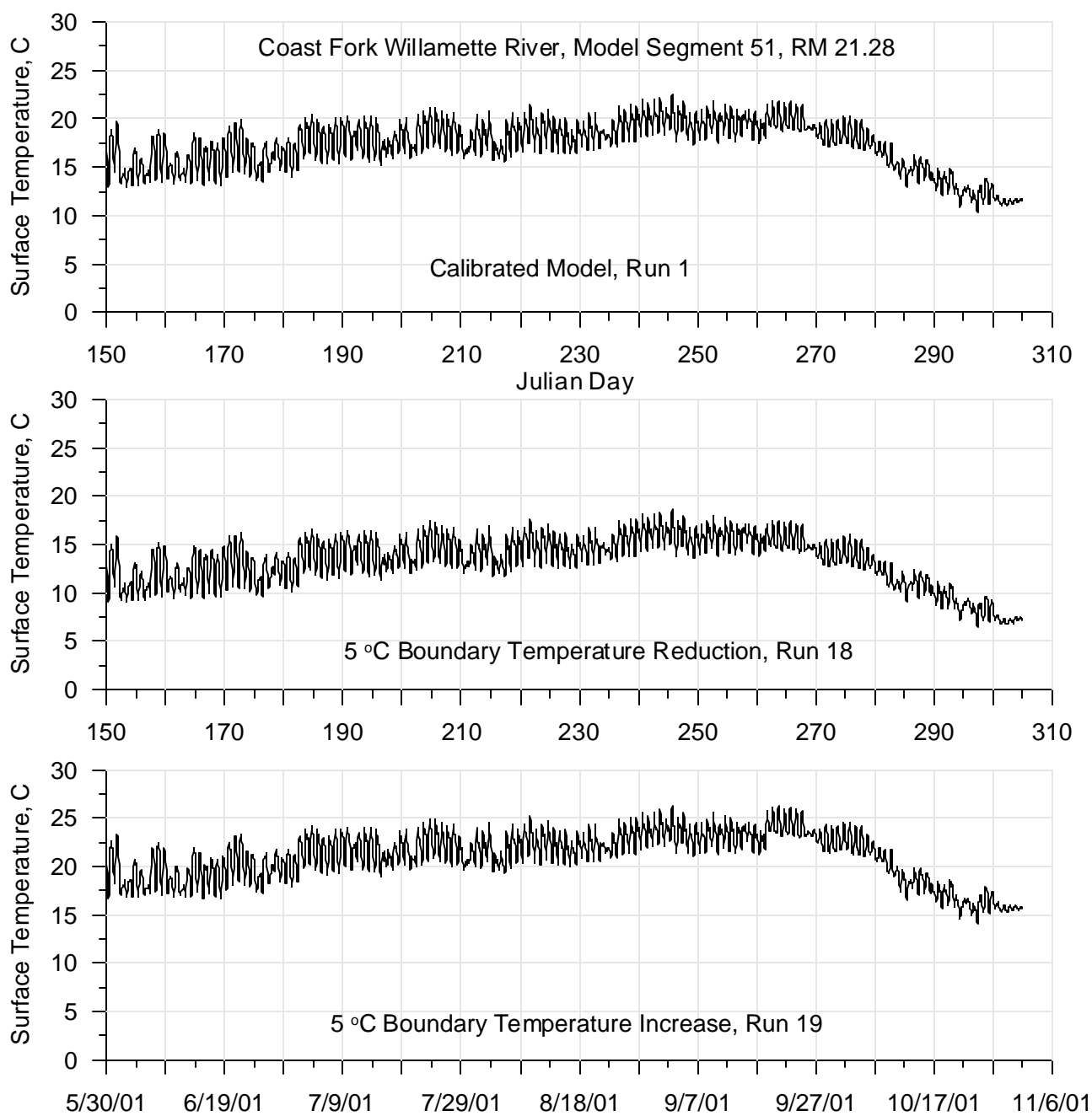
The sensitivity of the model to the upstream boundary temperature was examined by simulating the summer of 2001 and adjusting the upstream boundary temperatures by  $\pm 5^{\circ}\text{C}$ . These results were then compared with the results of the calibrated model in a series of time series plots. There are four types of time series output for each of the 21 locations identified above in Table 2: continuous temperature, continuous flow, the seven-day moving average of the daily maximum temperature, and the seven-day average of daily average flow.

### **Continuous Temperature**

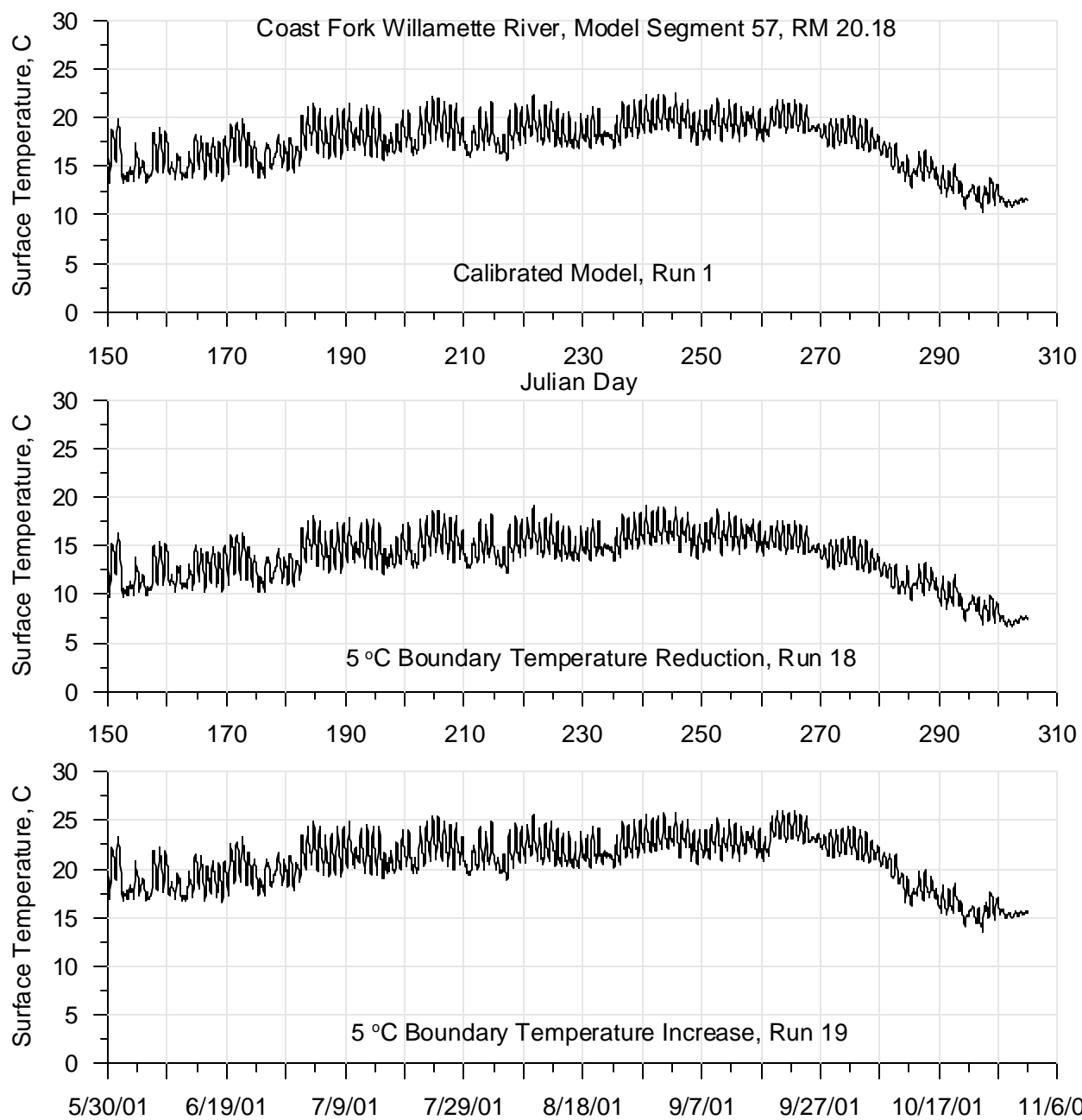




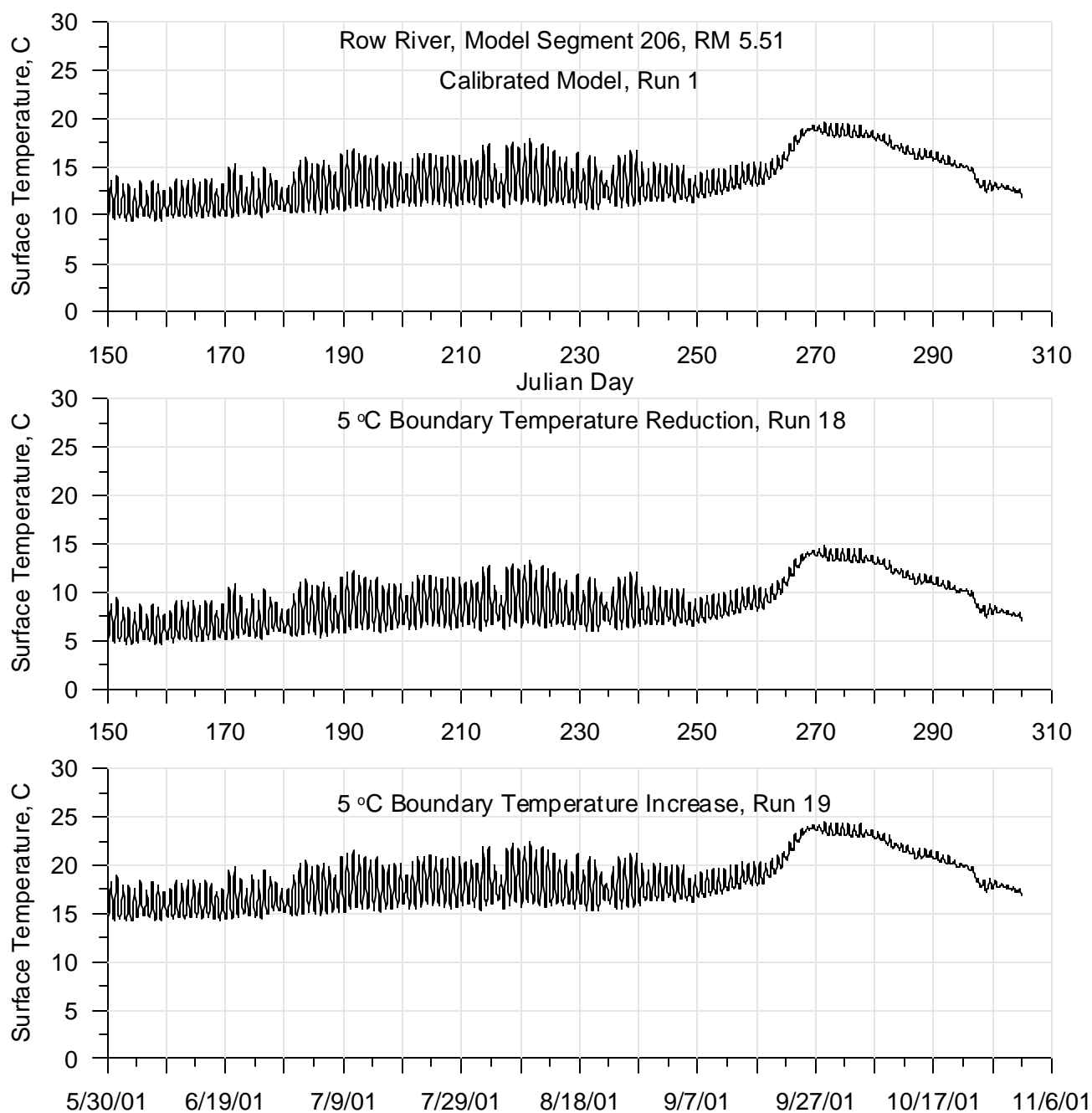
**Figure 523: Calibrated model compared with varying boundary temperature (+/- 5 °C) continuous temperature for 2001 for the Coast Fork Willamette River at RM 29.03**



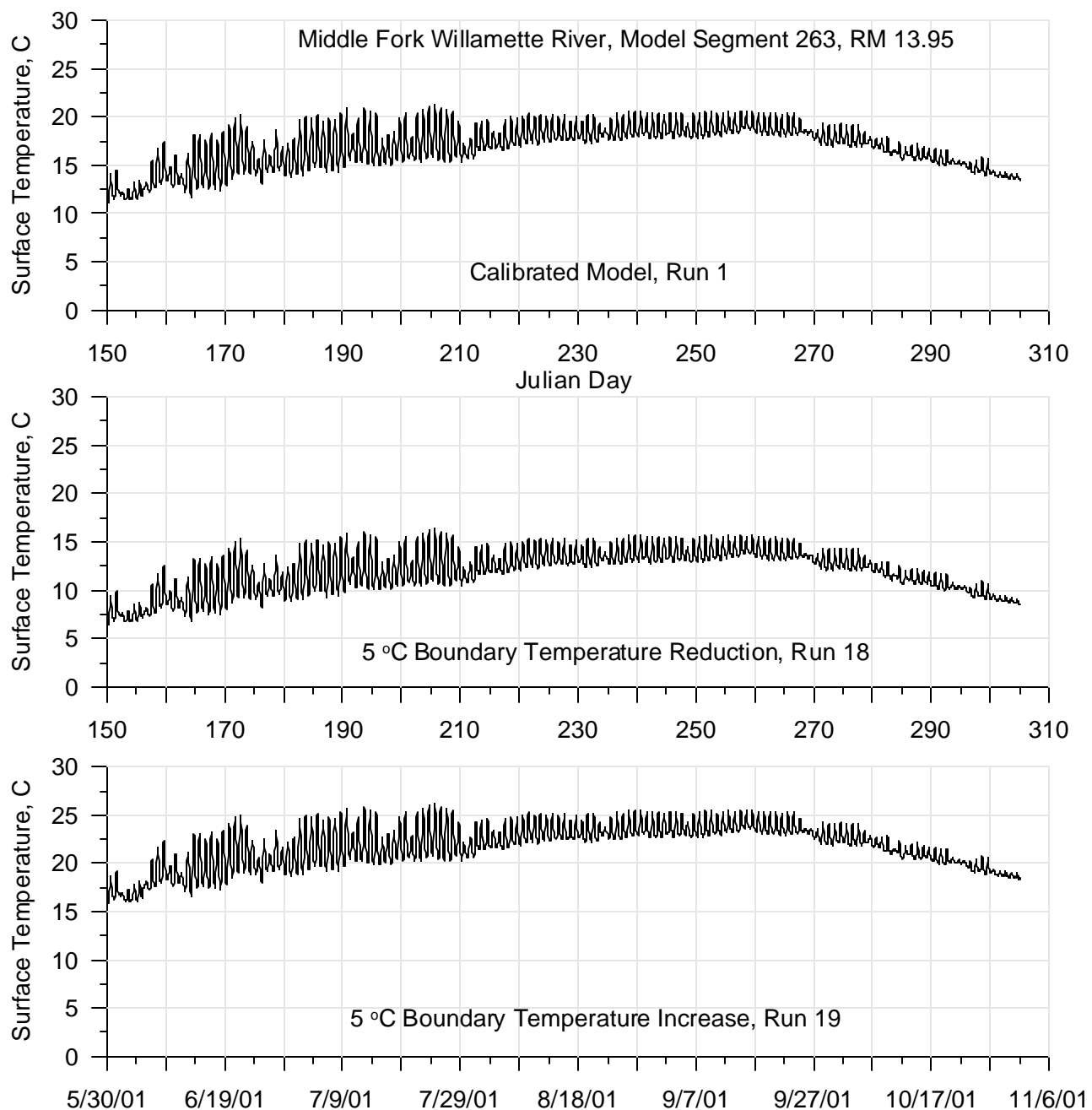
**Figure 524: Calibrated model compared with varying boundary temperature (+/- 5 °C) continuous temperature for 2001 for the Coast Fork Willamette River at RM 21.28**



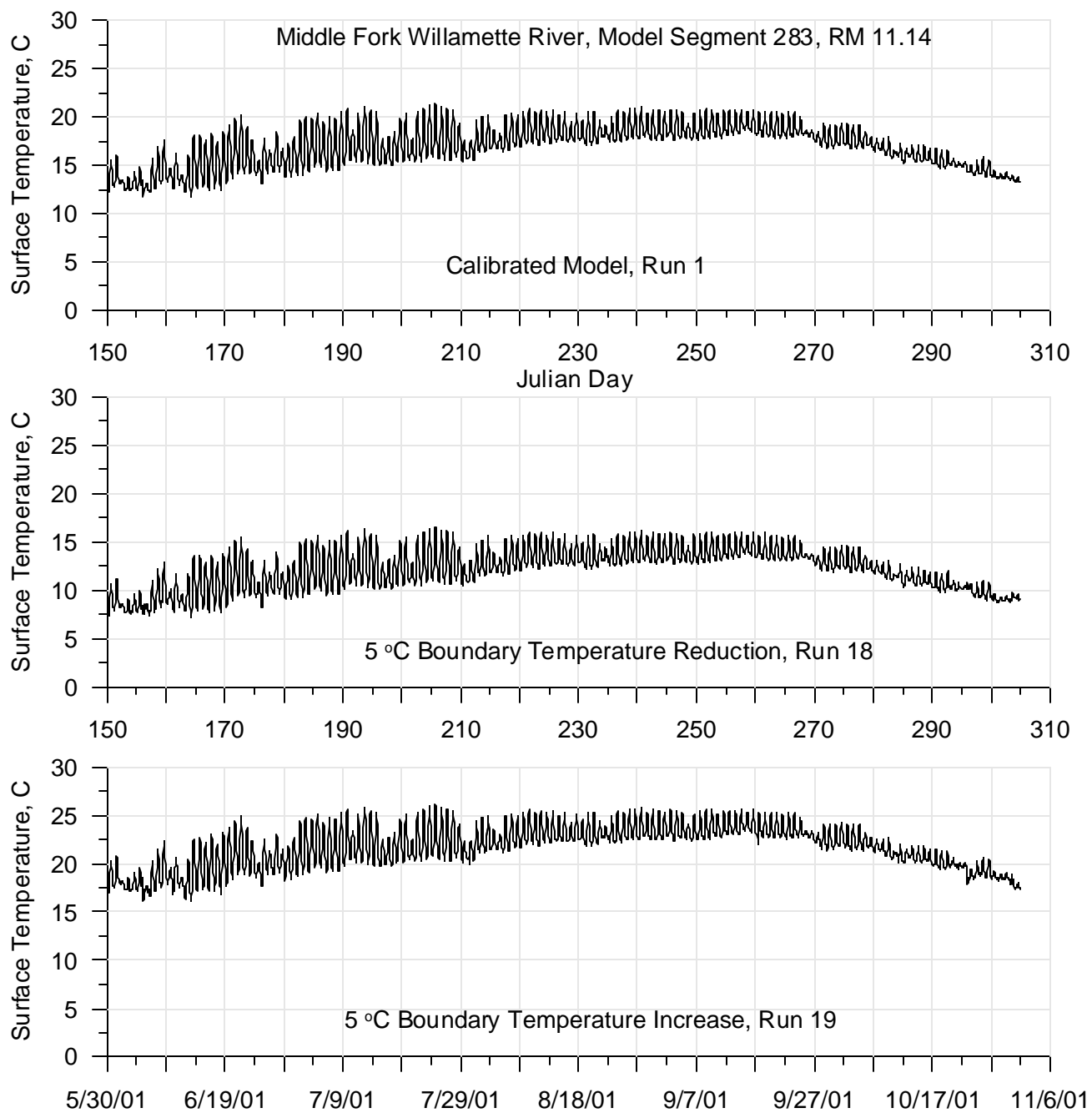
**Figure 525: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Coast Fork Willamette River at RM 20.18**



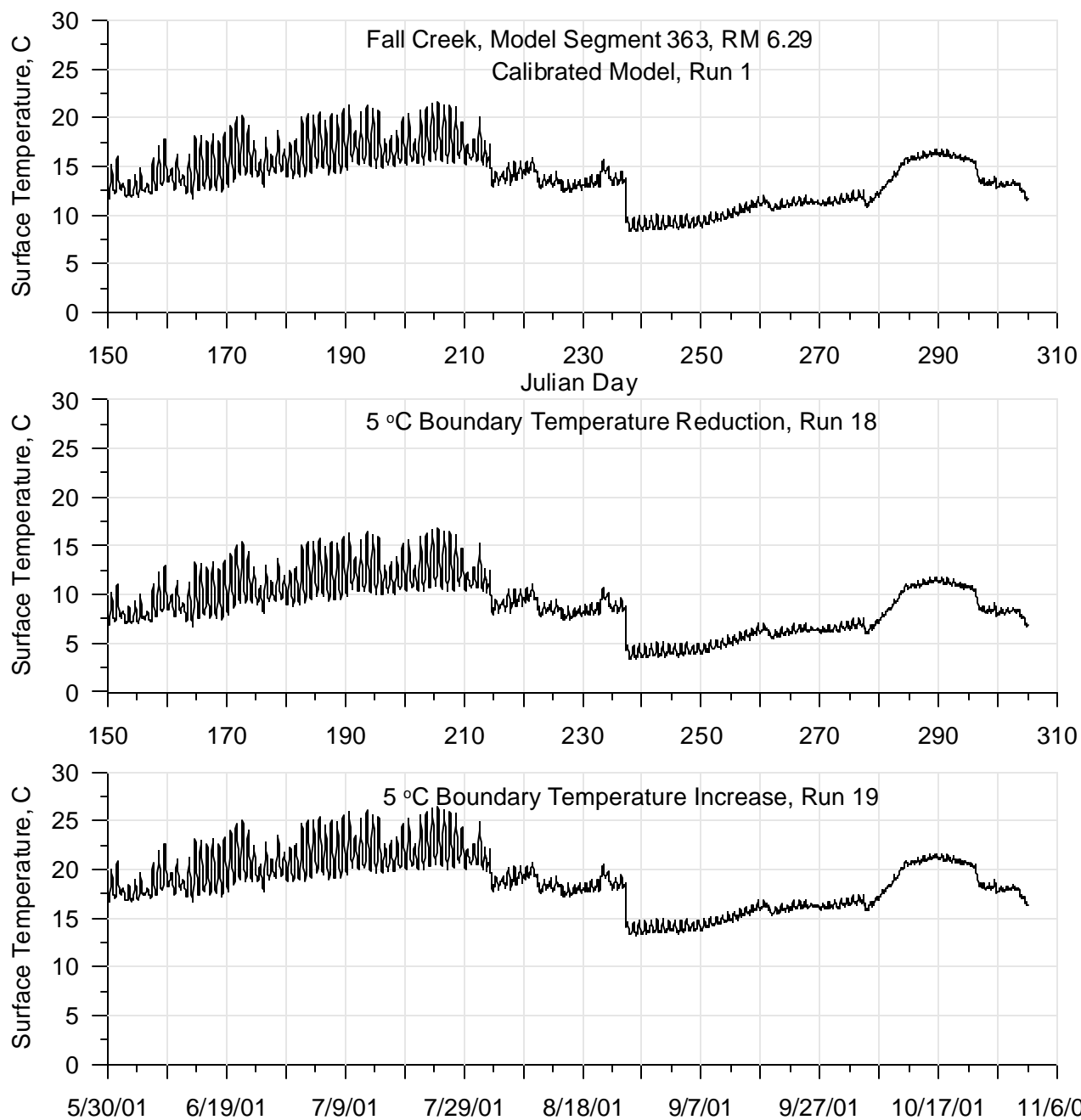
**Figure 526: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Row River at RM 5.51**



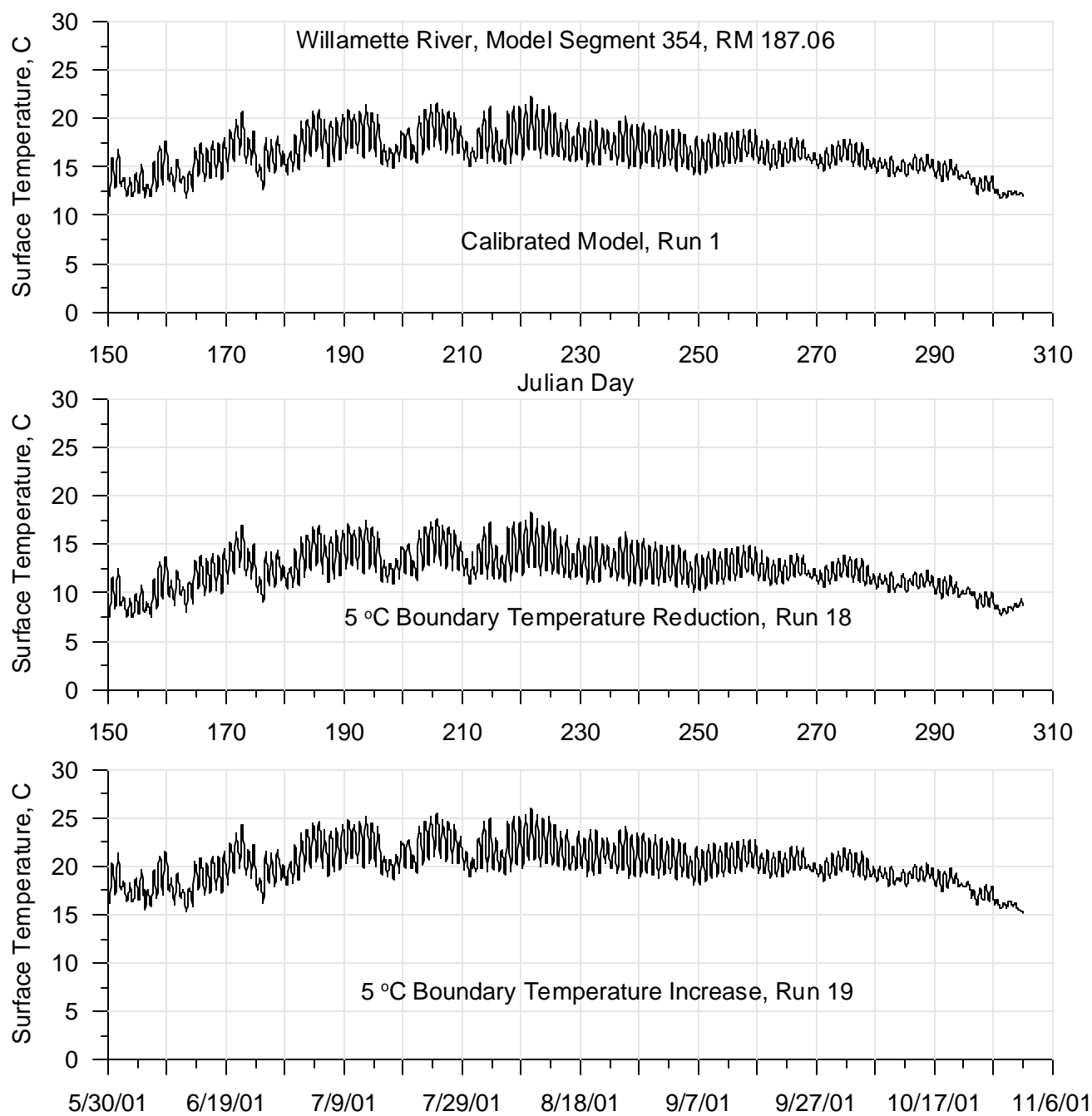
**Figure 527: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 528: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous te mperature for 2001 for the Middle Fork Willamette River at RM 11.14**

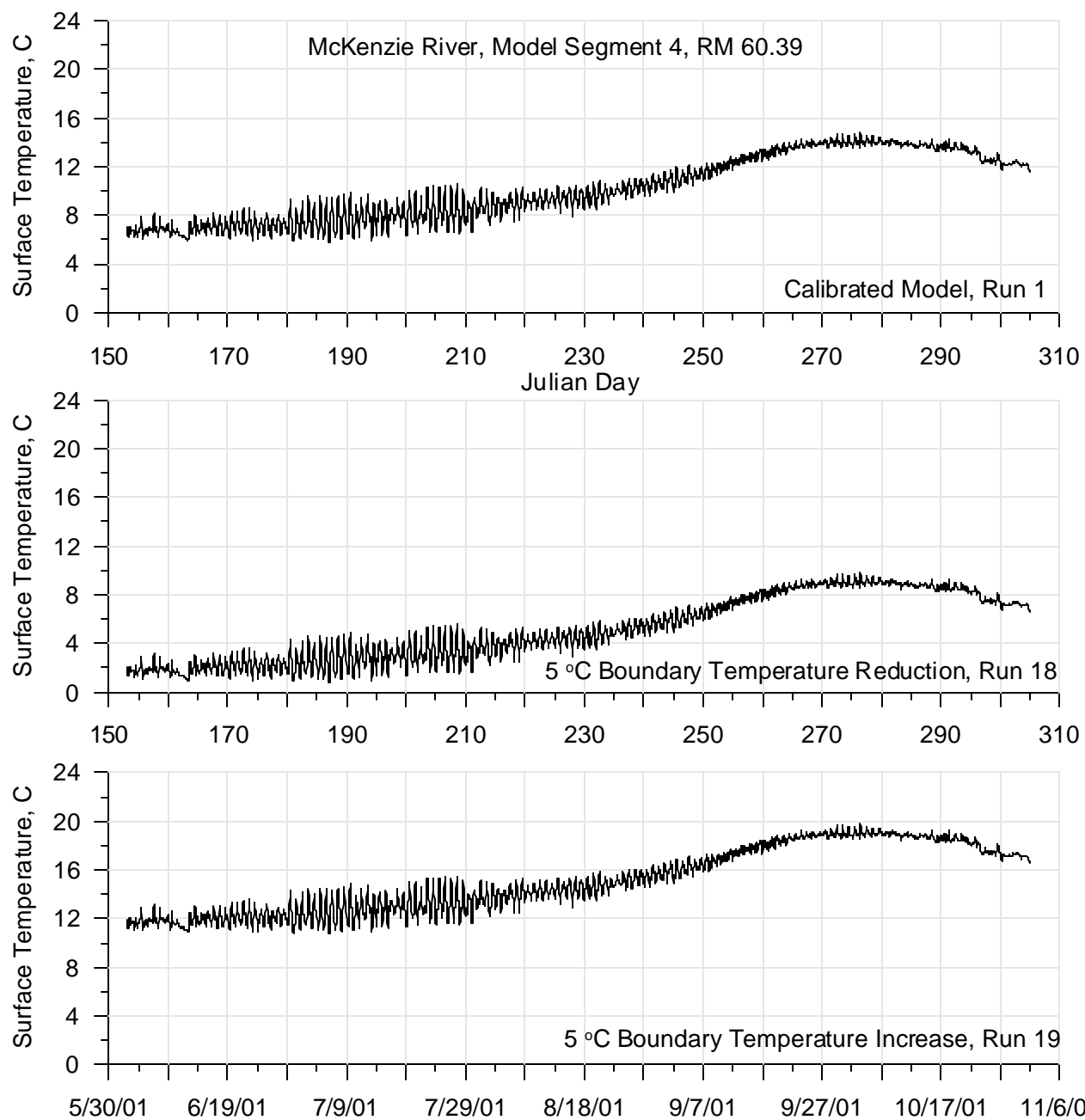


**Figure 529: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for Fall Creek at RM 6.29**

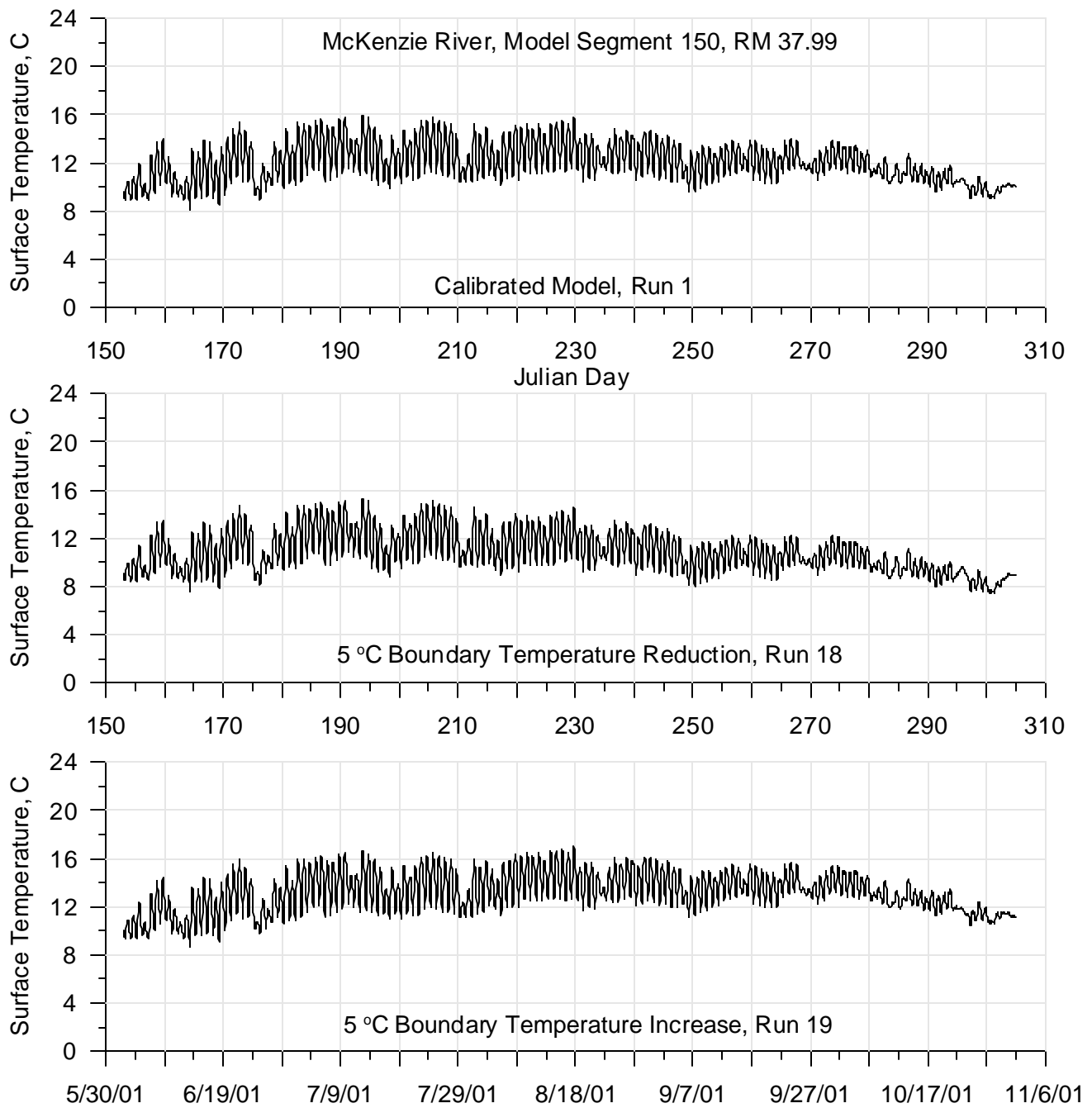


**Figure 530: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous te mperature for 2001 for the Willamette River at RM 187.06**

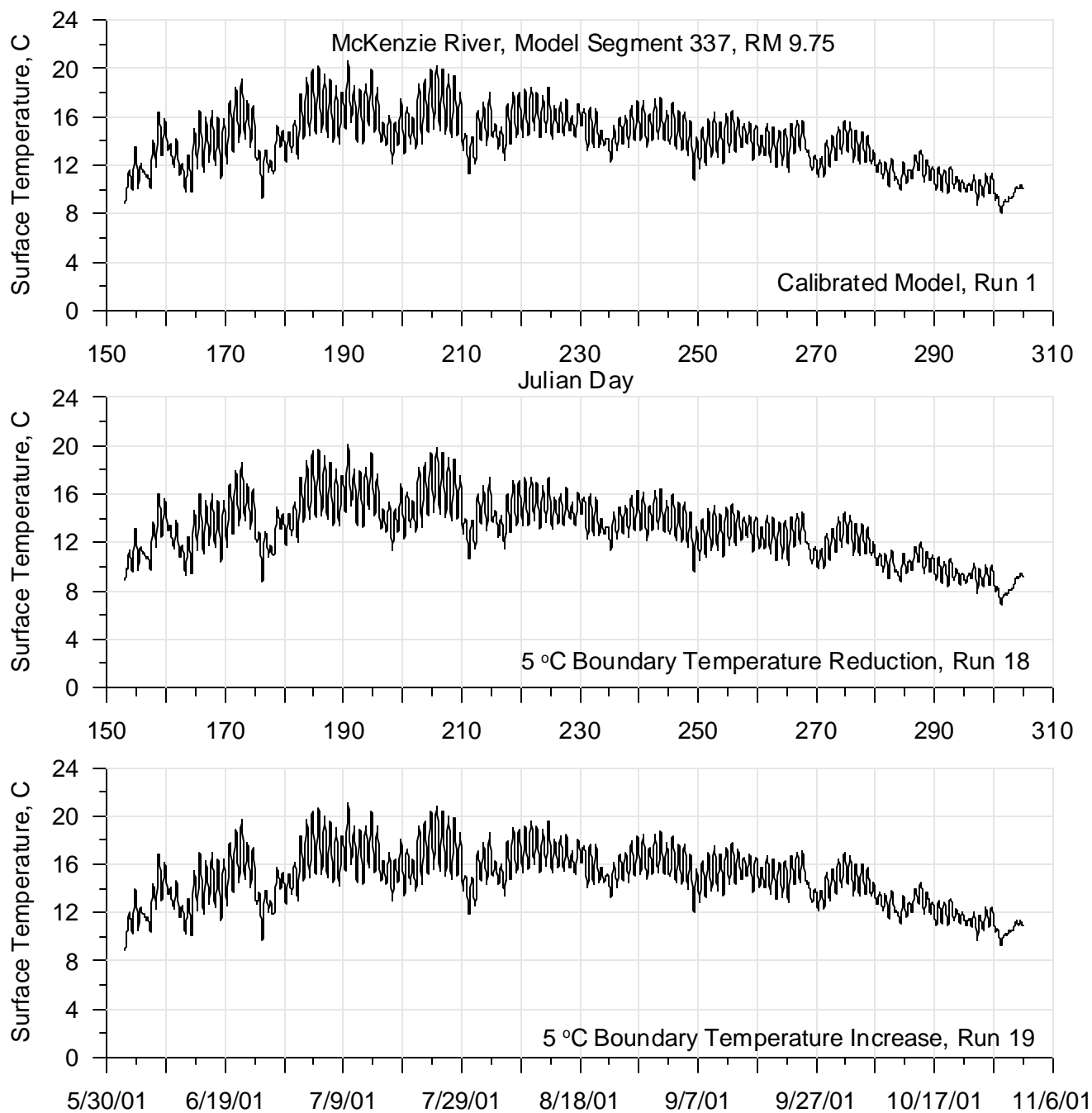




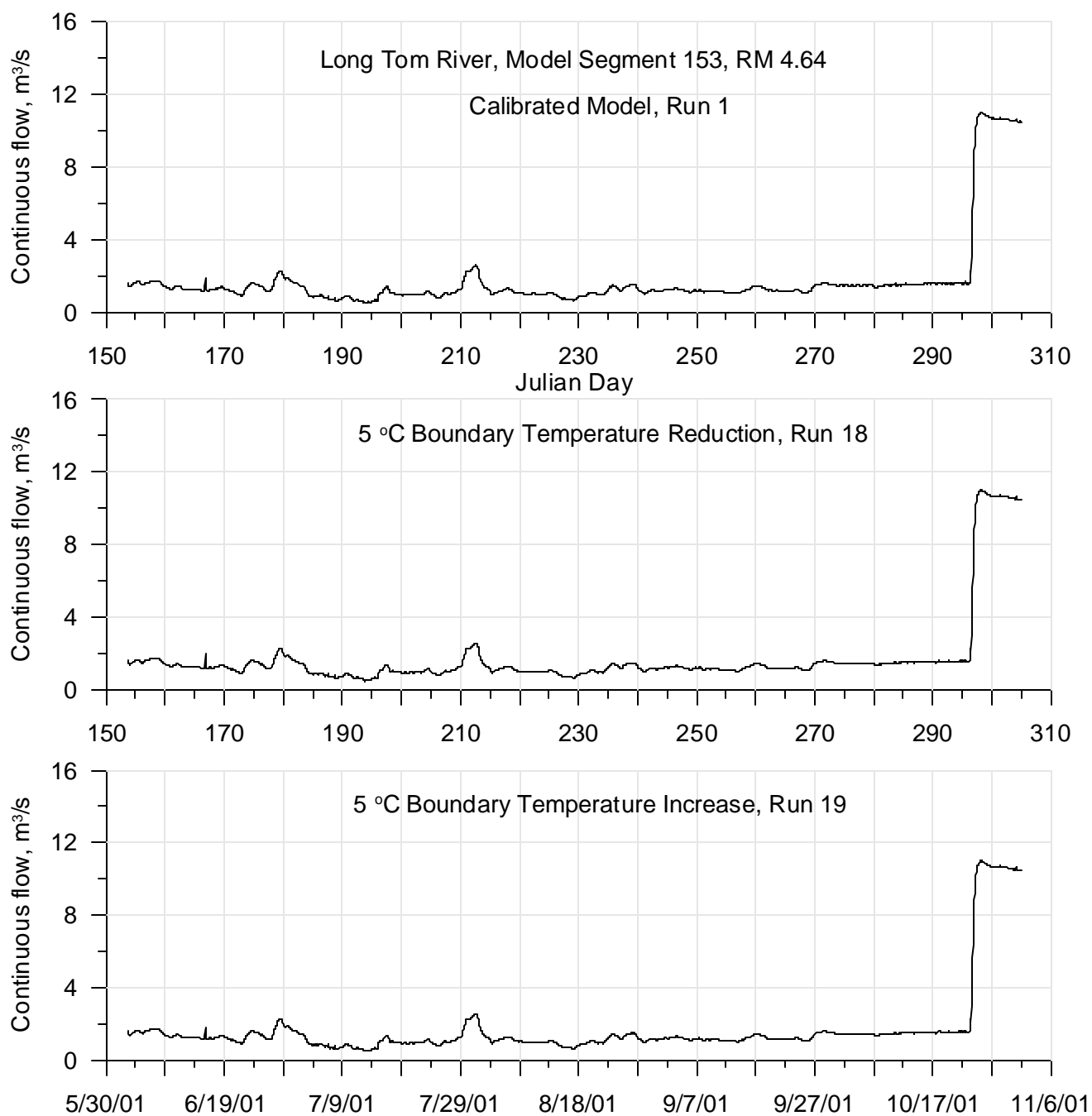
**Figure 531: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the McKenzie River at RM 60.39**



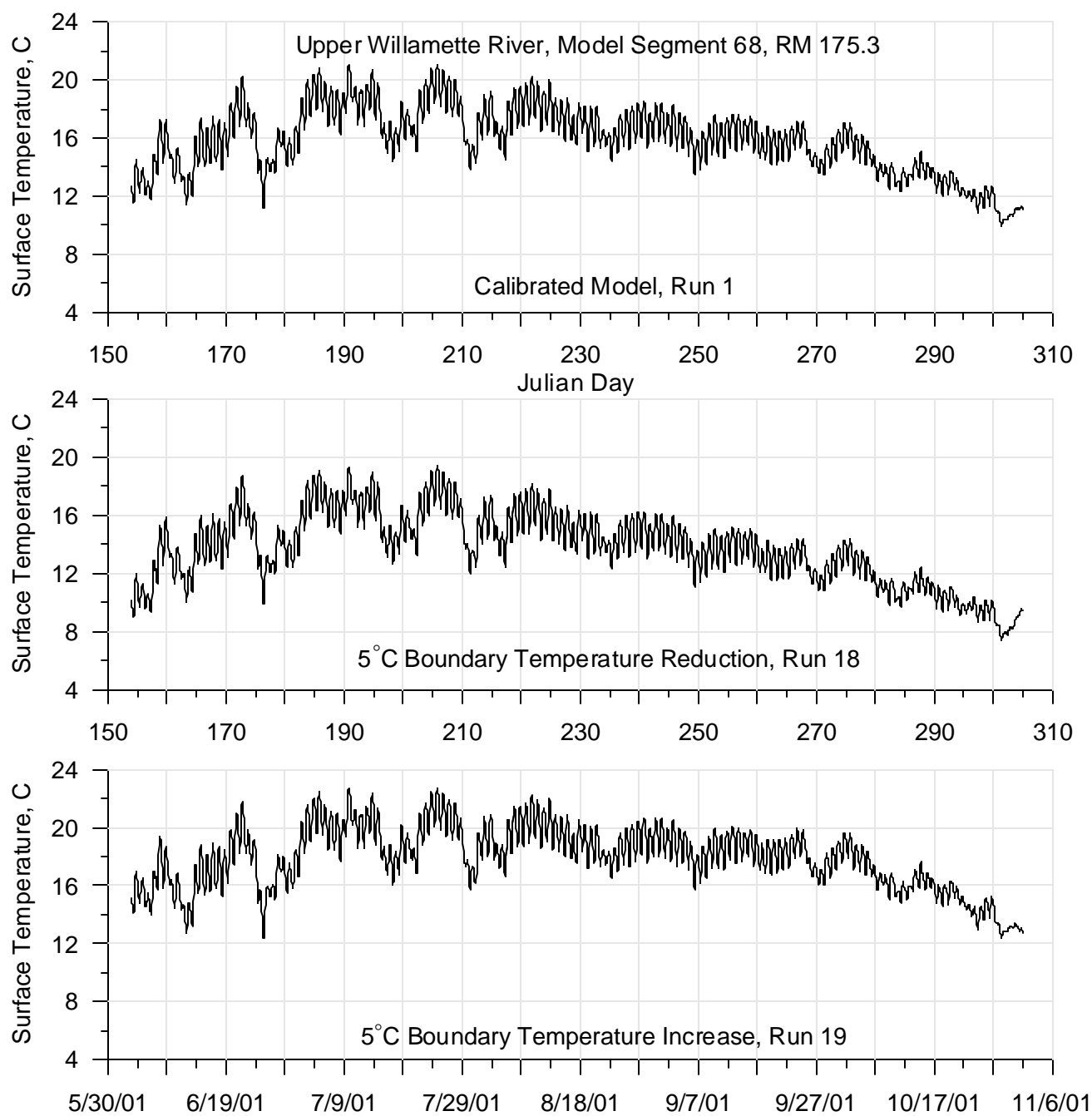
**Figure 532: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the McKenzie River at RM 37.99**



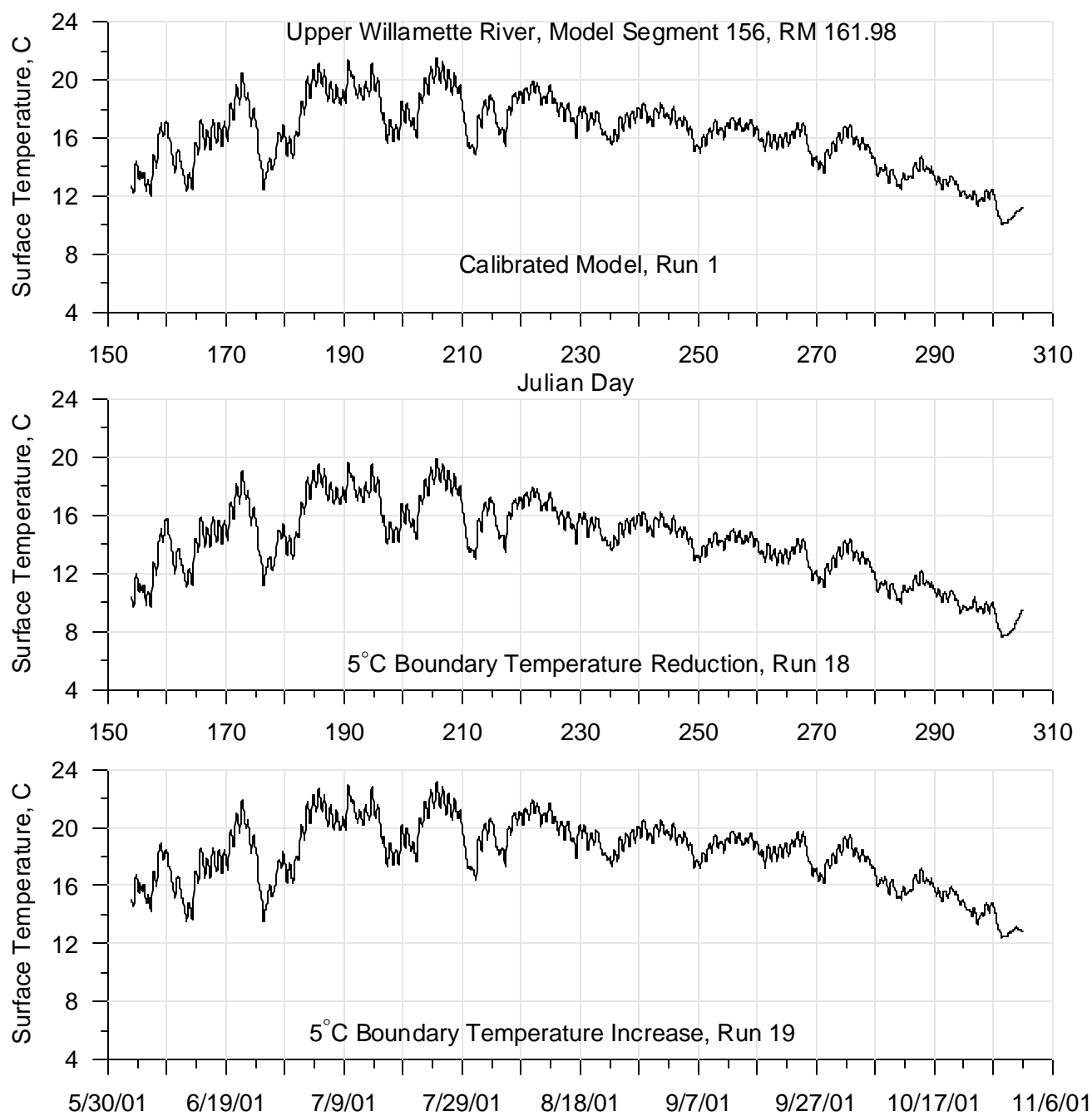
**Figure 533: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the McKenzie River at RM 9.75**



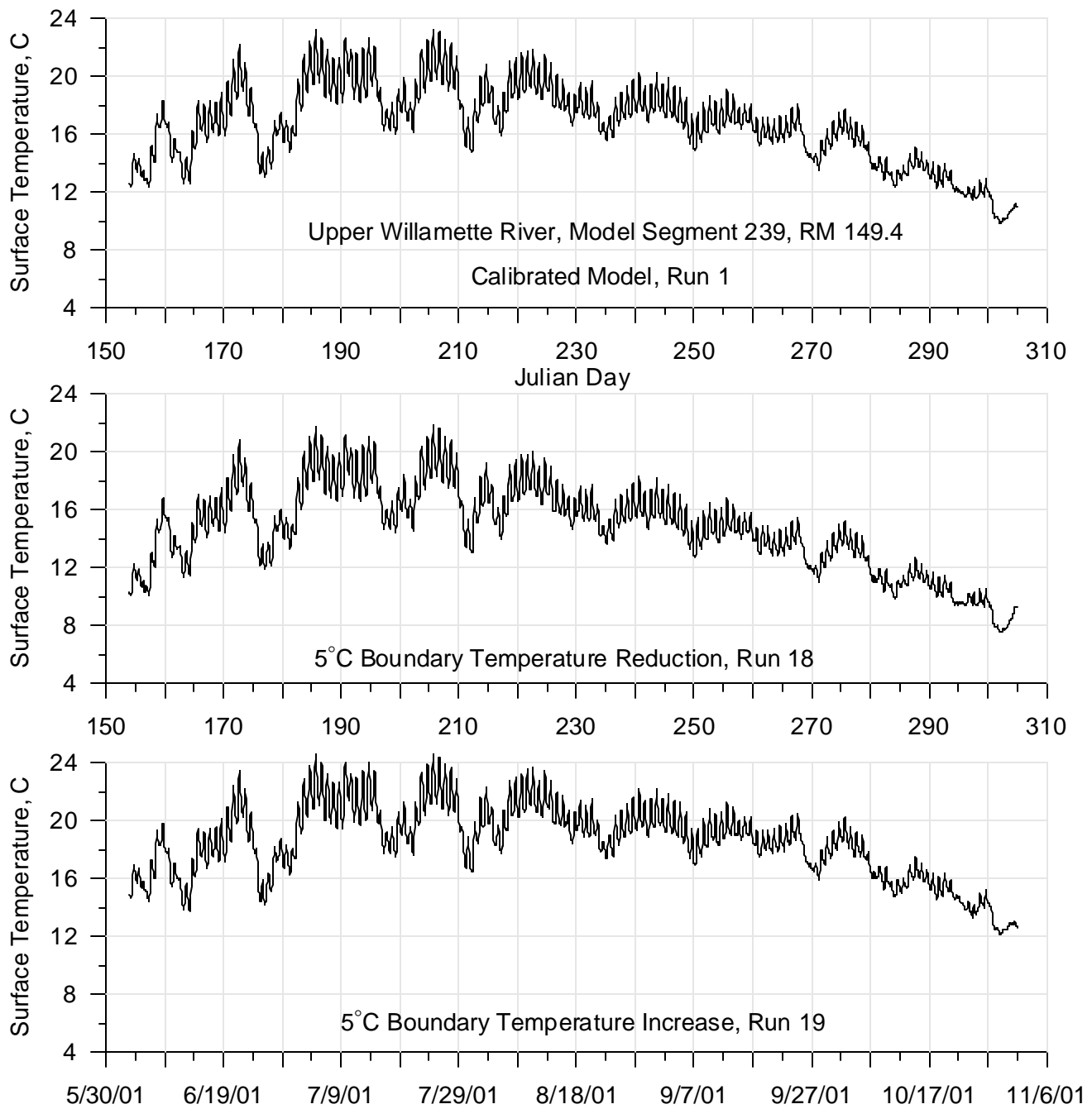
**Figure 534: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Long Tom River at RM 4.64**



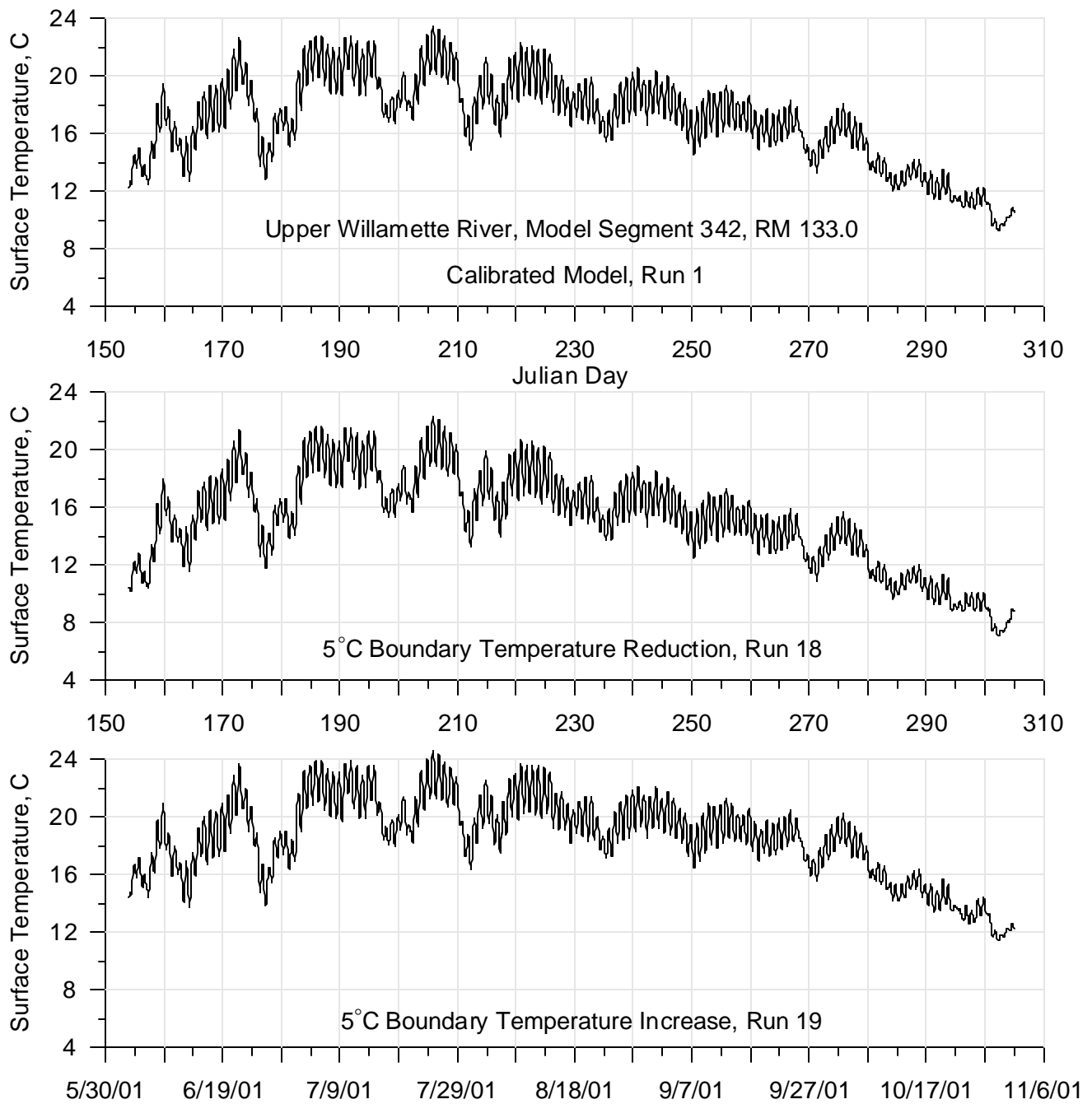
**Figure 535: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 175.3**



**Figure 536: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 161.98**

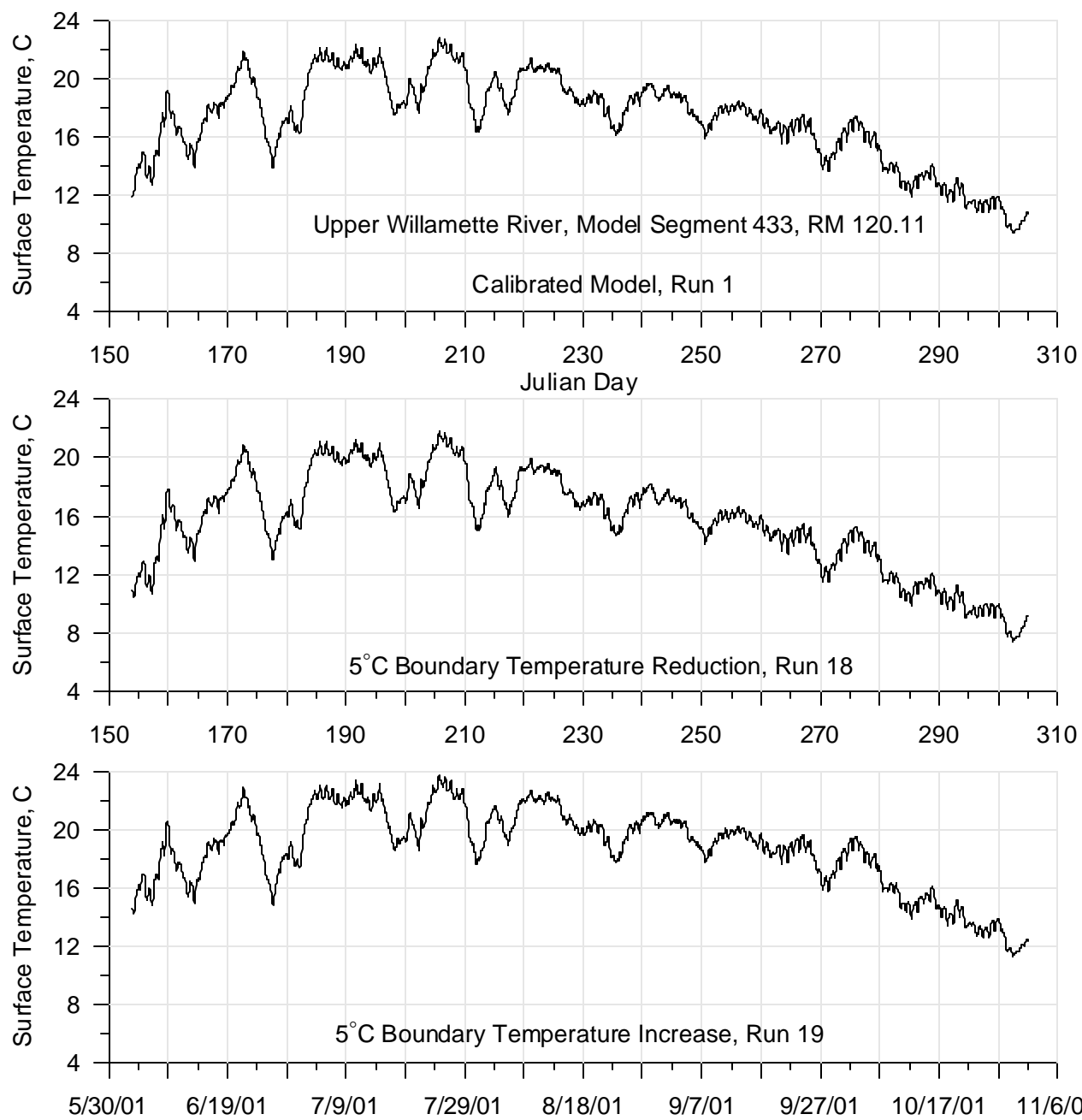


**Figure 537: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 149.4**

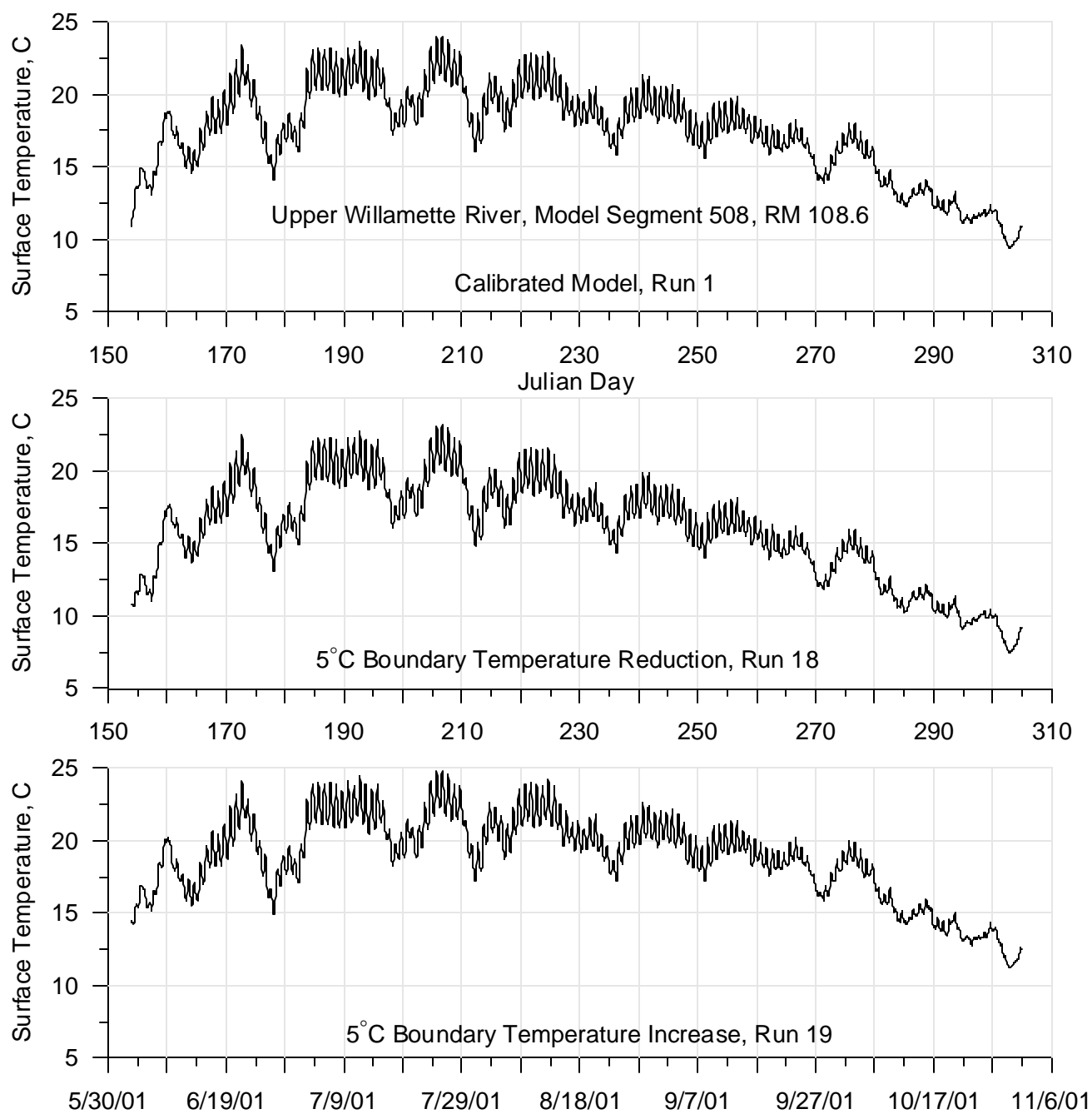


**Figure 538: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 133**

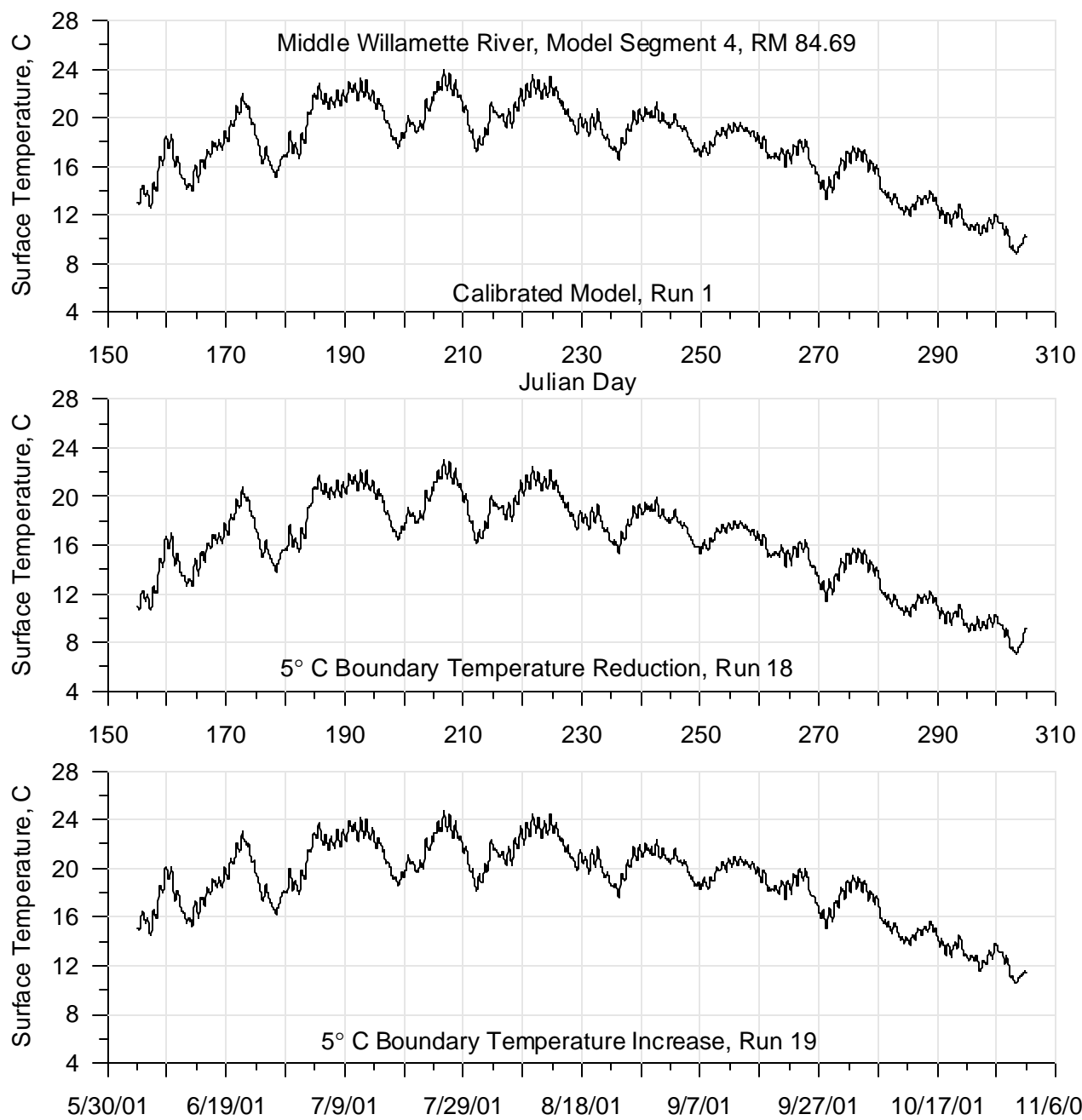




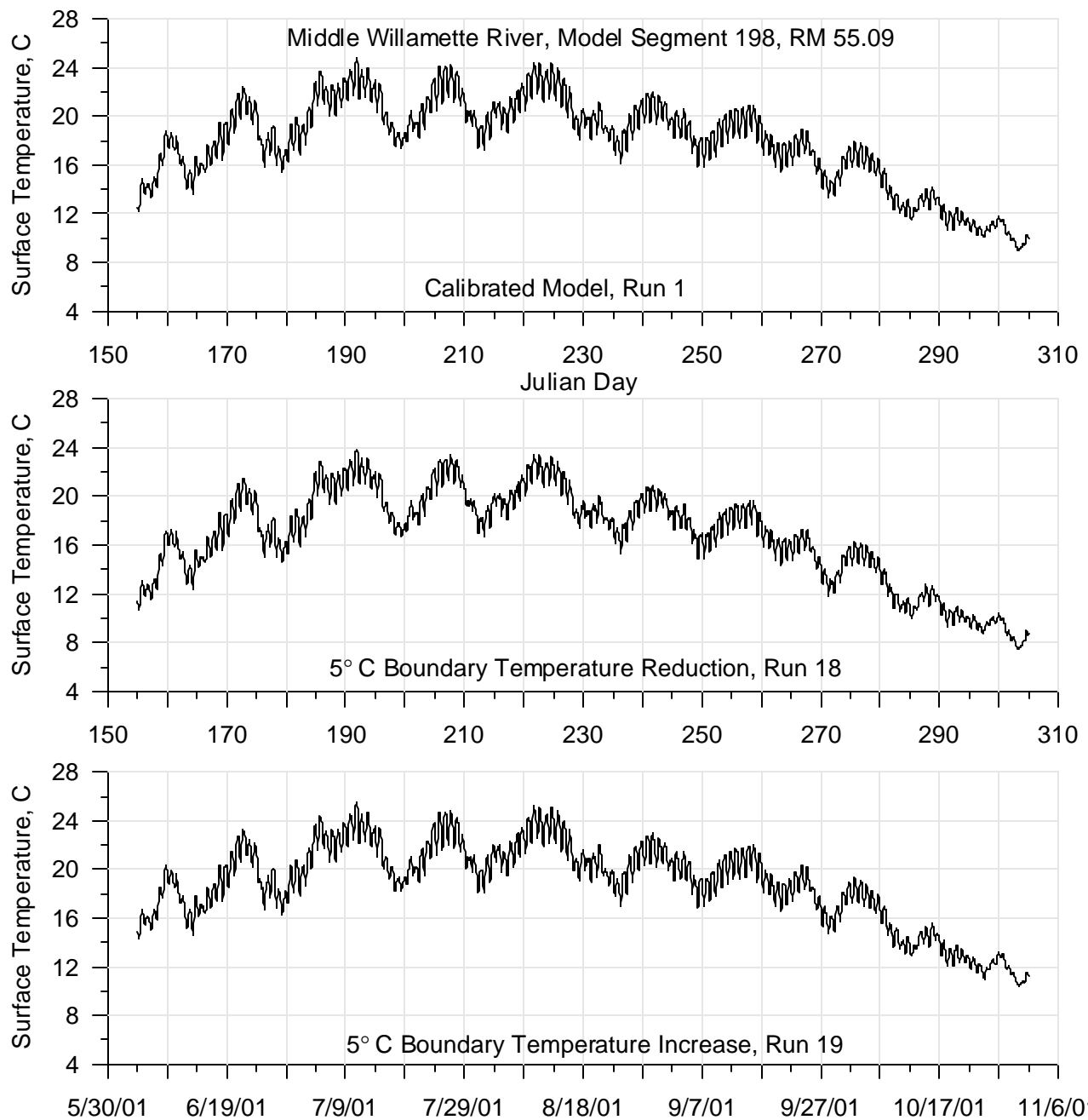
**Figure 539: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 120.11**



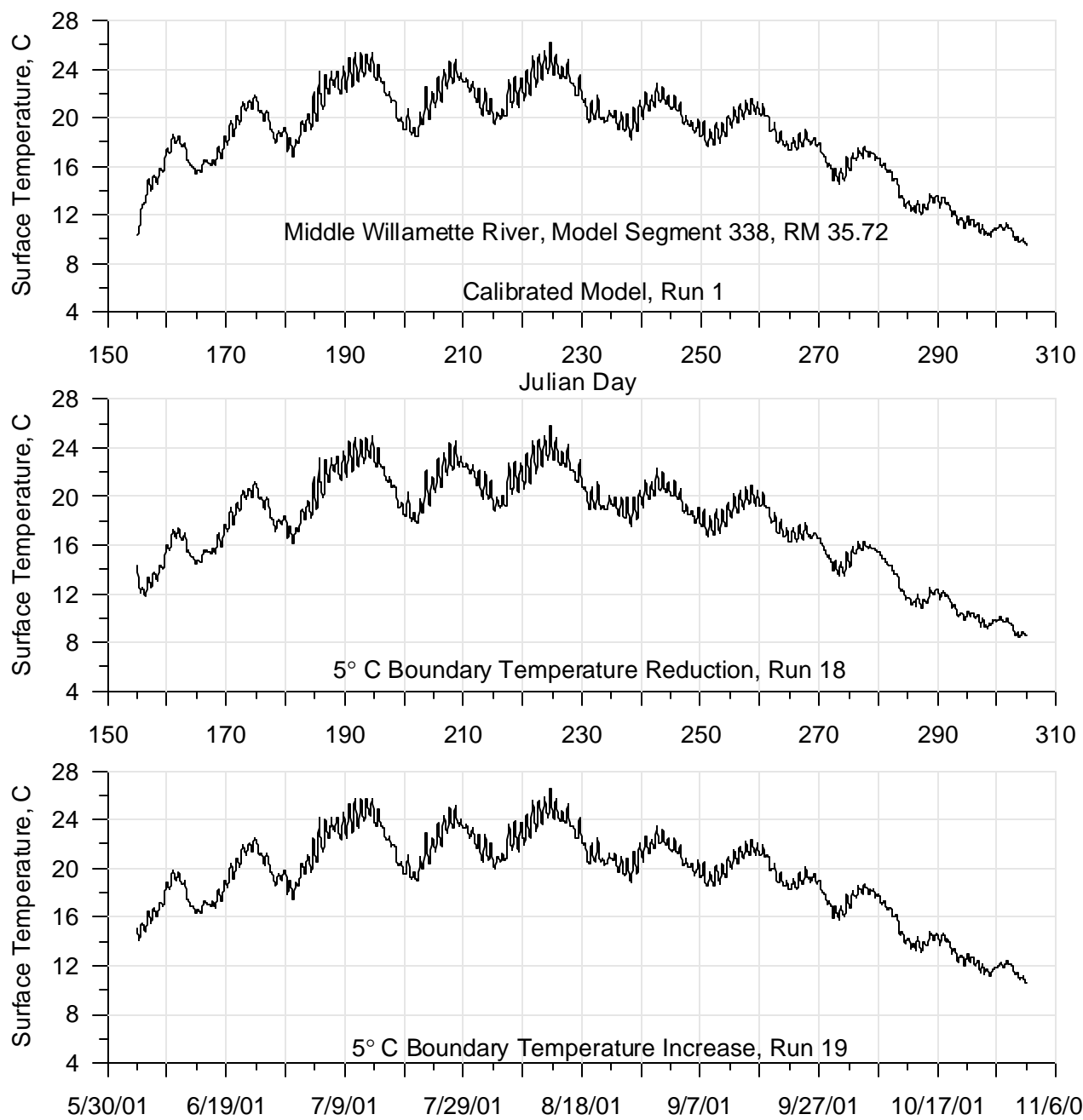
**Figure 540: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 108.6**



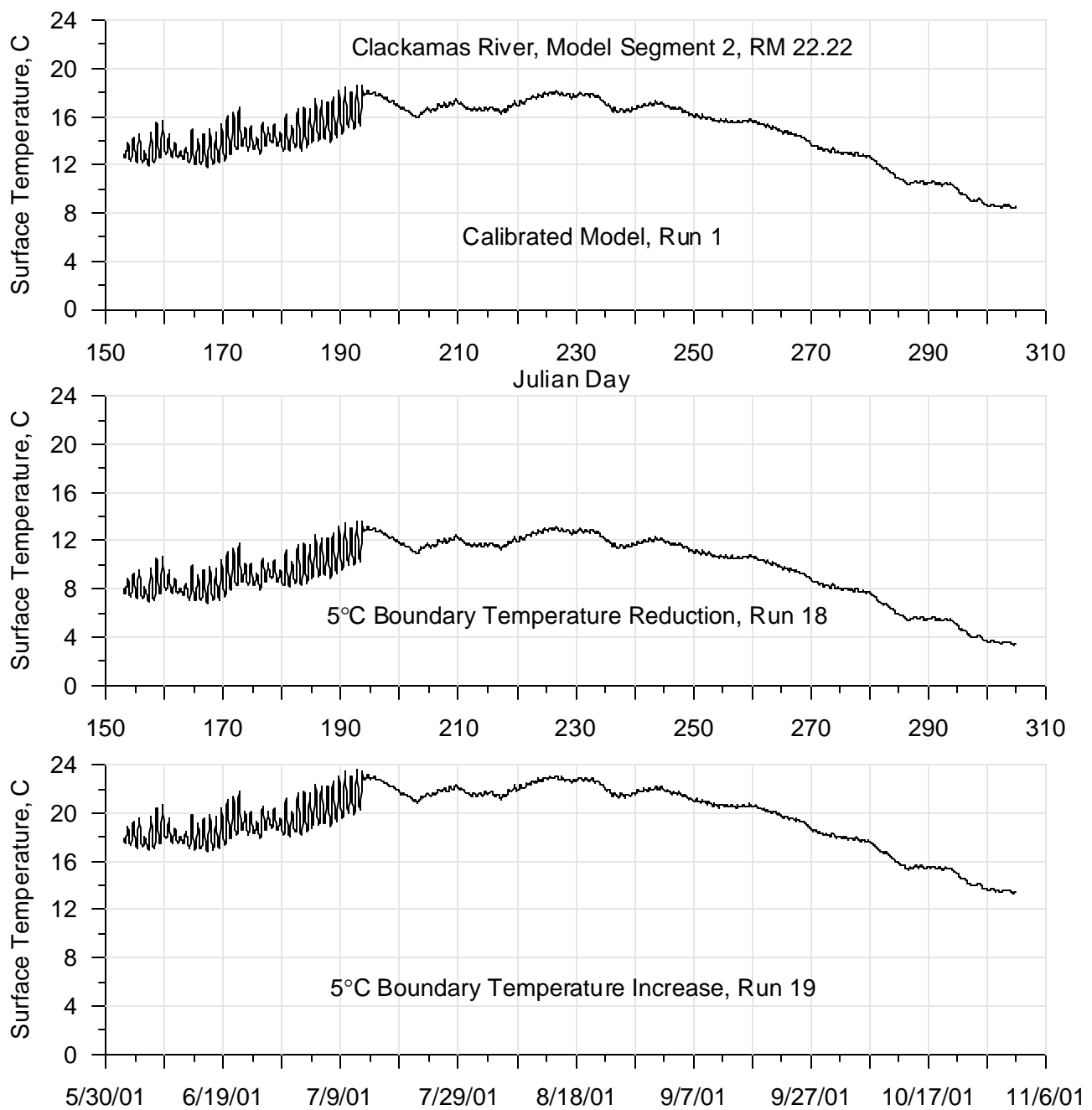
**Figure 541: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 84.69**



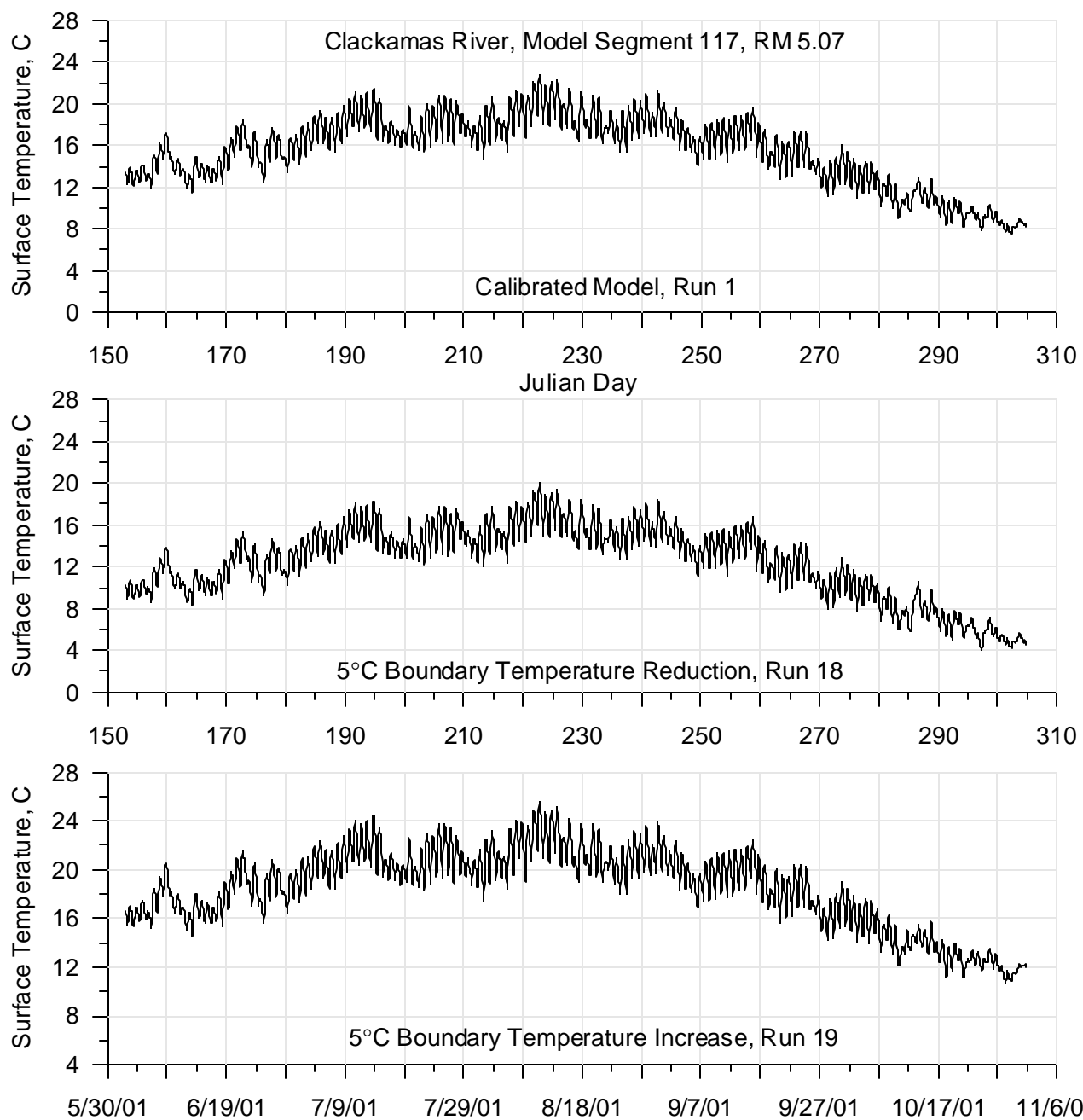
**Figure 542: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 55.09**



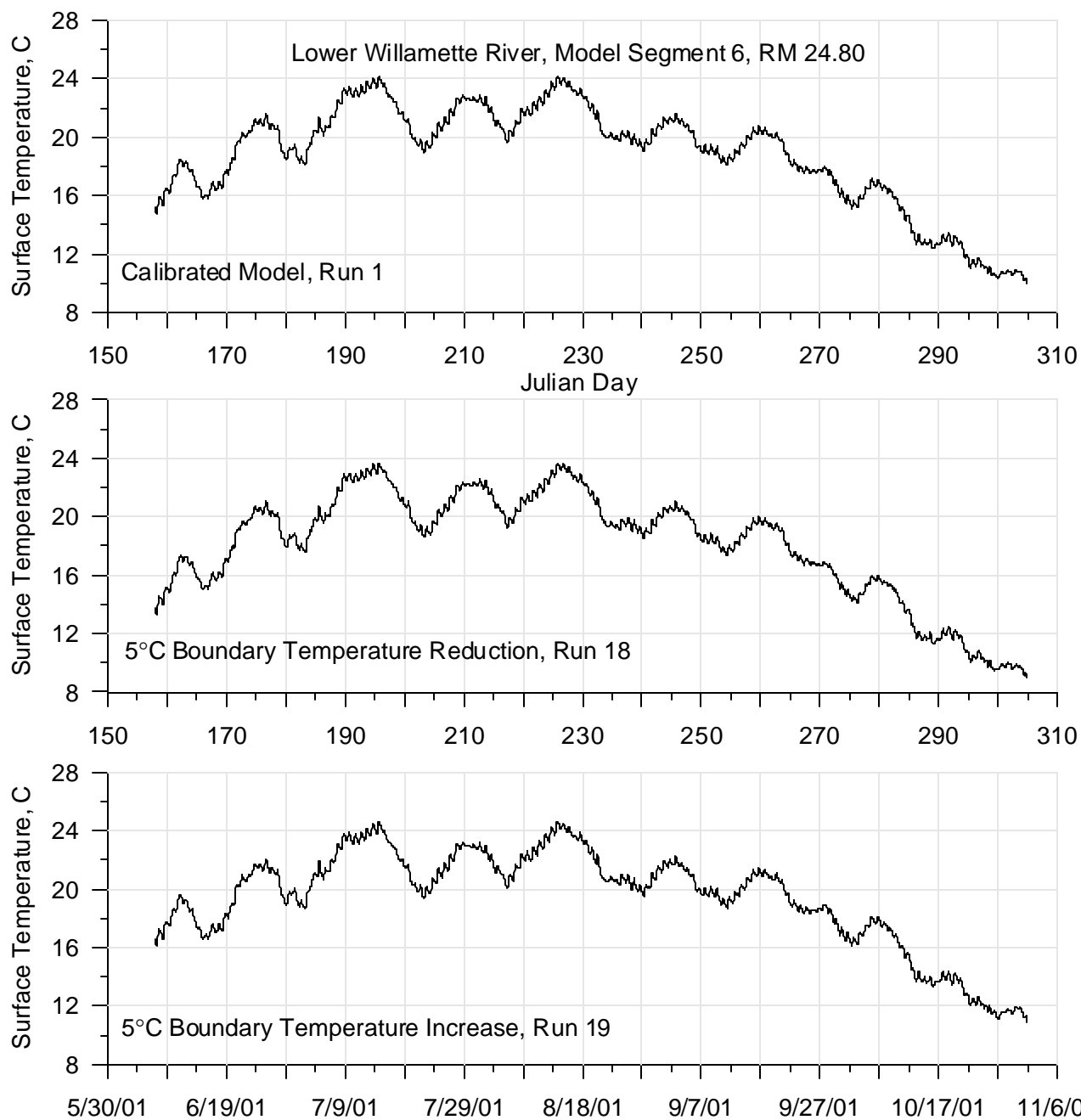
**Figure 543: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 35.72**



**Figure 544: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Clackamas River at RM 22.22**

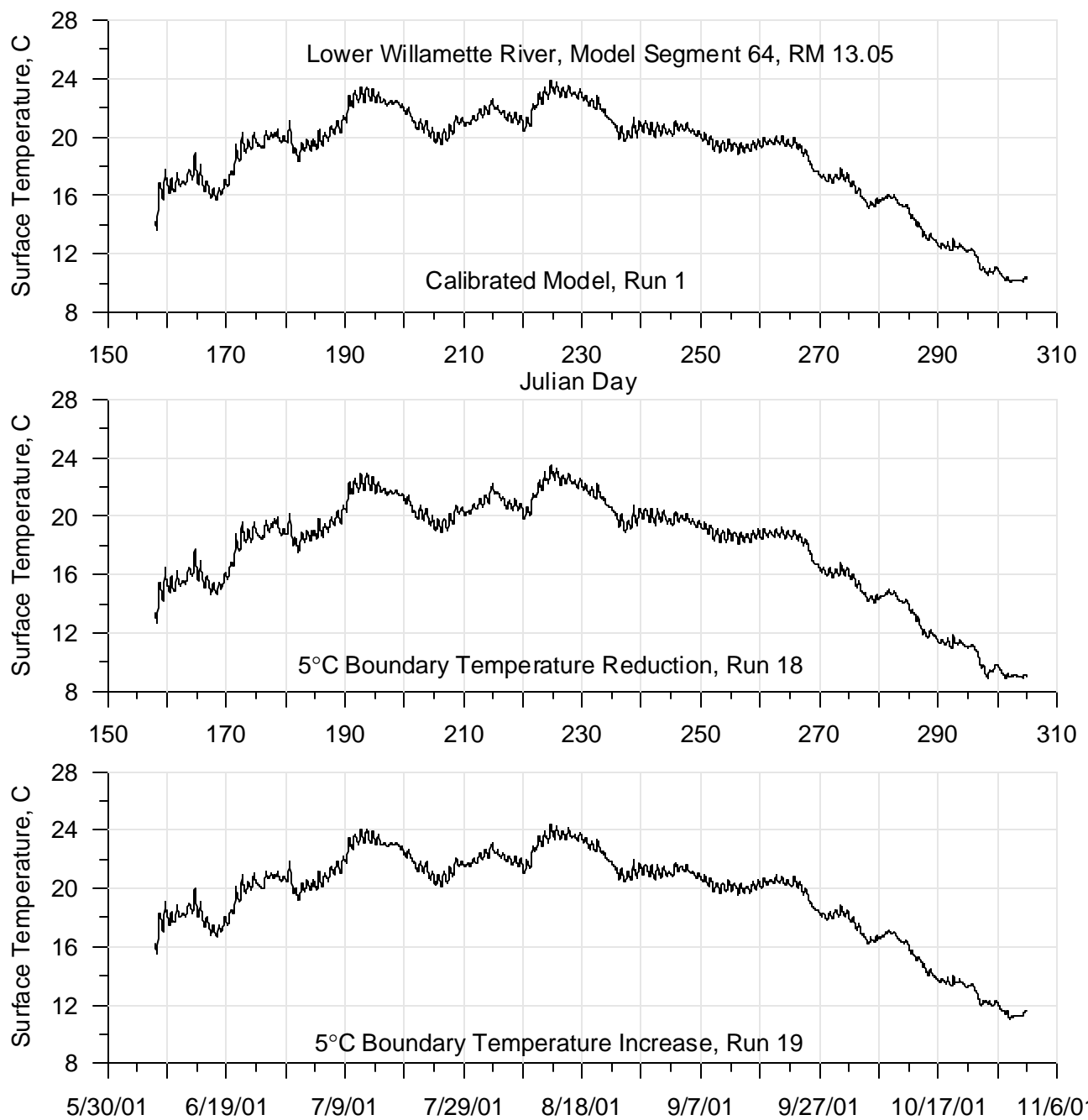


**Figure 545: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Clackamas River at RM 5.07**

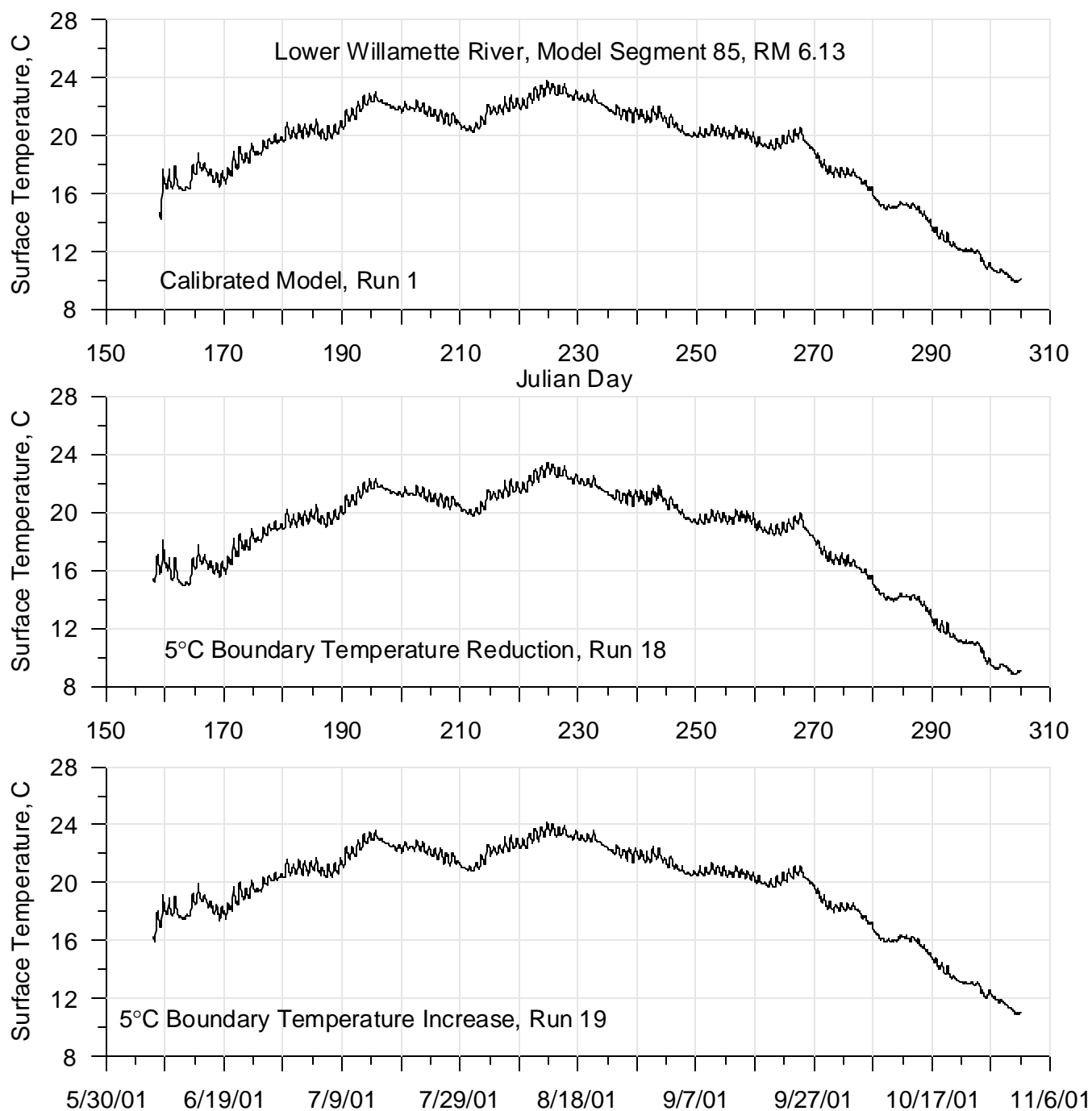


**Figure 546: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 24.8**



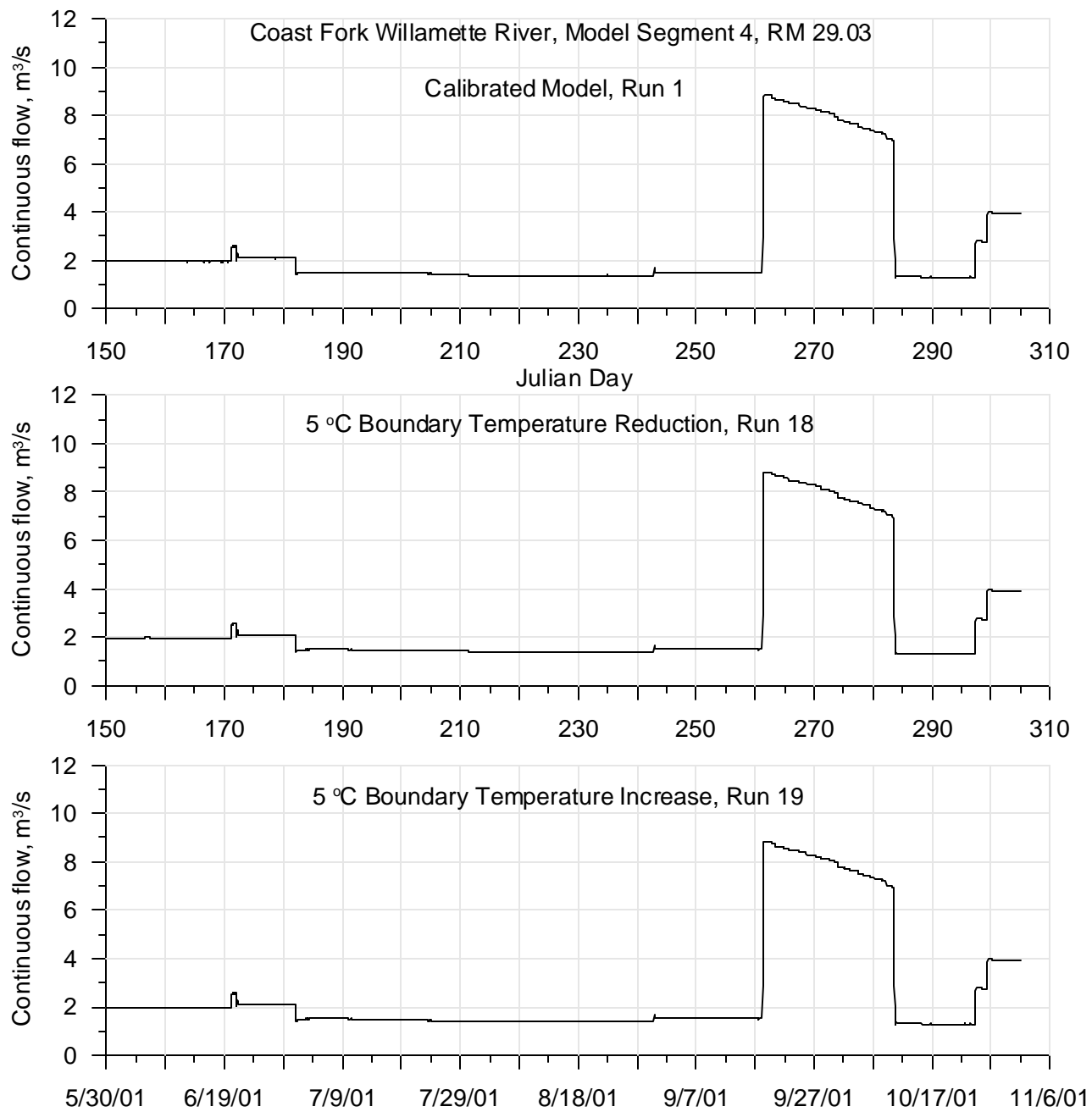


**Figure 547: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 13.05**

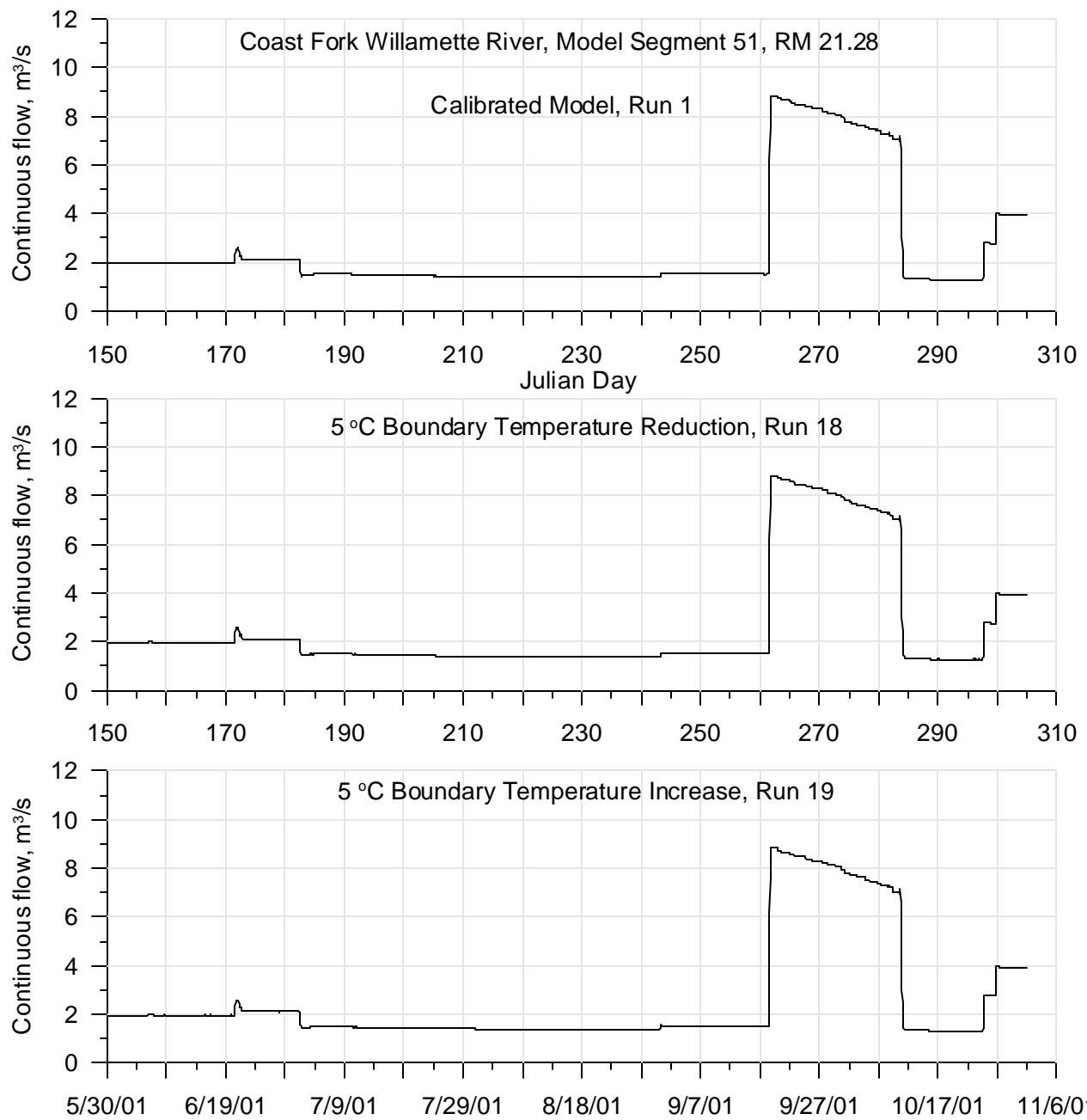


**Figure 548: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous temperature for 2001 for the Willamette River at RM 6.13**

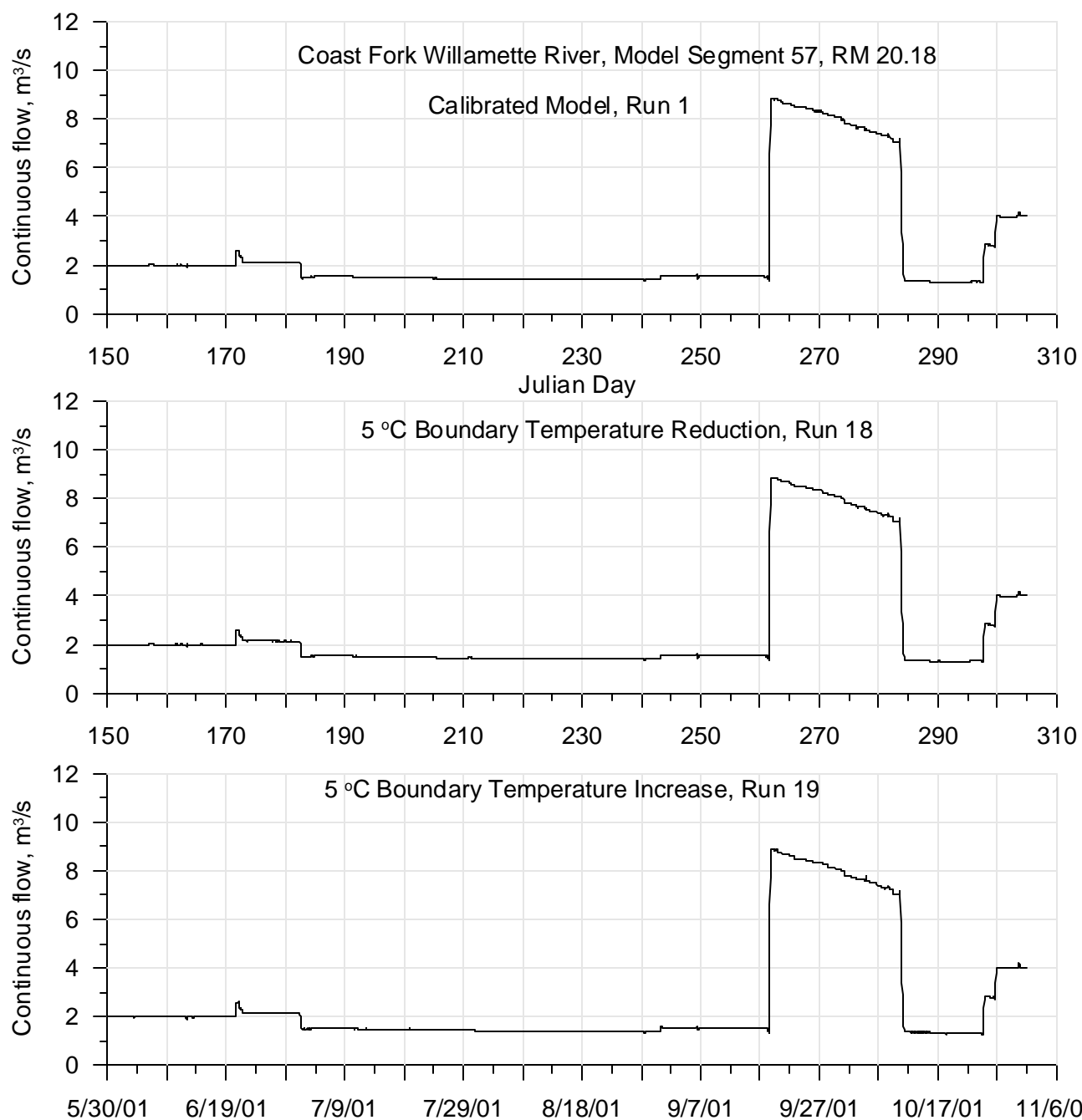
## Continuous Flow



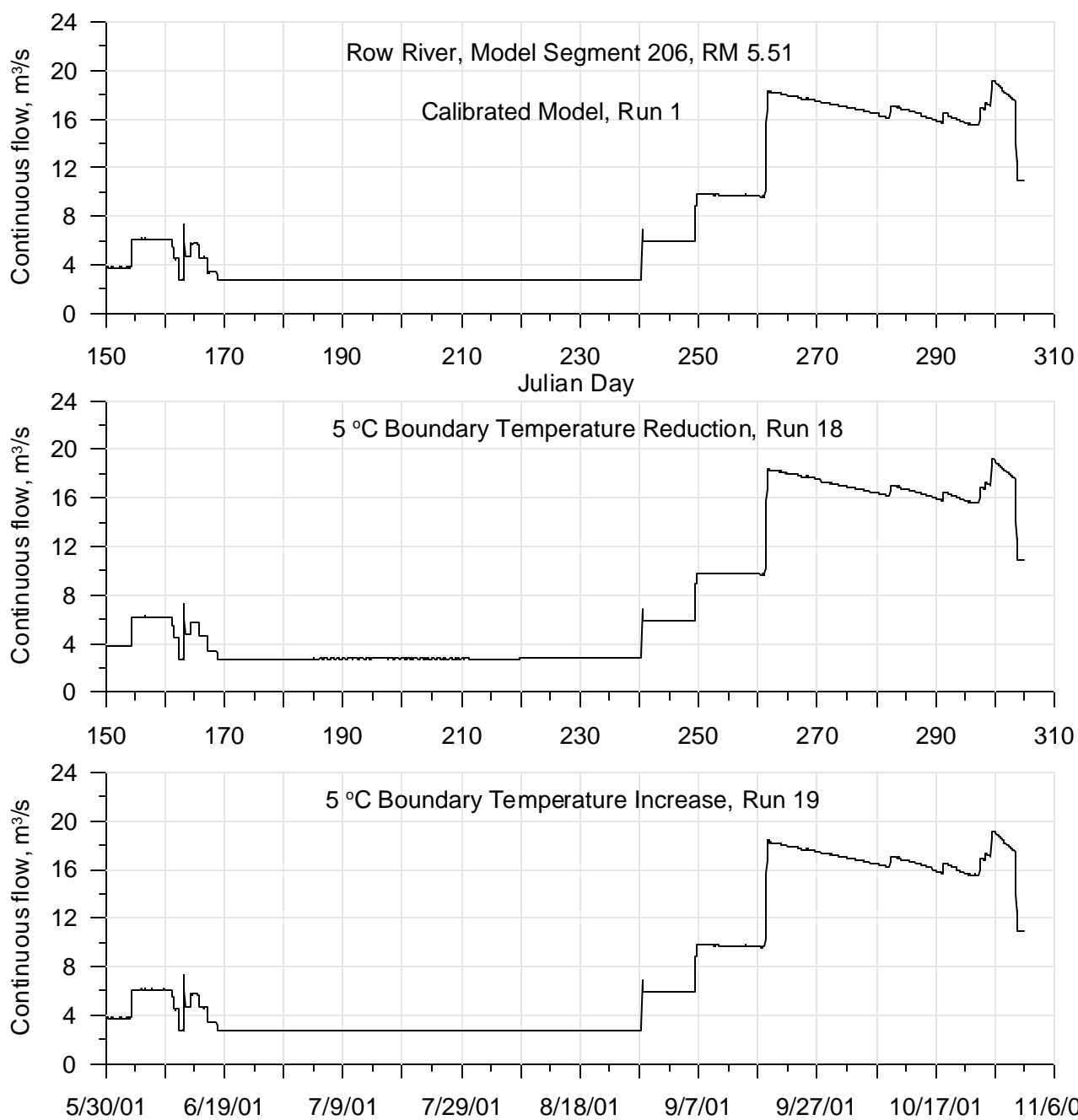
**Figure 549: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Coast Fork Willamette River at RM 29.03**



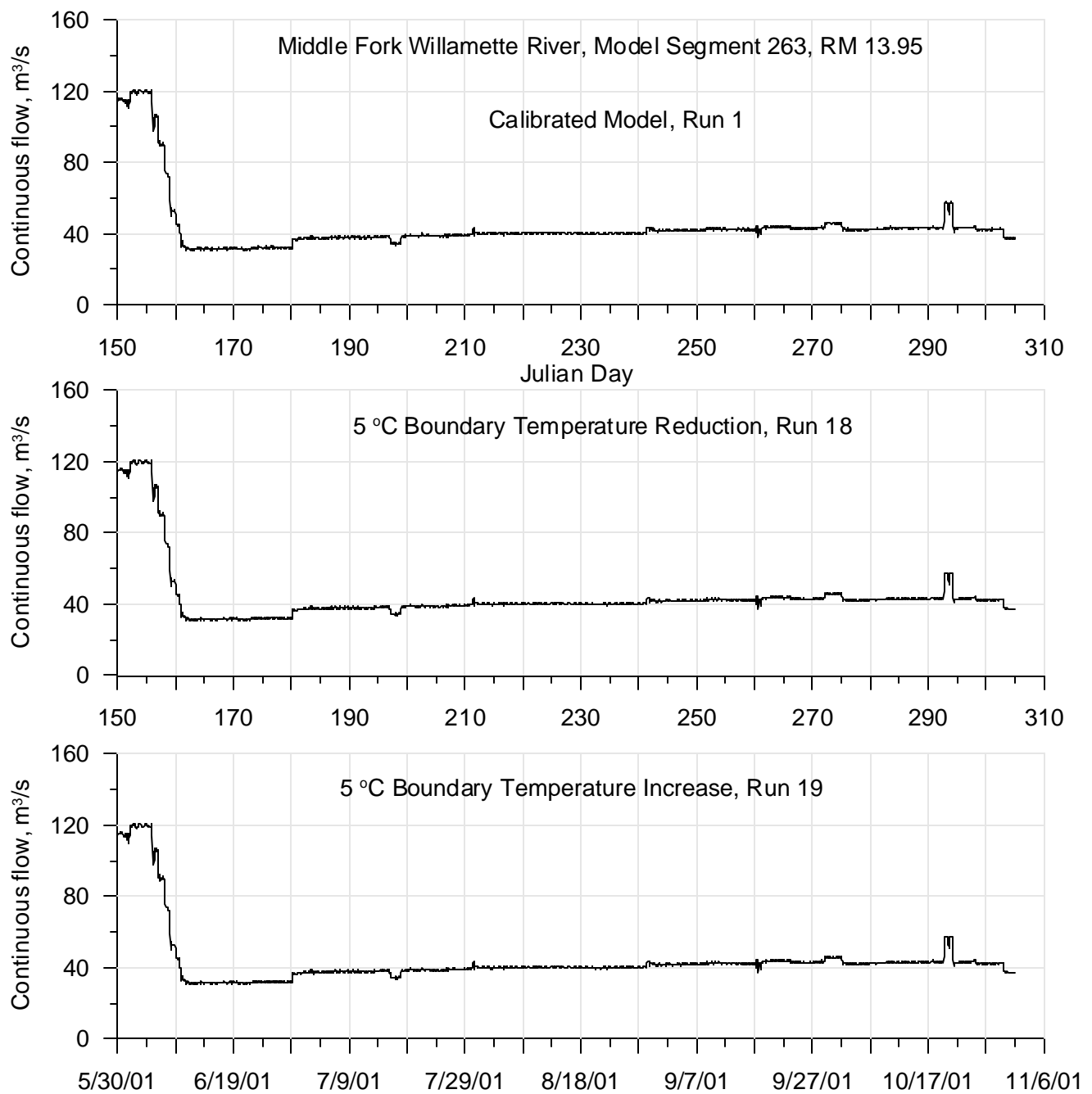
**Figure 550: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Coast Fork Willamette River at RM 21.28**



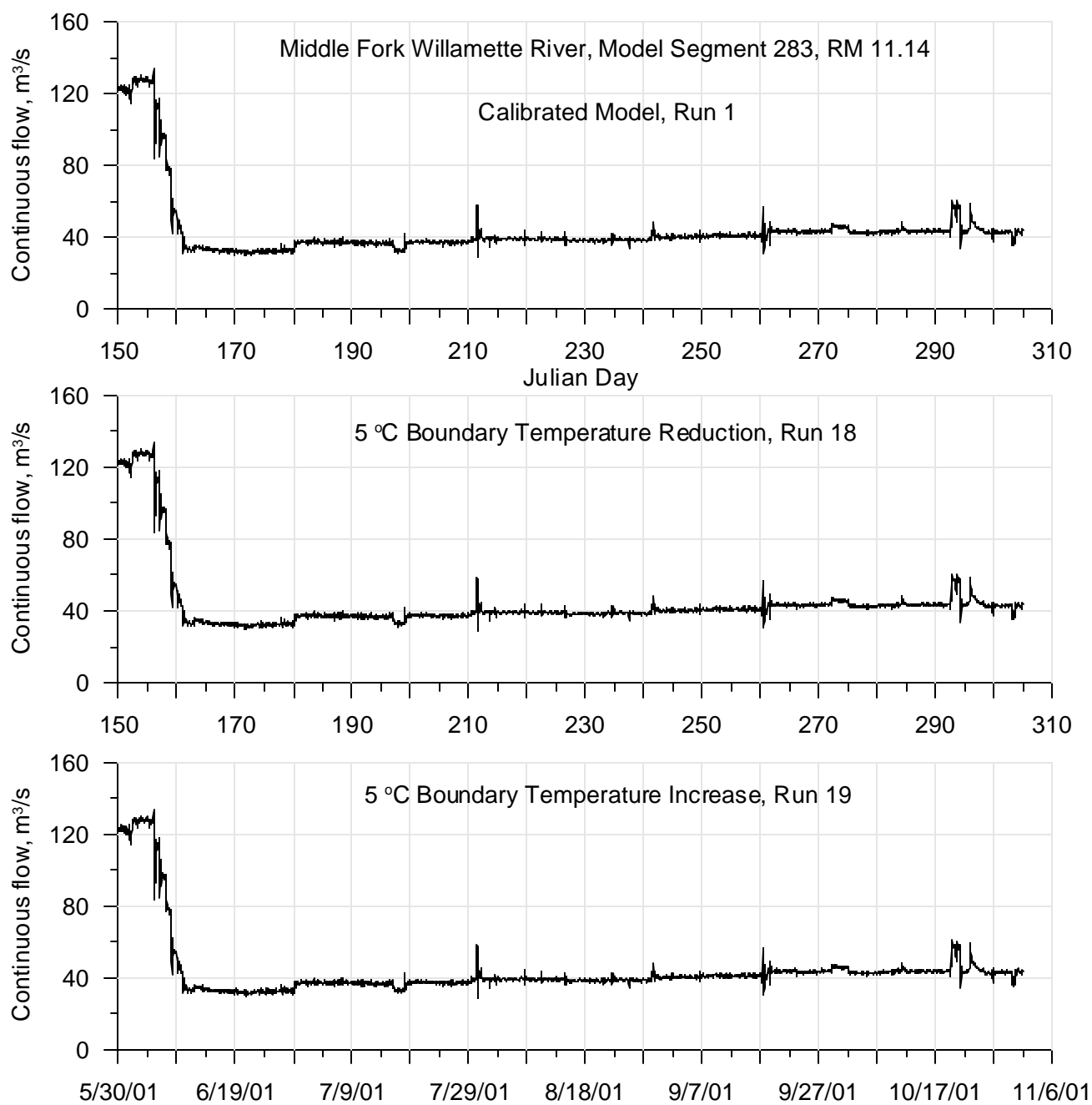
**Figure 551: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Coast Fork Willamette River at RM 20.18**



**Figure 552: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Row River at RM 5.51**

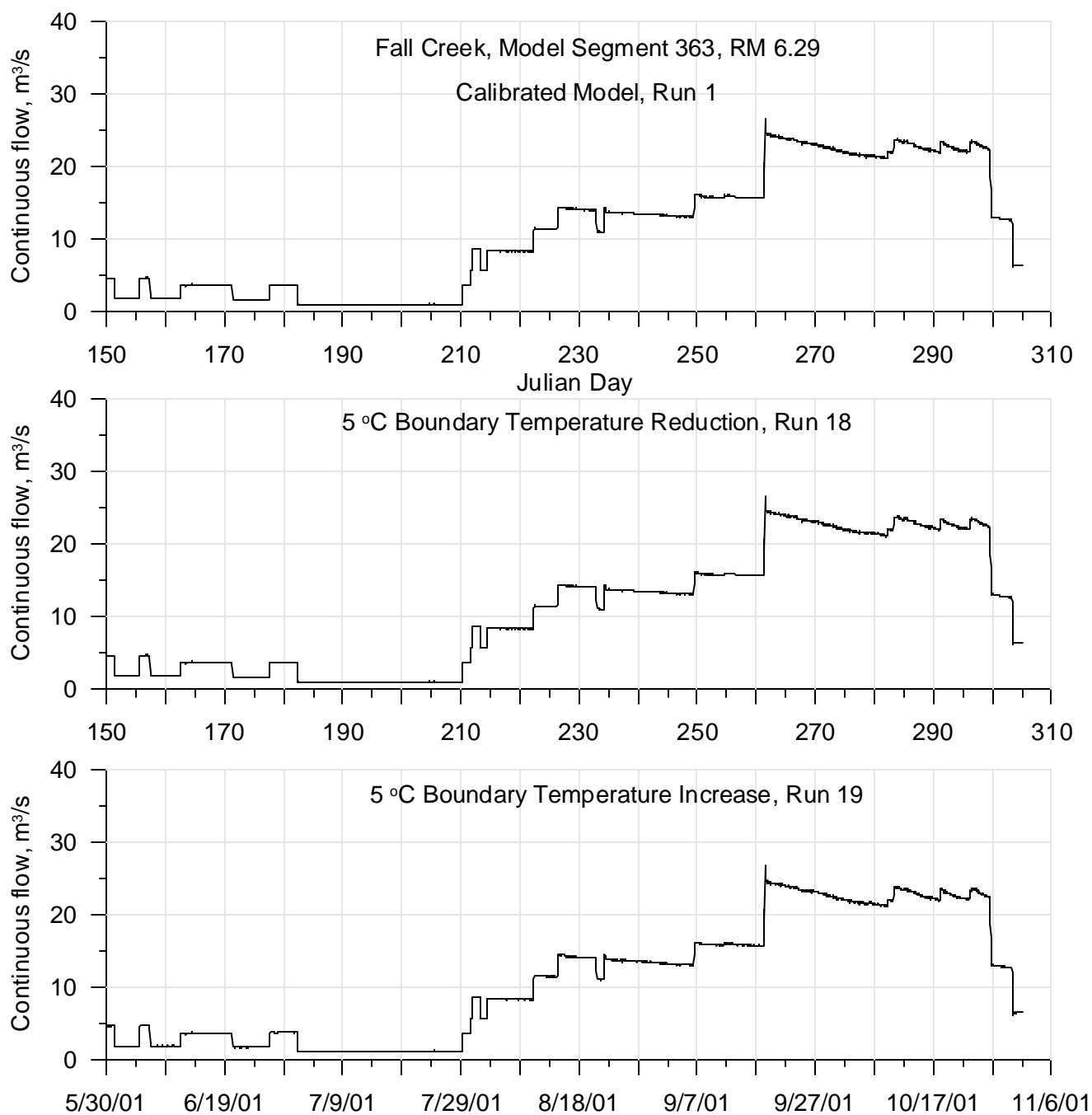


**Figure 553: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Middle Fork Willamette River at RM 13.95**

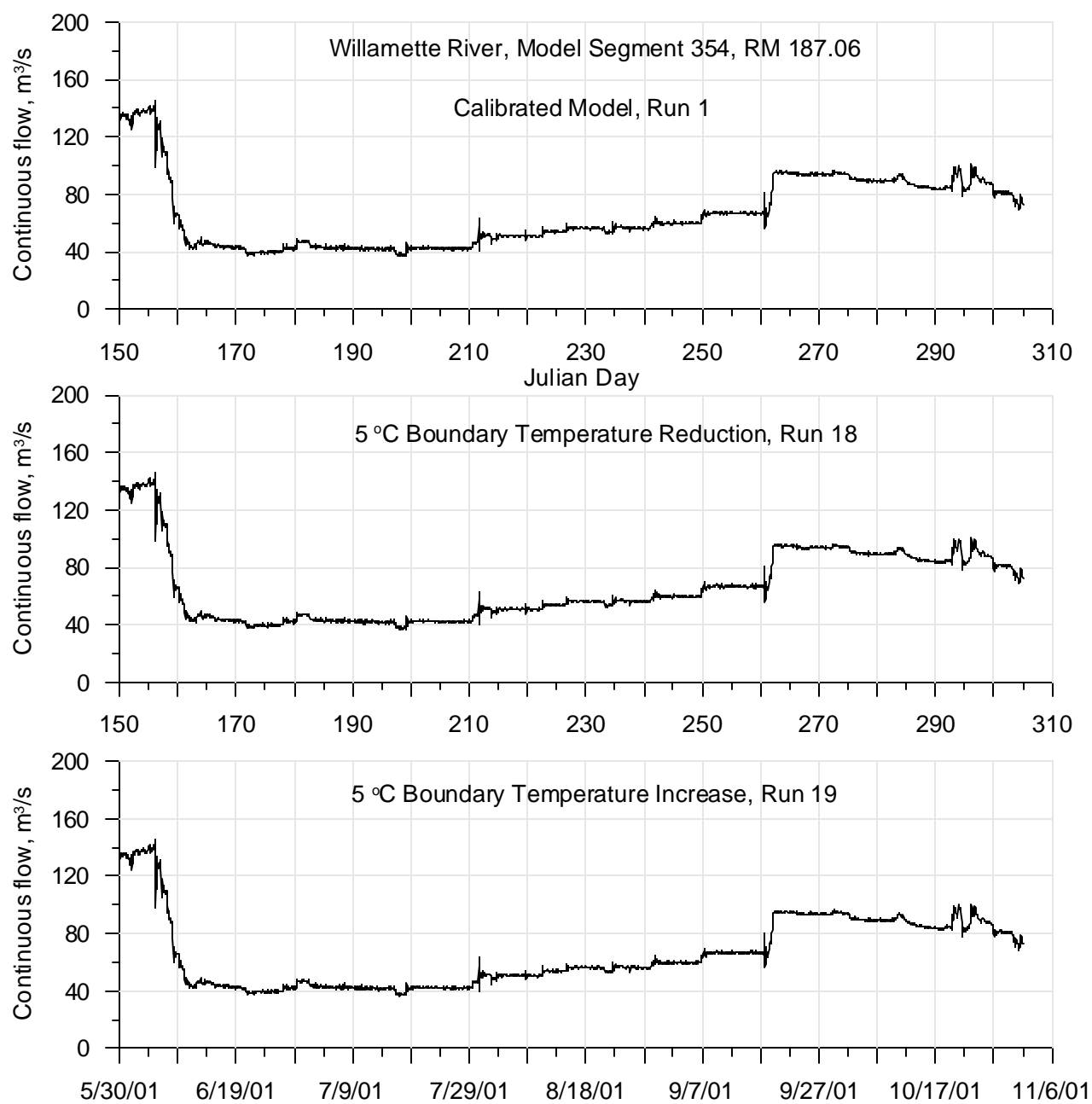


**Figure 554: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Middle Fork Willamette River at RM 11.14**

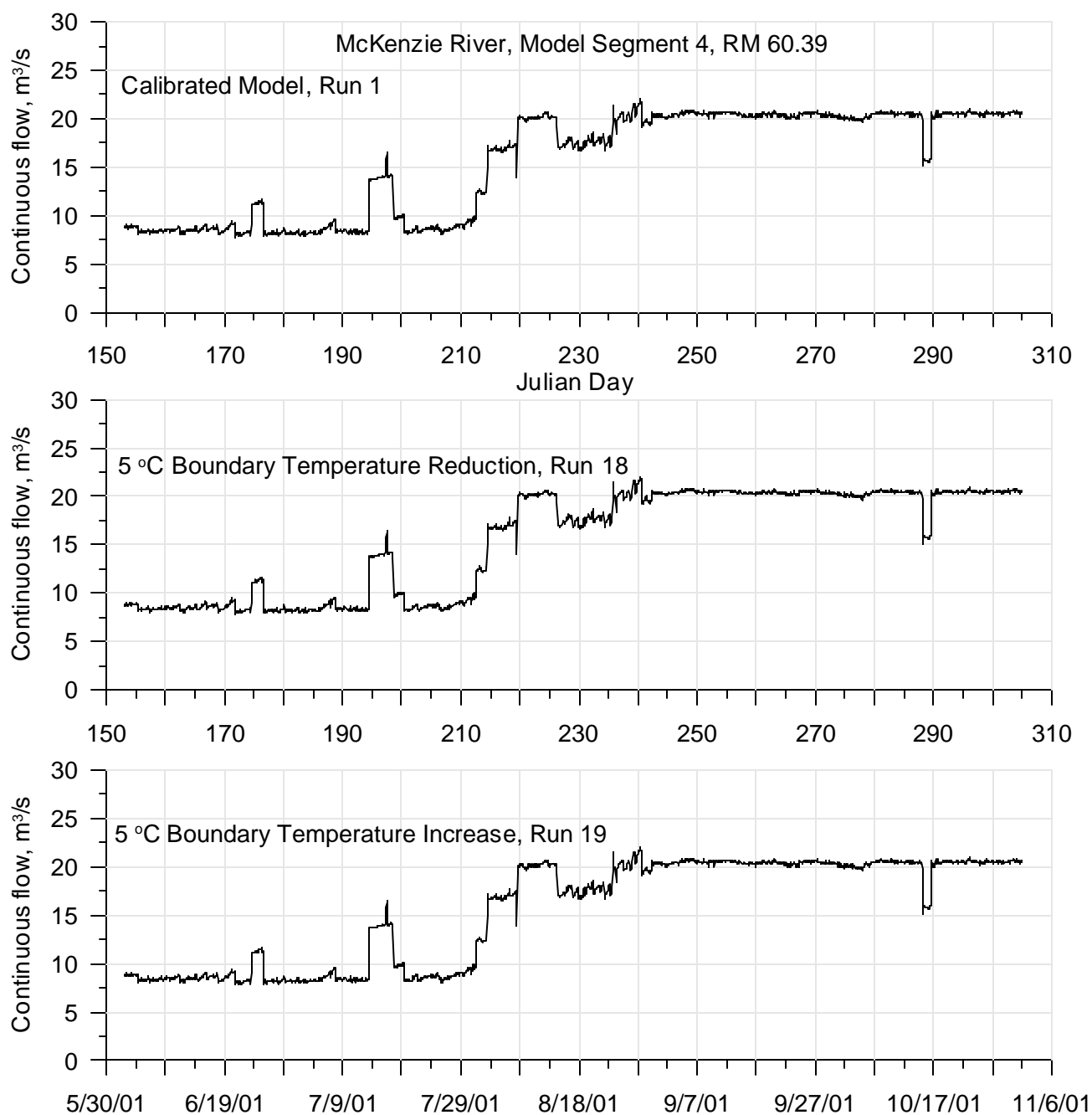




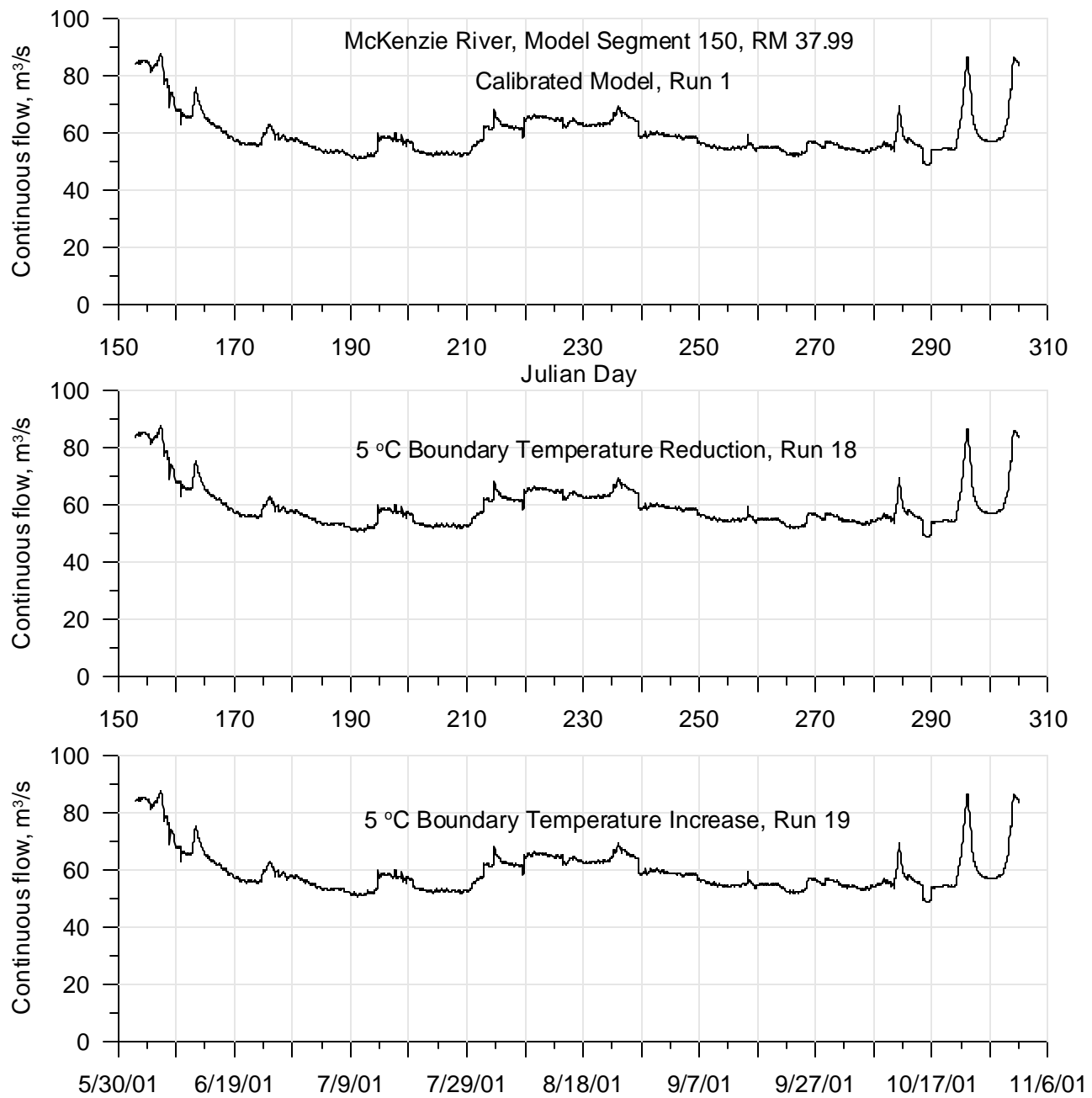
**Figure 555: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for Fall Creek at RM 6.29**



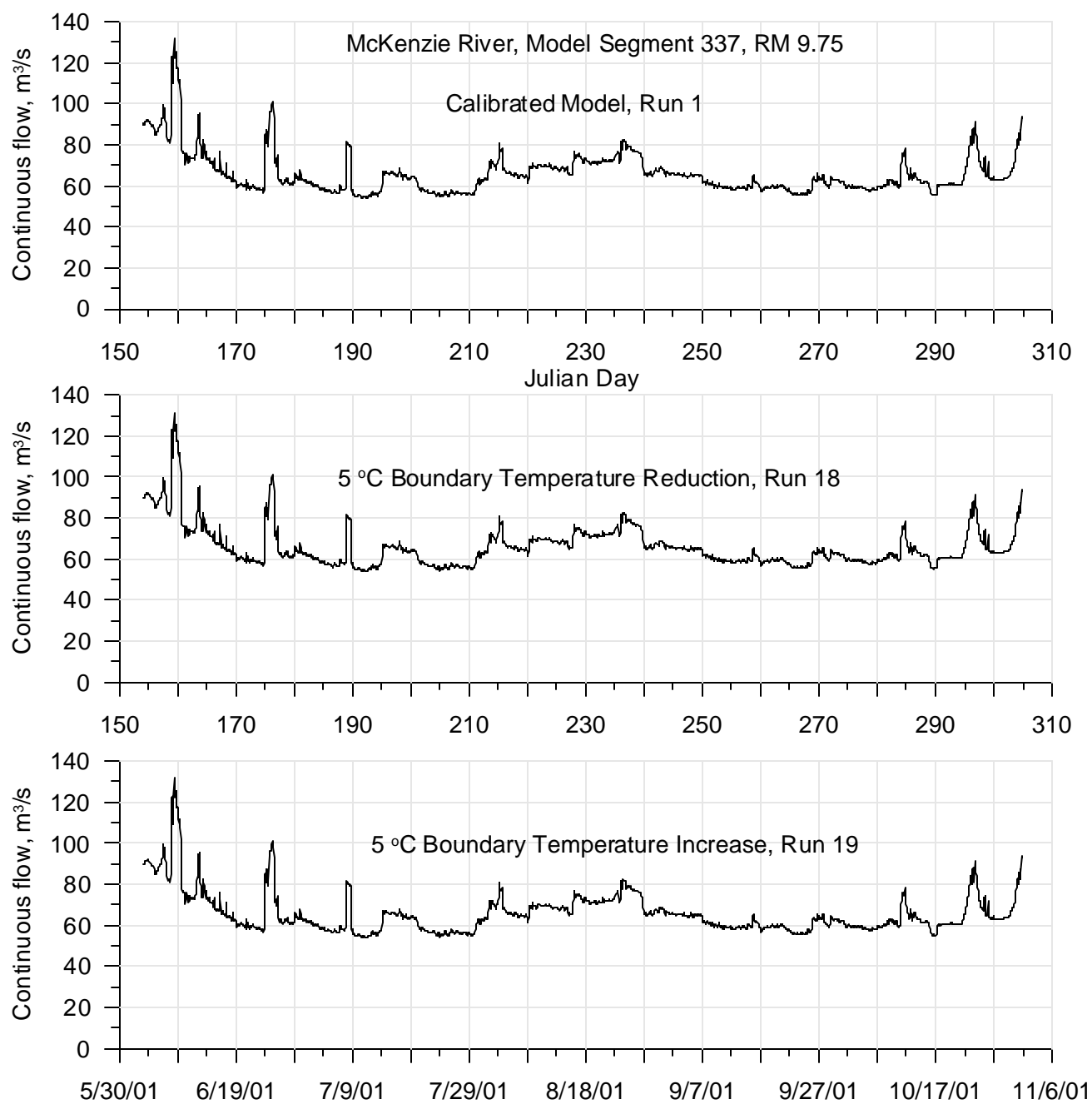
**Figure 556: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 187.06**



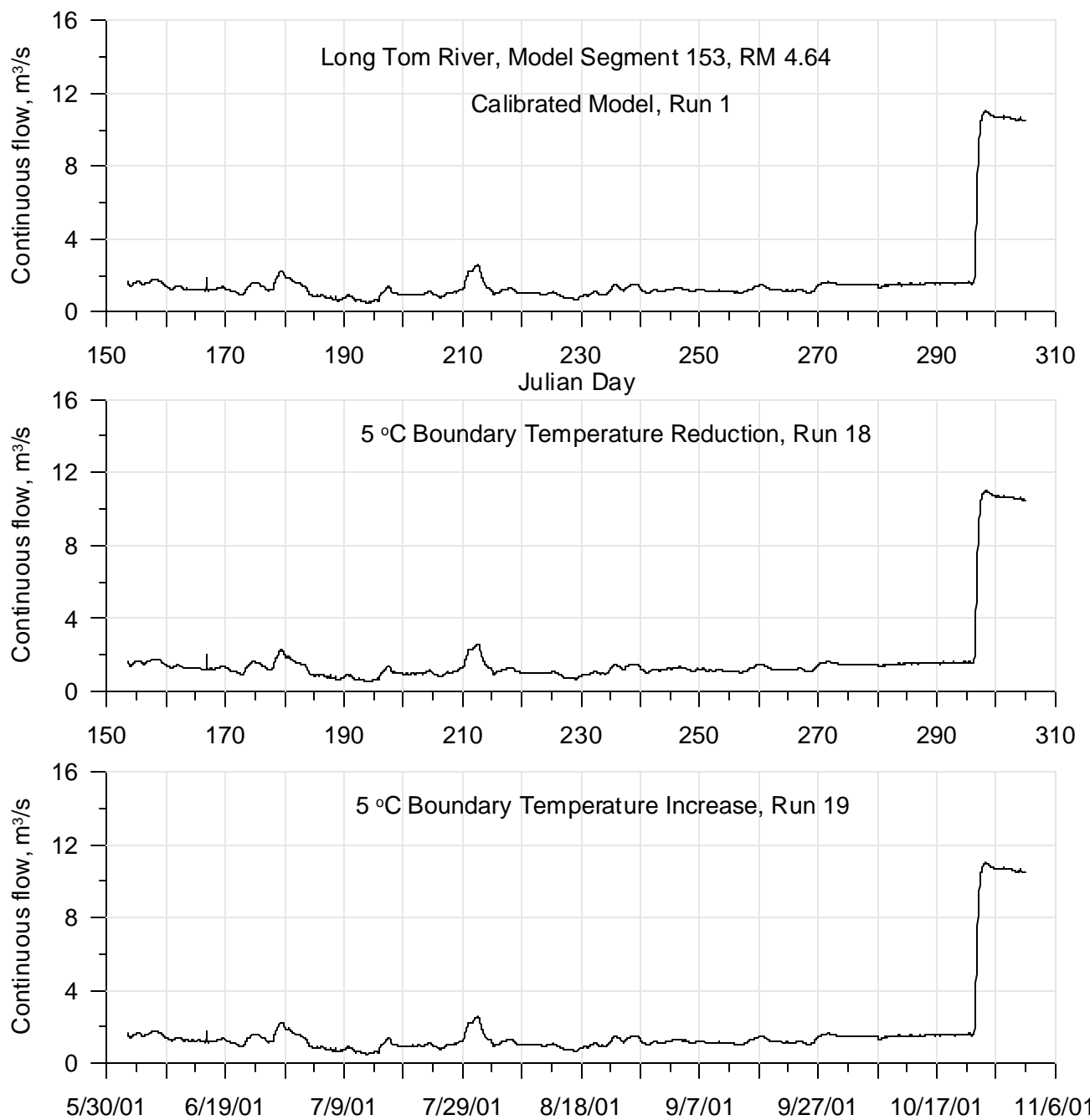
**Figure 557: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the McKenzie River at RM 60.39**



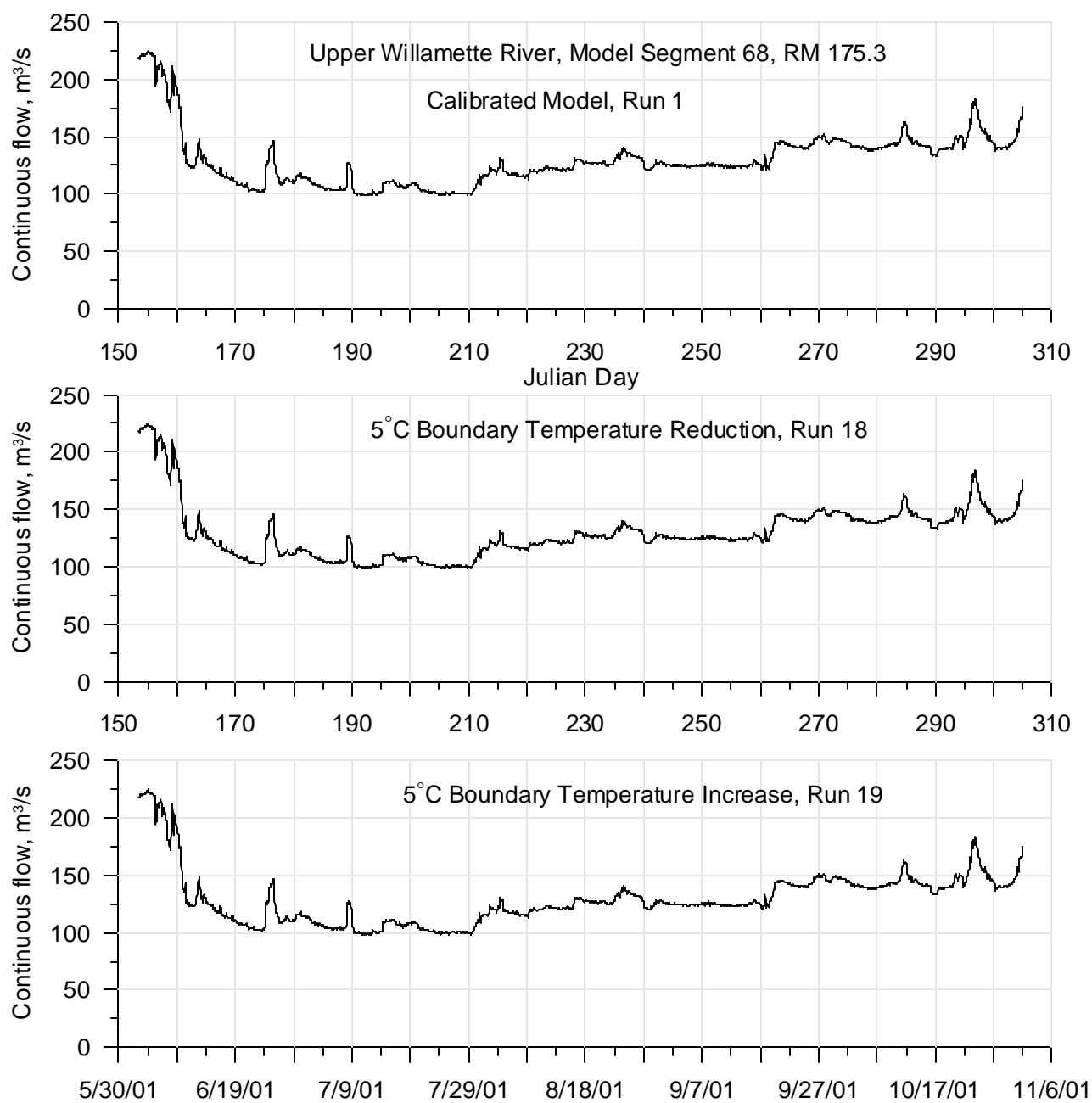
**Figure 558: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the McKenzie River at RM 37.99**



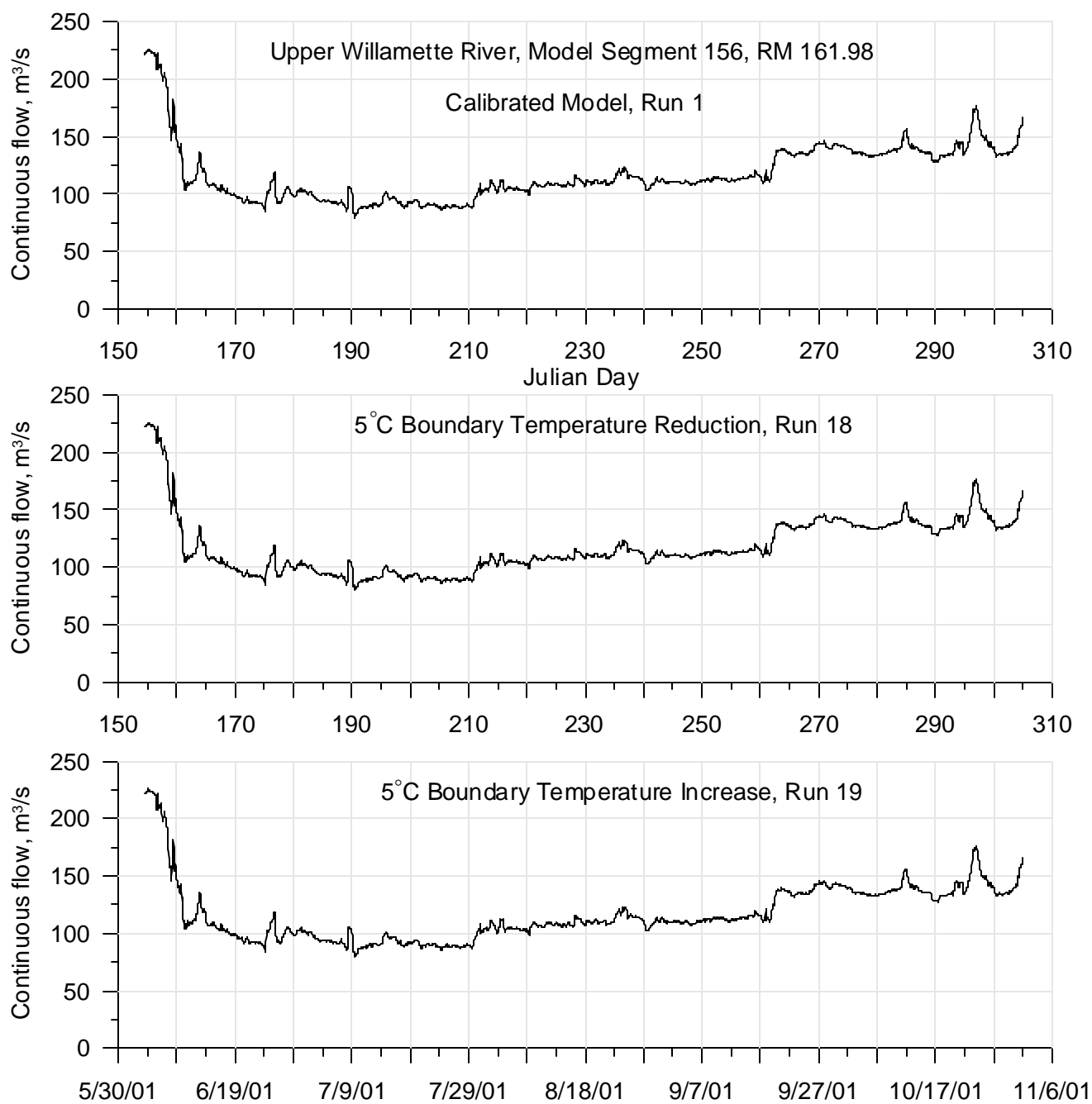
**Figure 559: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the McKenzie River at RM 9.75**



**Figure 560: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Long Tom River at RM 4.64**

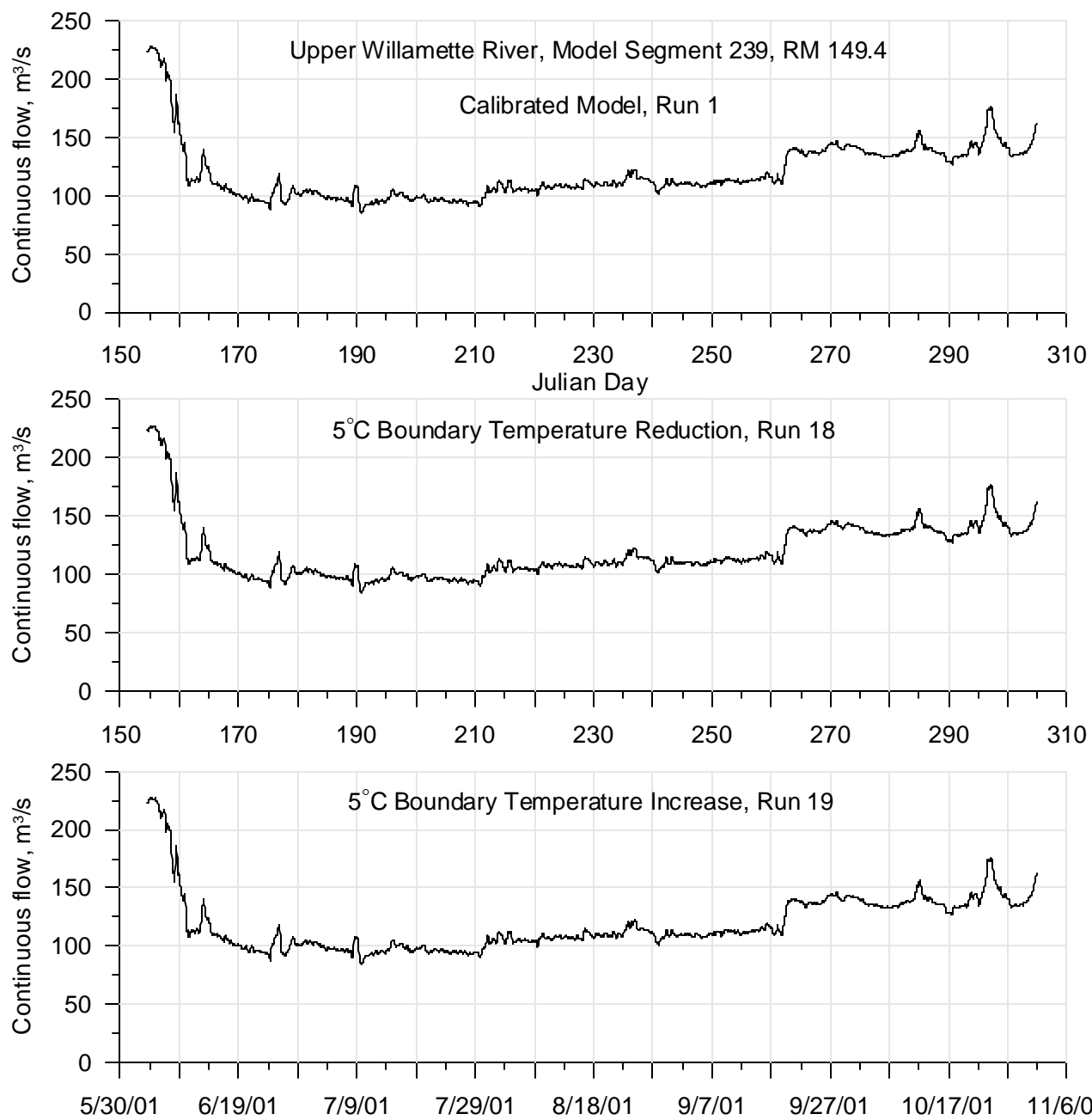


**Figure 561: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 175.3**

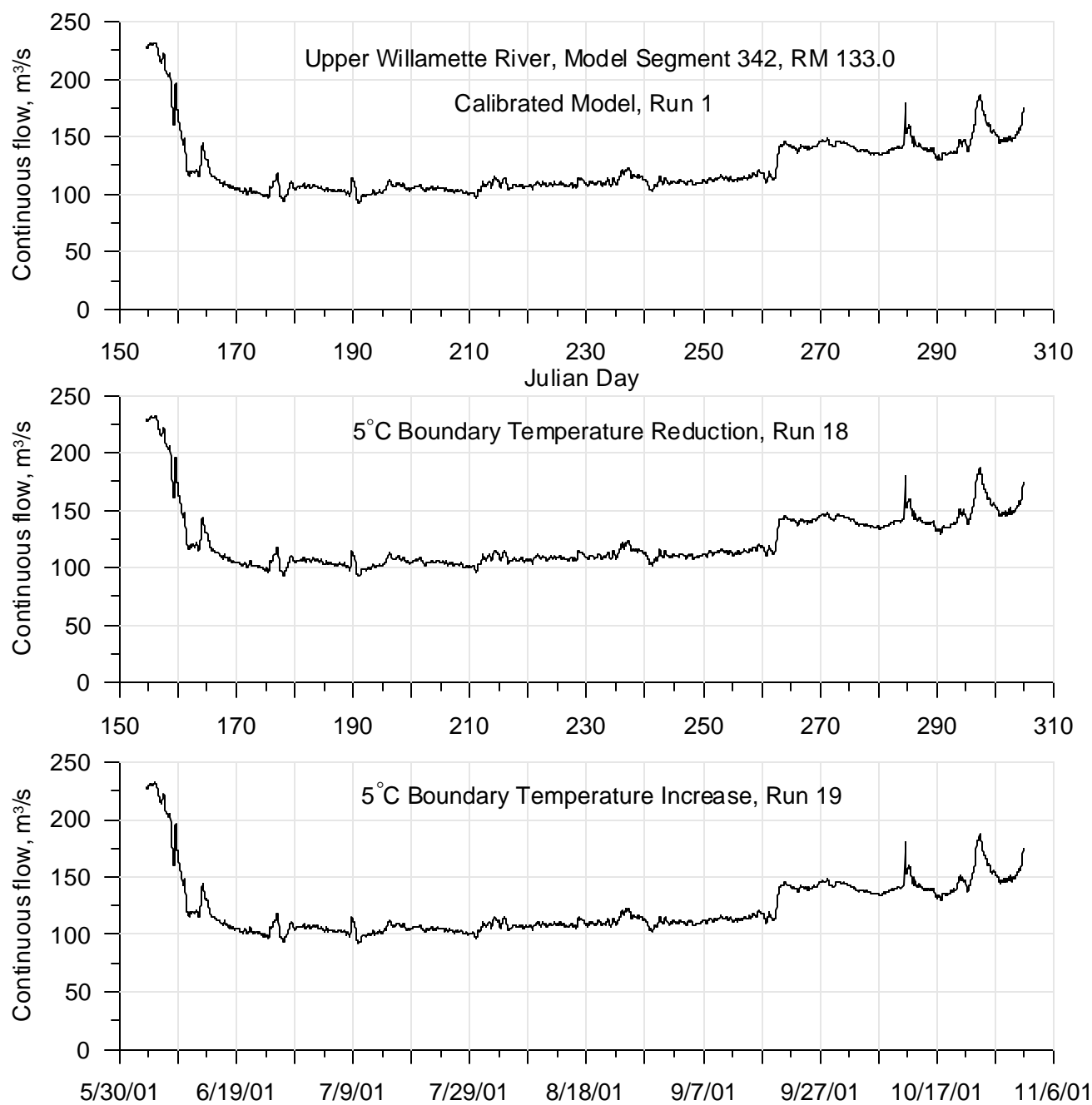


**Figure 562: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 161.98**

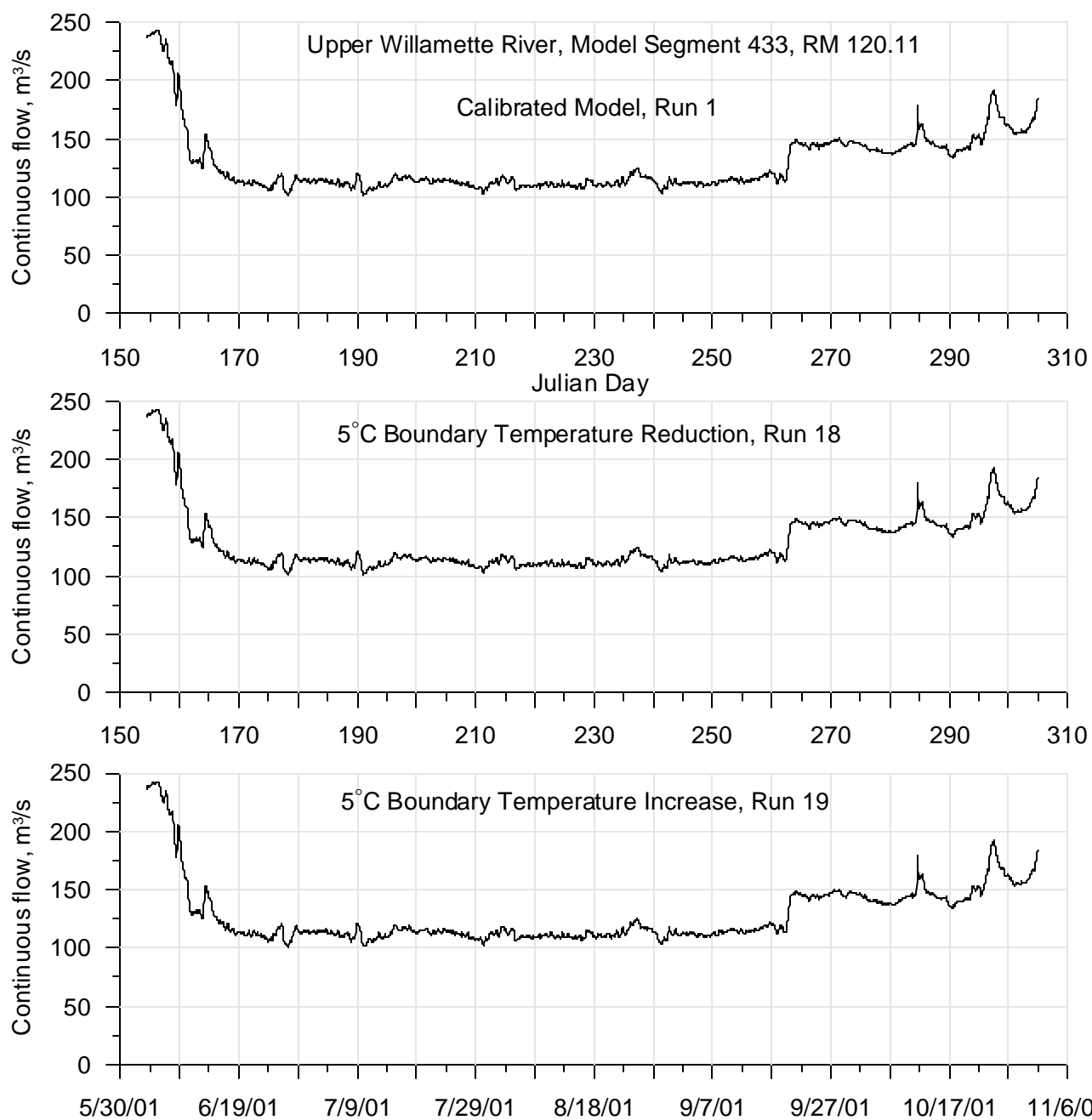




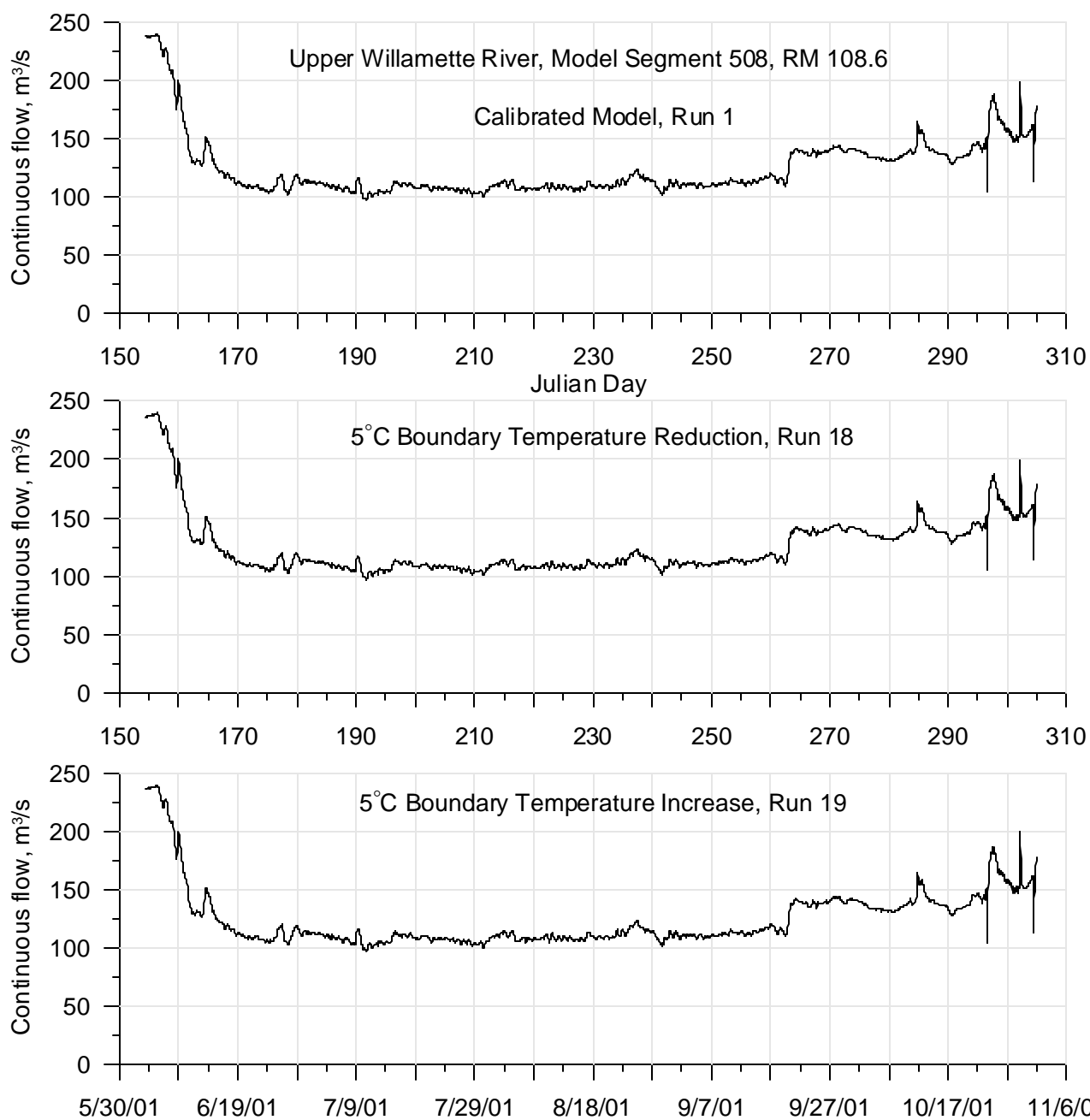
**Figure 563: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 169.4**



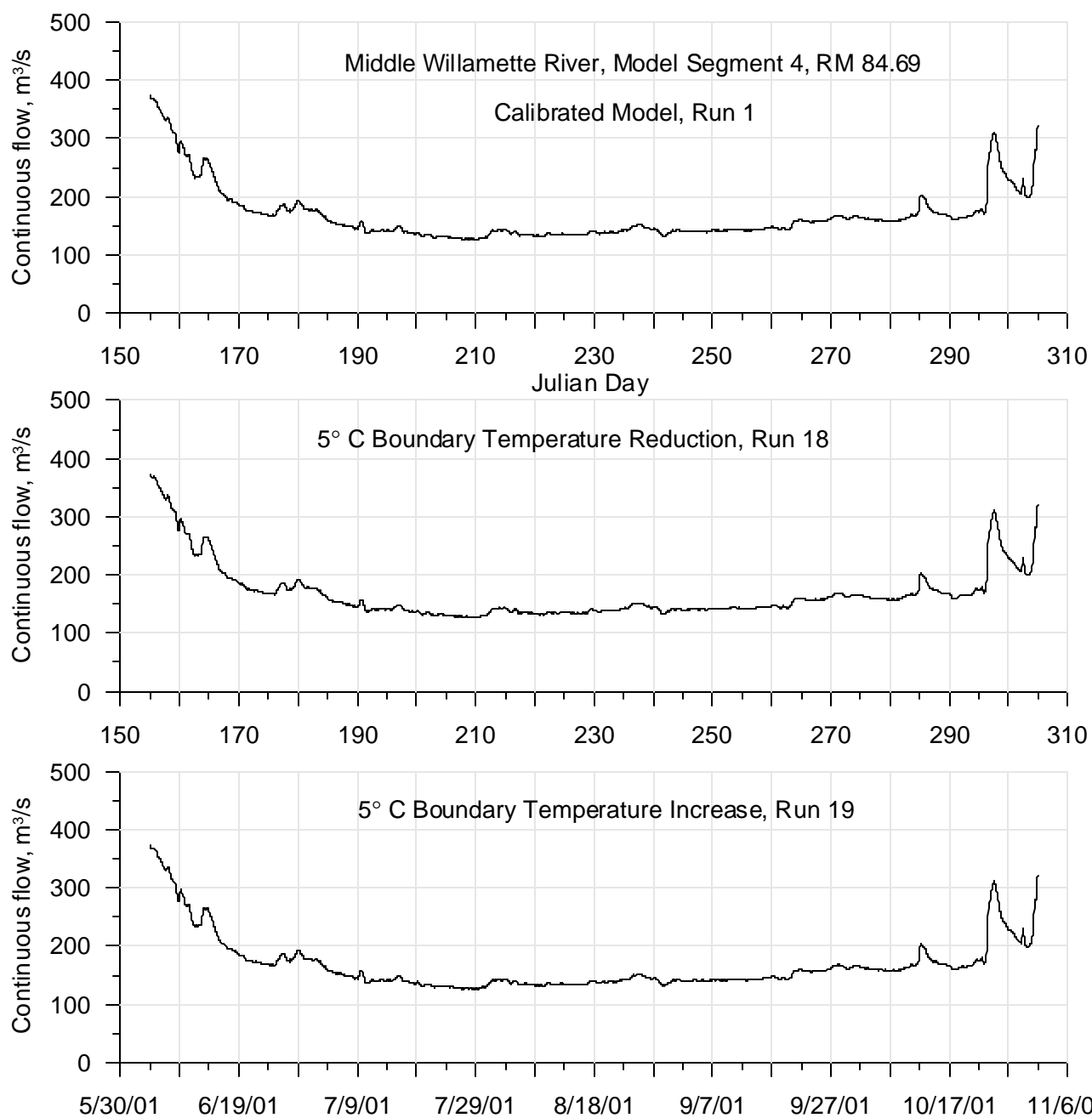
**Figure 564: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 133**



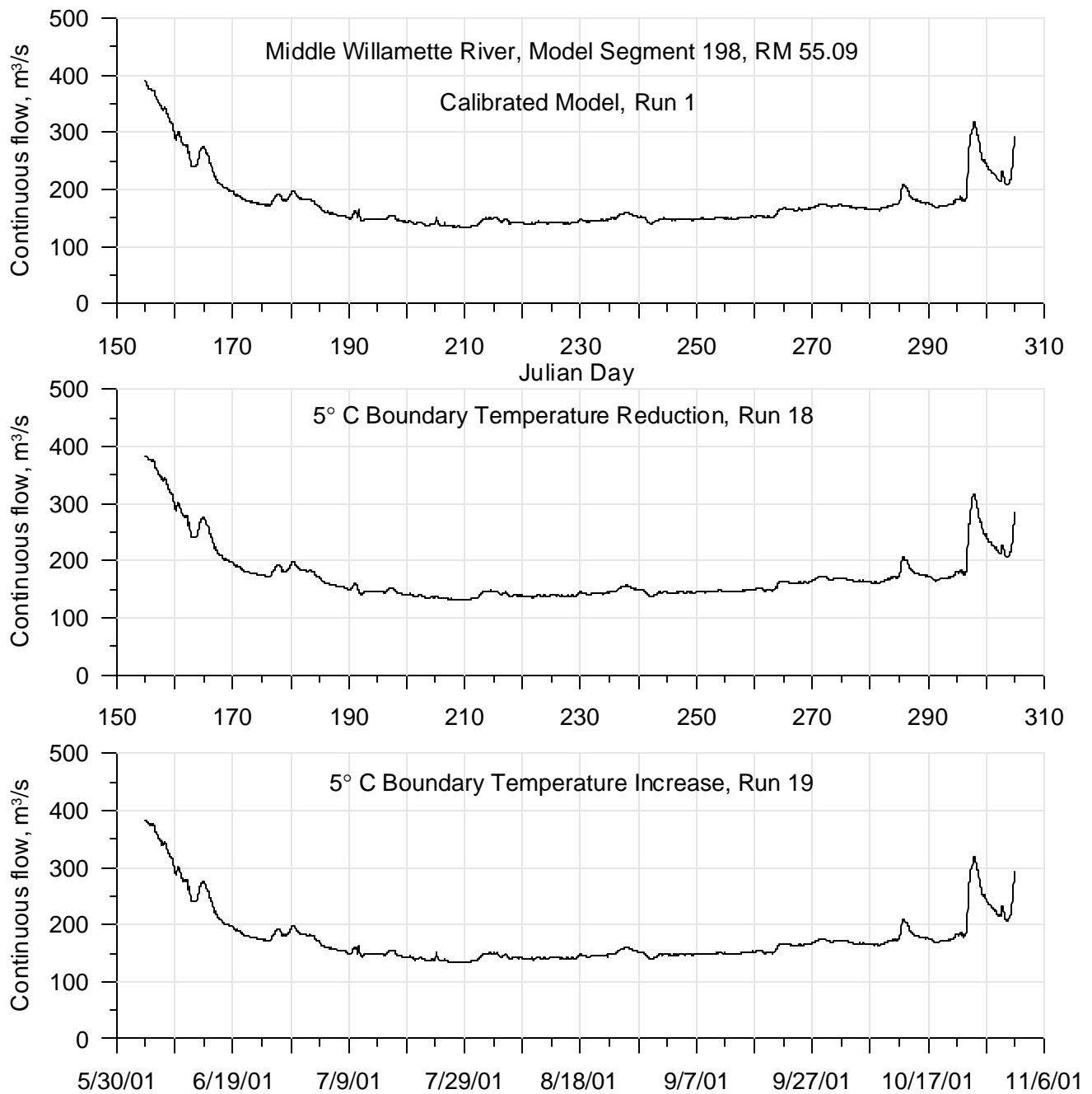
**Figure 565: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 120.11**



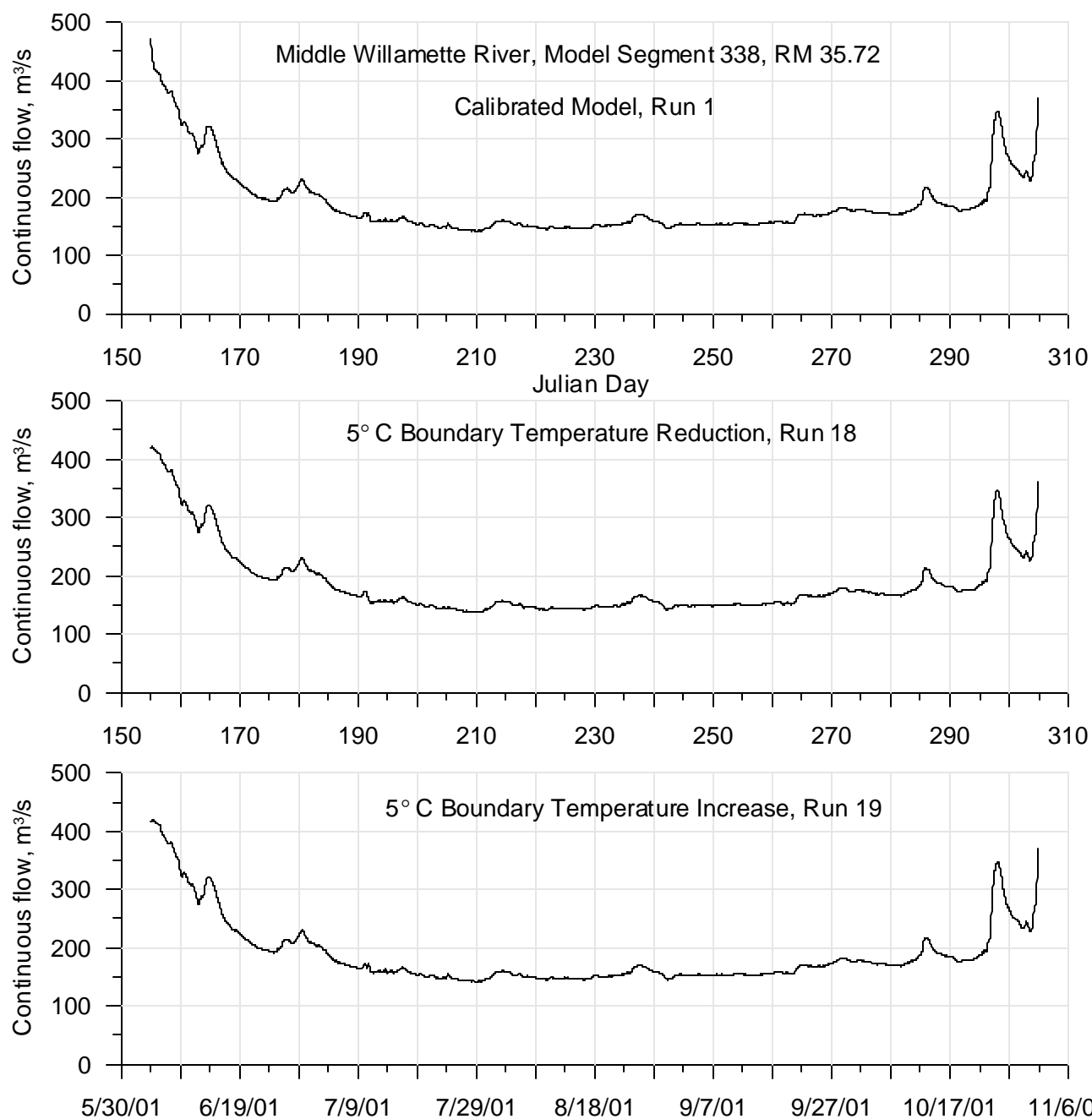
**Figure 566: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 108.6**



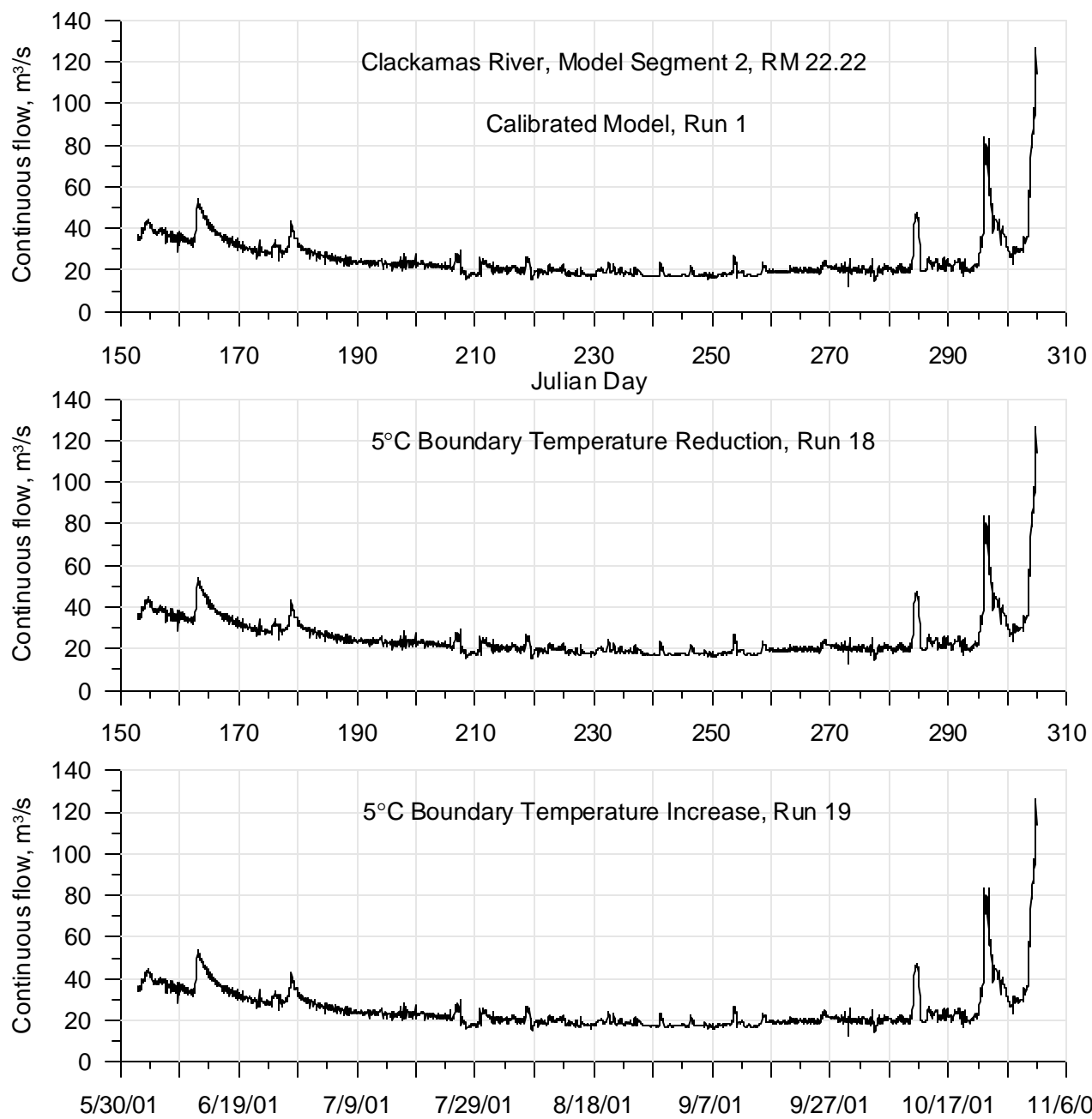
**Figure 567: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 84.69**



**Figure 568: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 55.09**

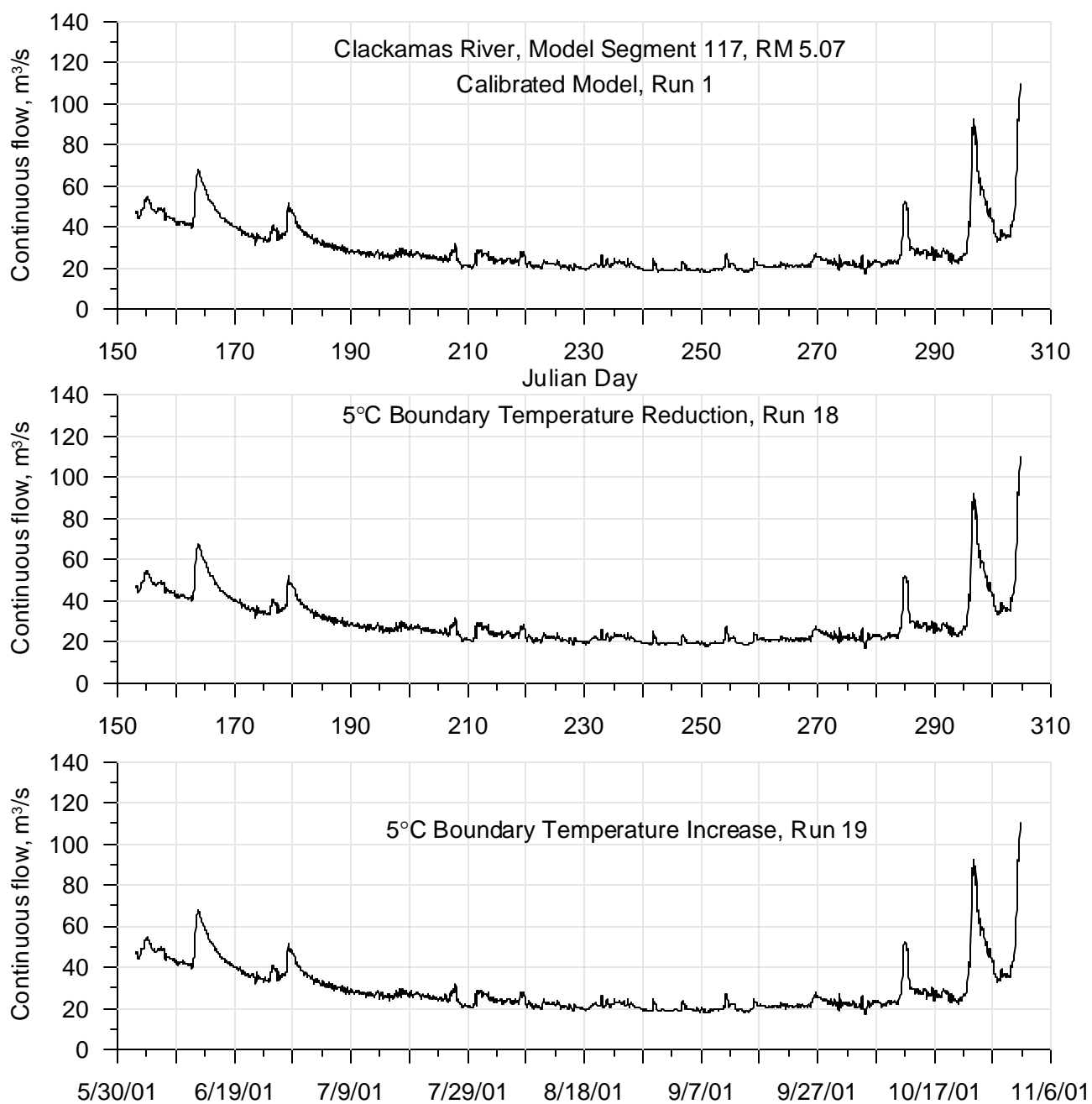


**Figure 569: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 35.72**

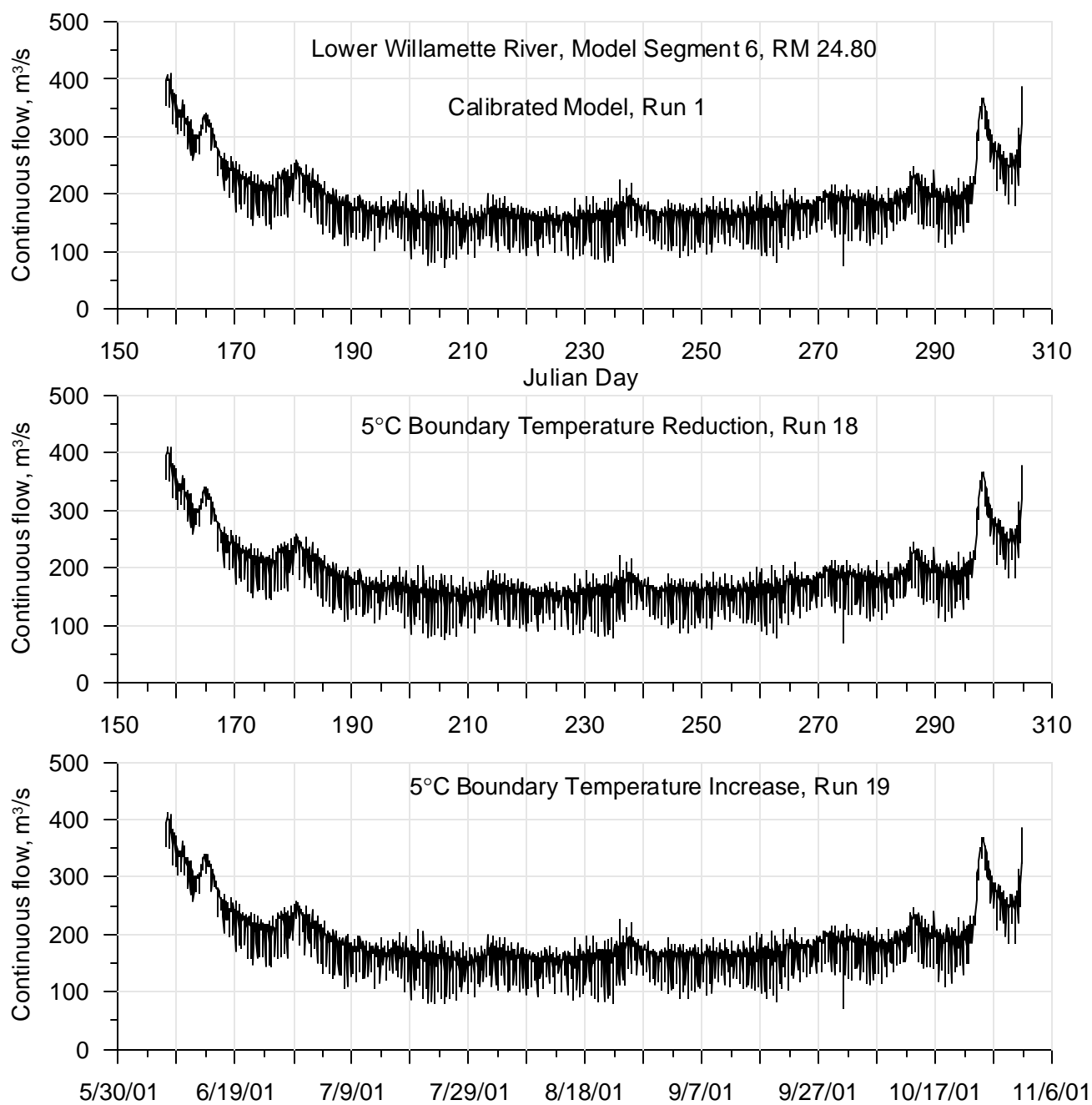


**Figure 570: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Clackamas River at RM 22.22**

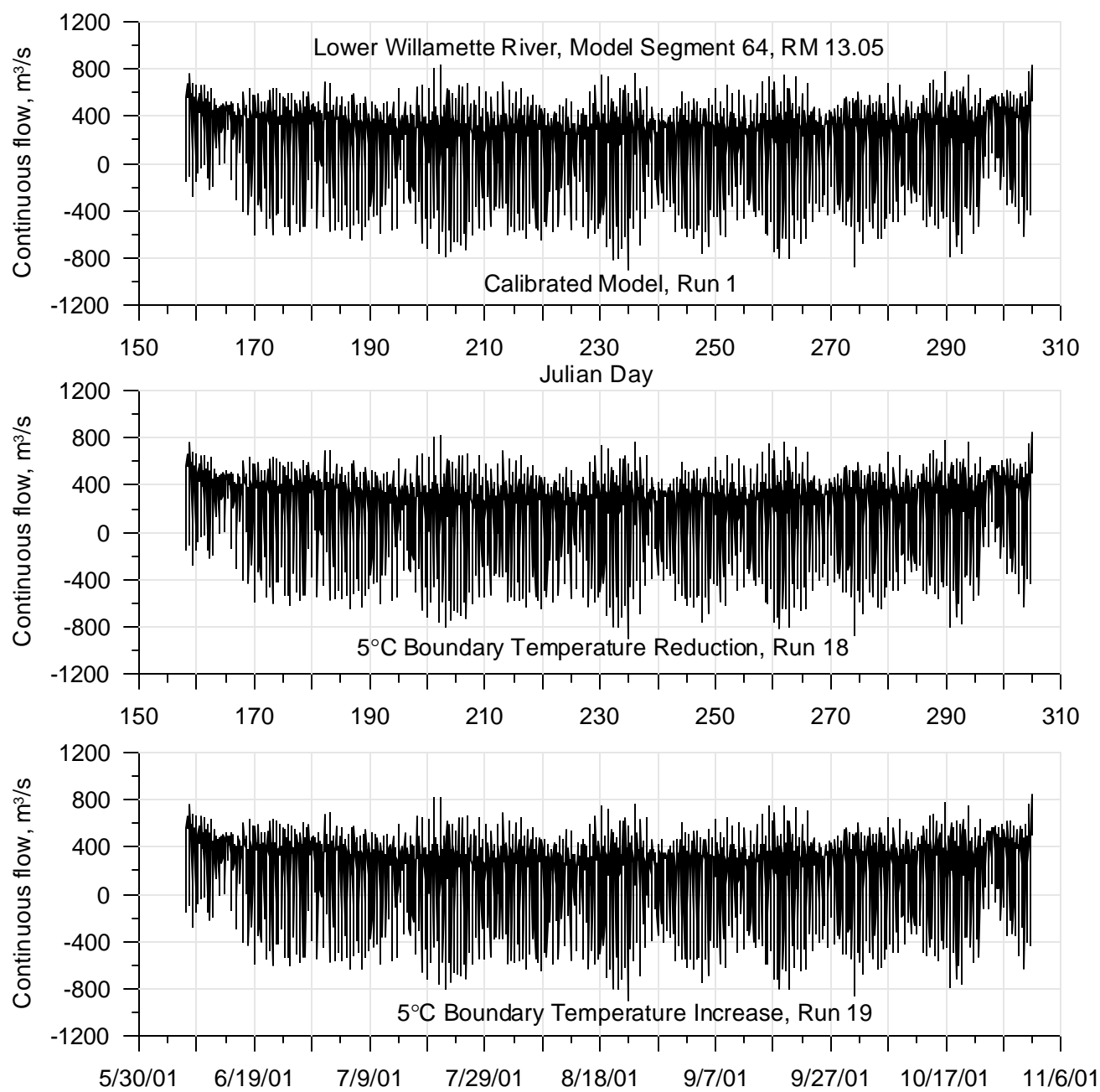




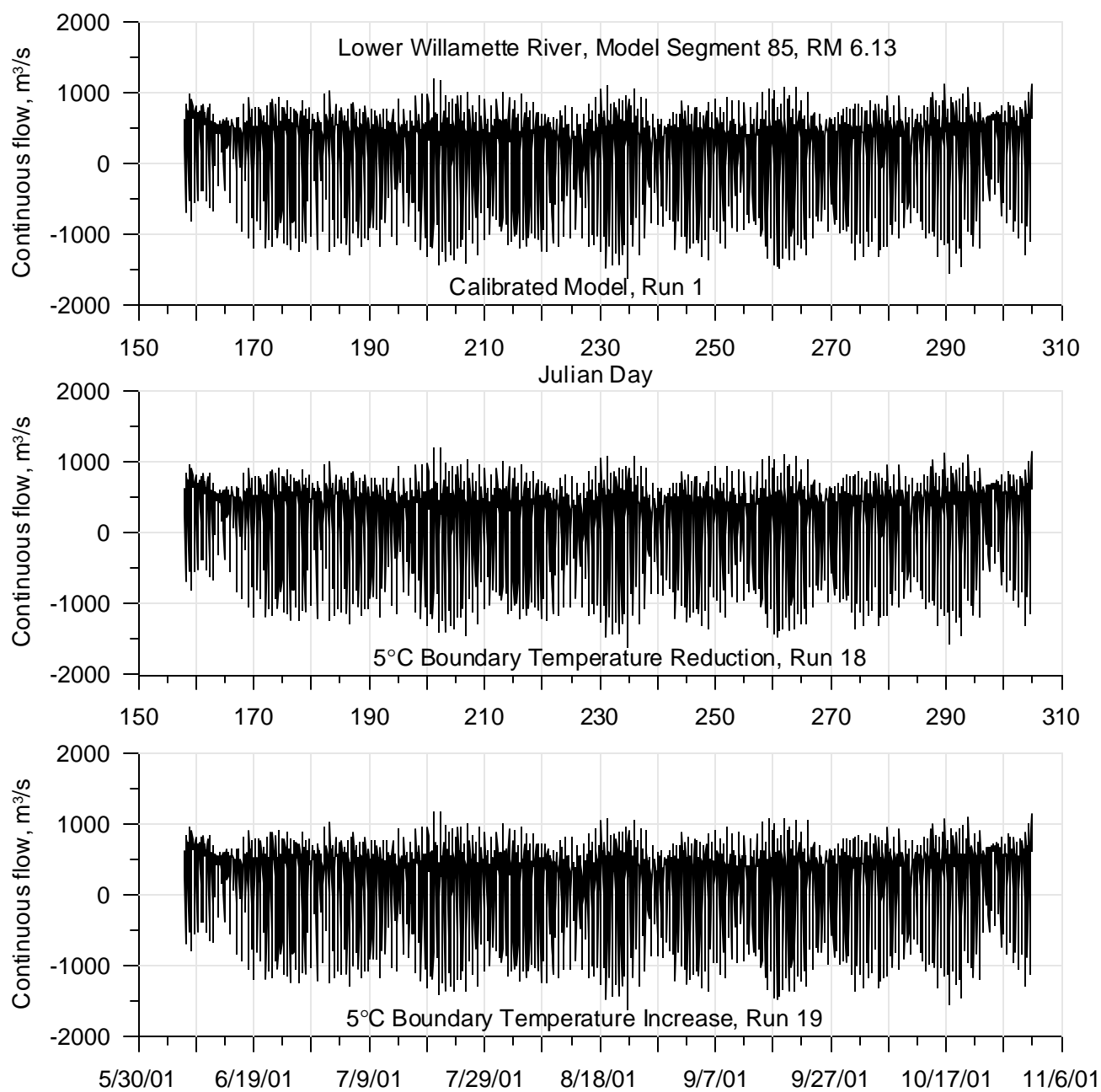
**Figure 571: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Clackamas River at RM 5.07**



**Figure 572: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 24.8**

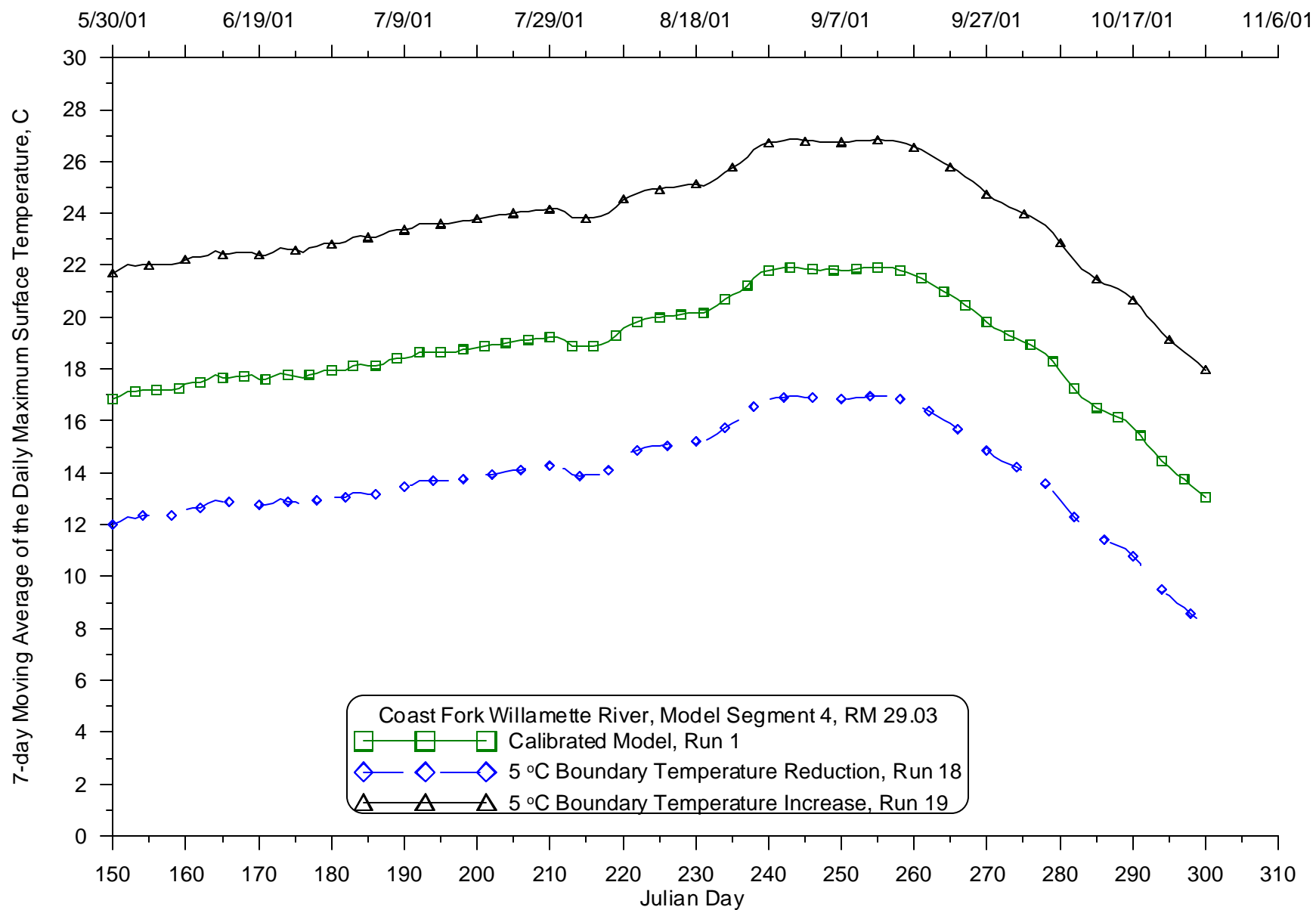


**Figure 573: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 13.05**

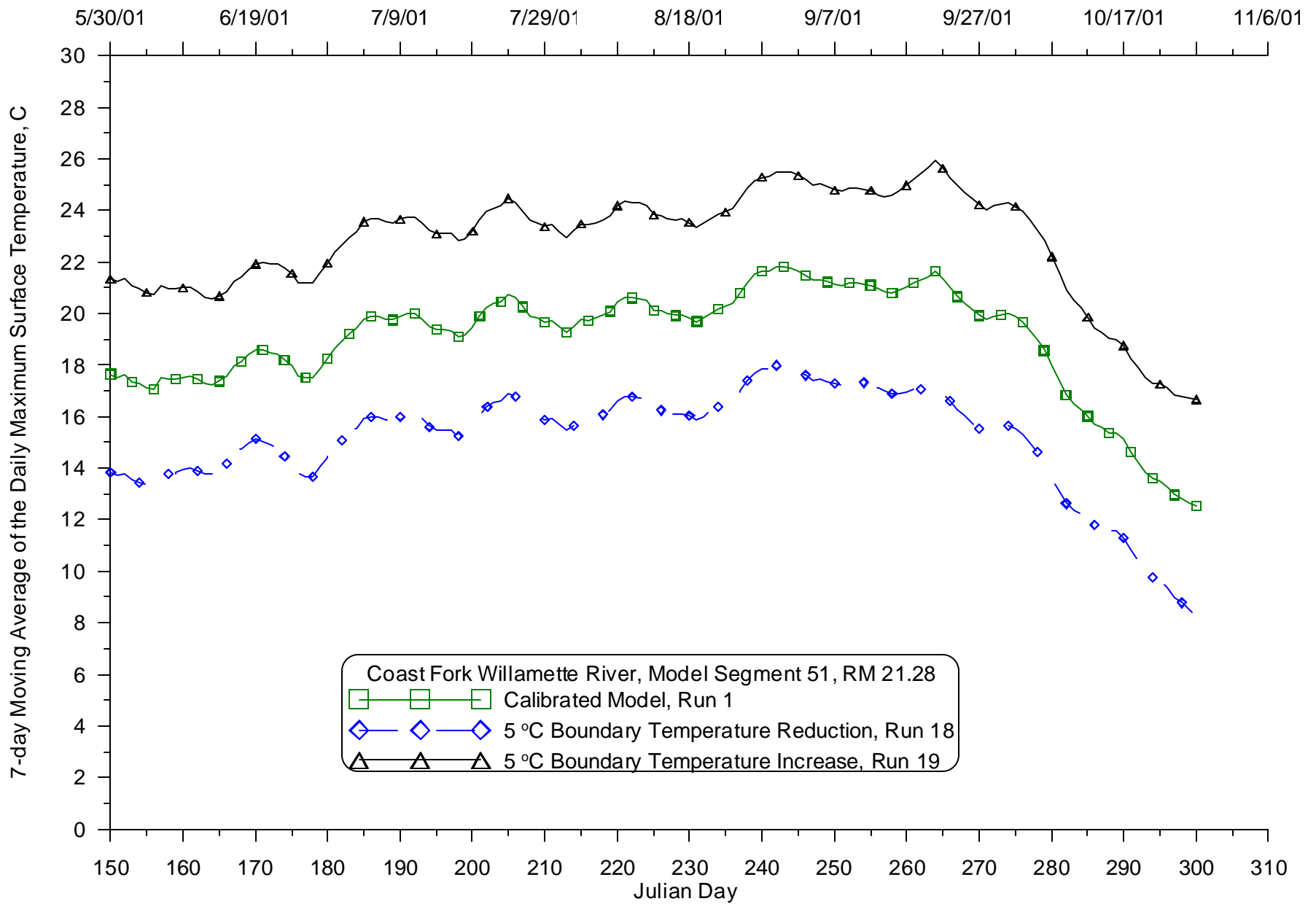


**Figure 574: Calibrated model compared with varying boundary temperature (+/- 5 oC) continuous flow for 2001 for the Willamette River at RM 6.13**

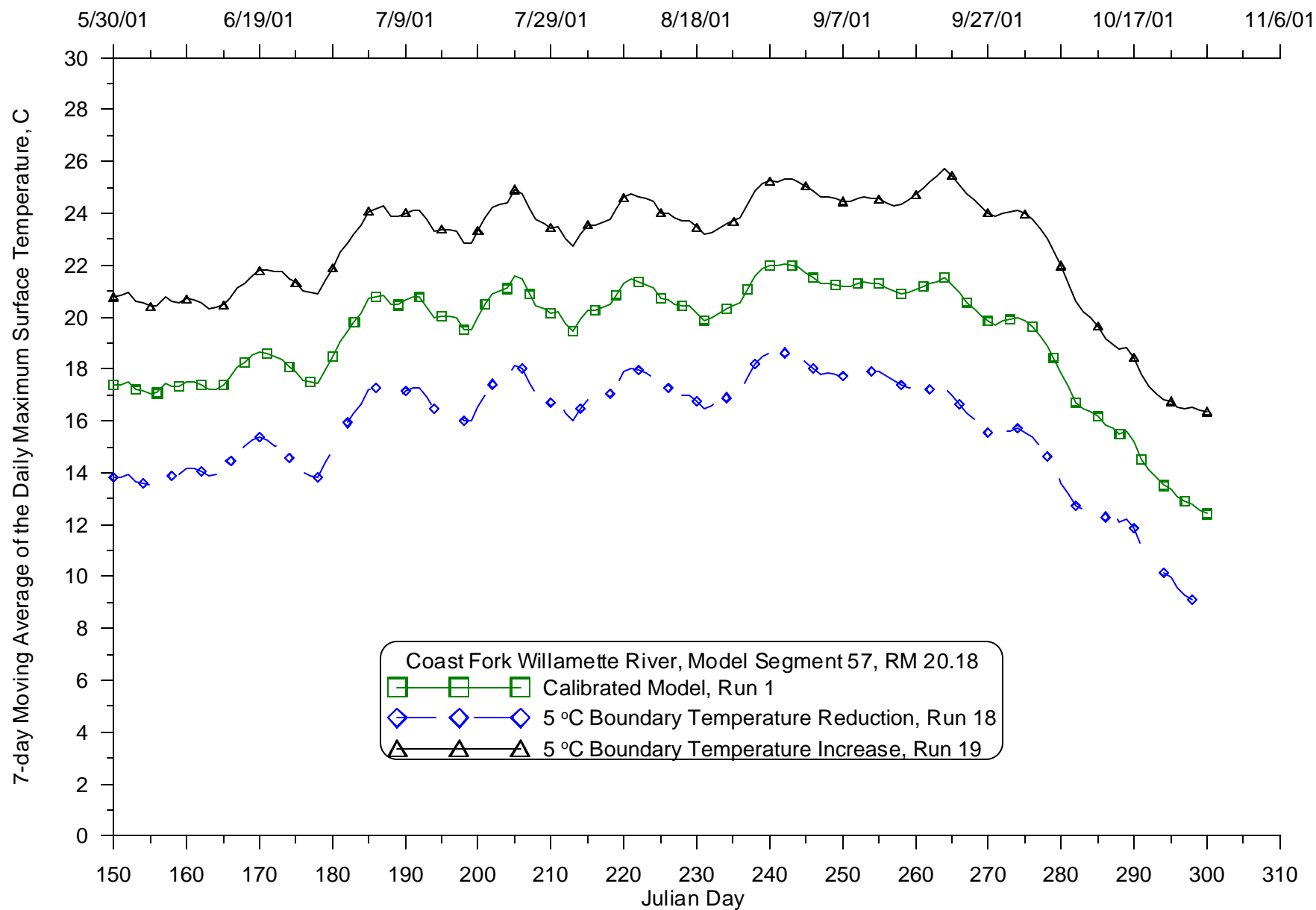
**Daily seven day moving average of daily maximum temperature**



**Figure 575: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 29.03**



**Figure 576: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 21.28**



**Figure 577: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 20.18**



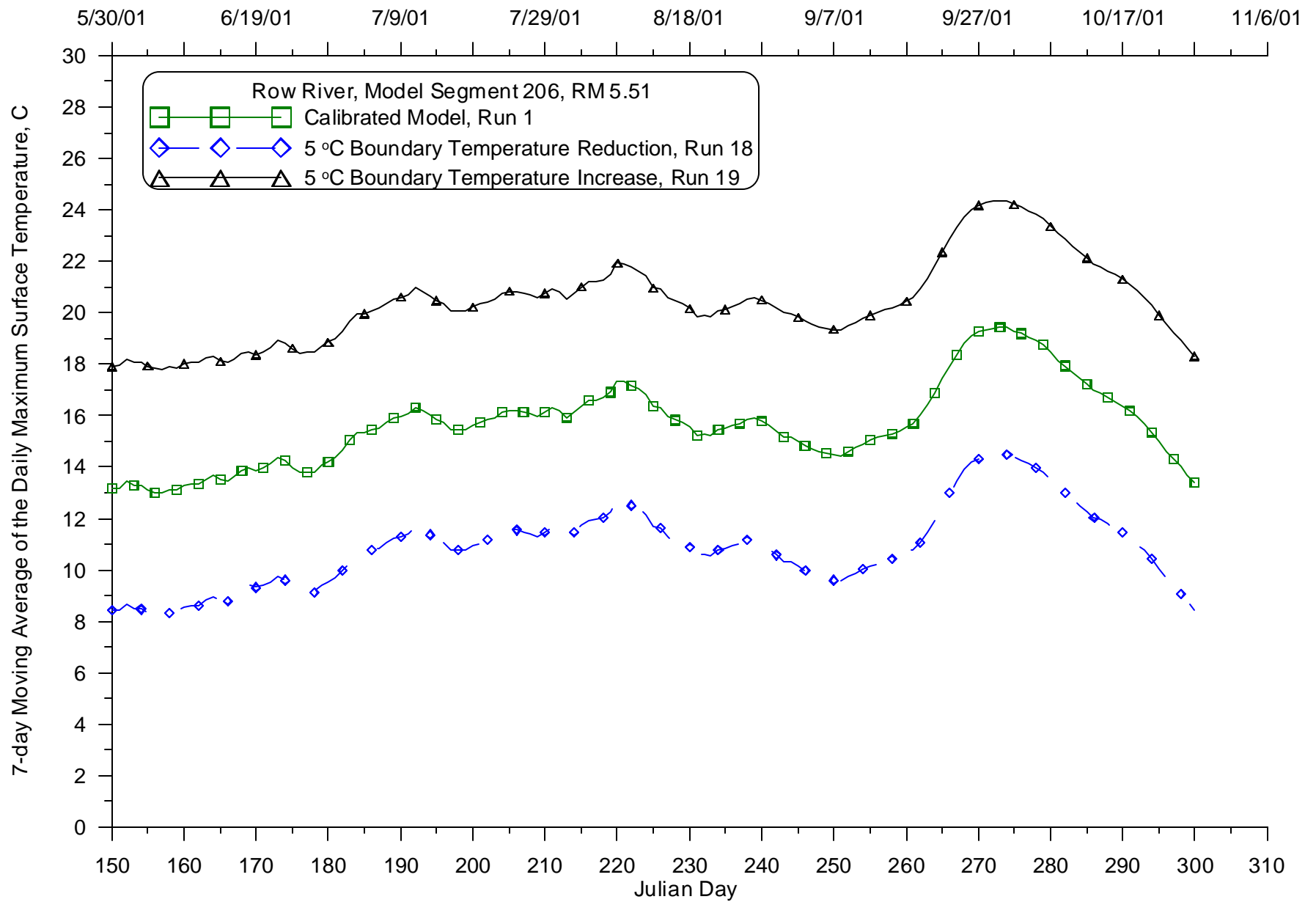
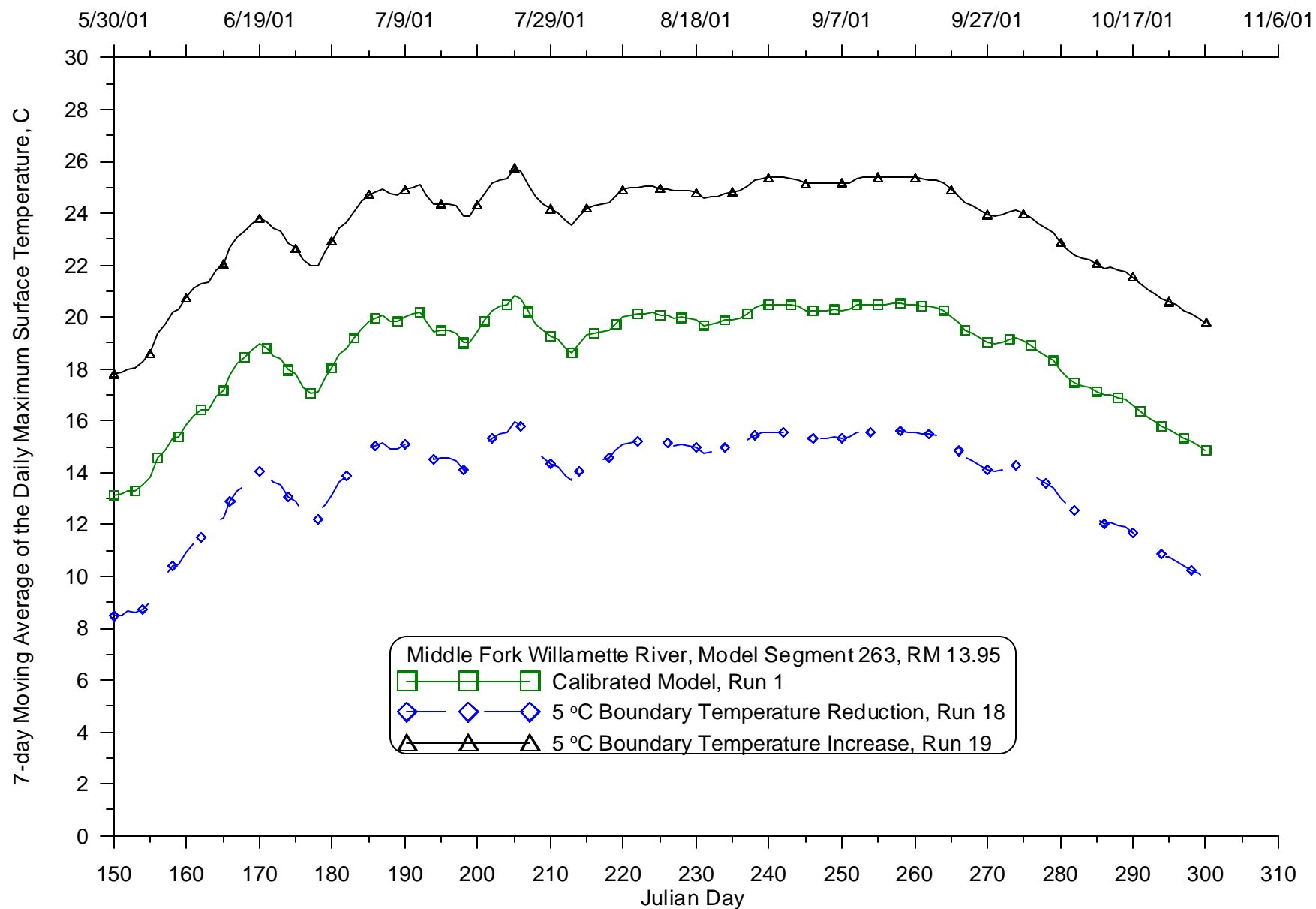
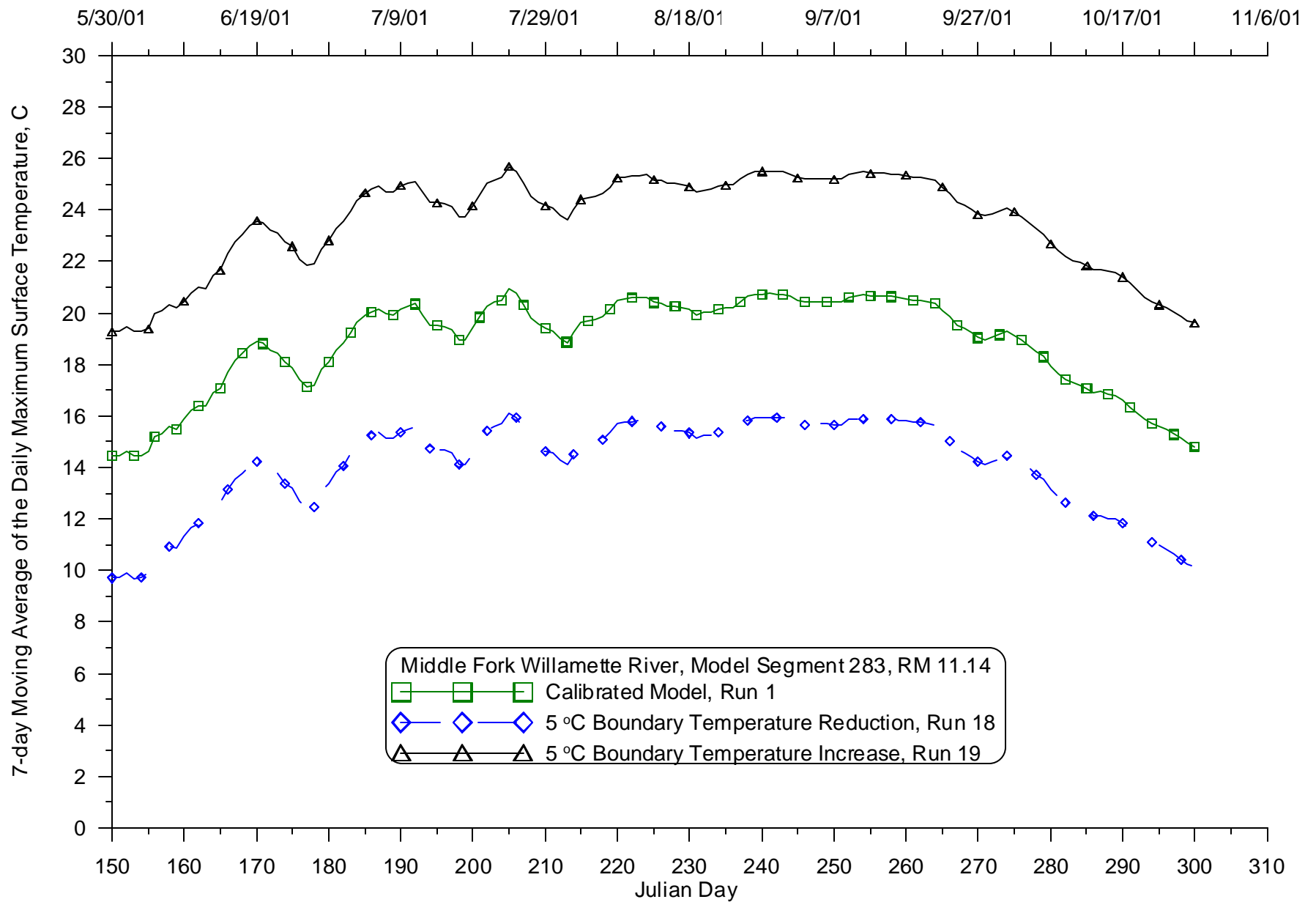


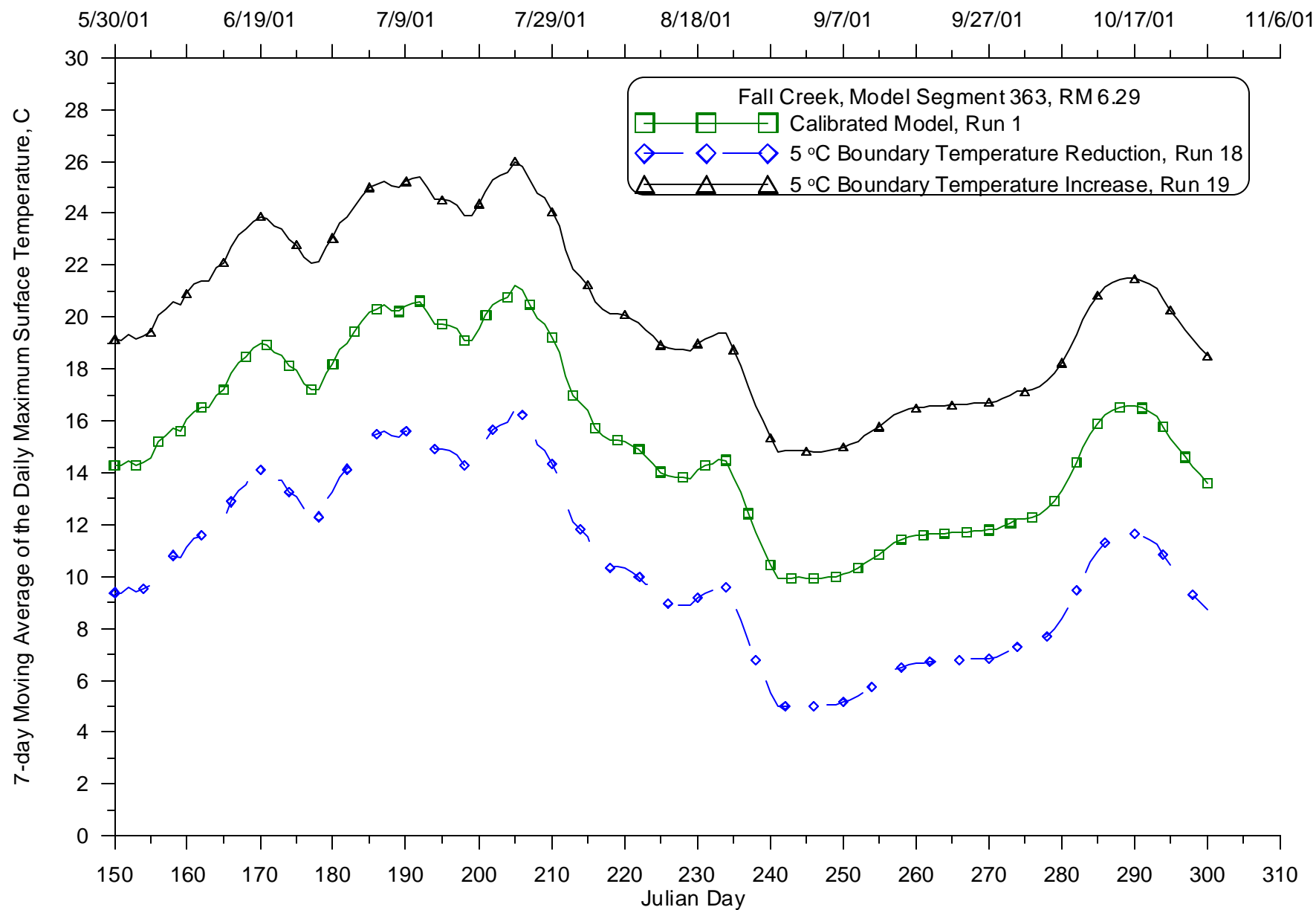
Figure 578: Calibrated model compared with varying boundary temperature (+/- 5 °C) 7-day average of the daily maximum temperature for 2001 for the Row River at RM 5.51



**Figure 579: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 580: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Middle Fork Willamette River at RM 11.14**



**Figure 581: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for Fall Creek at RM 6.29**

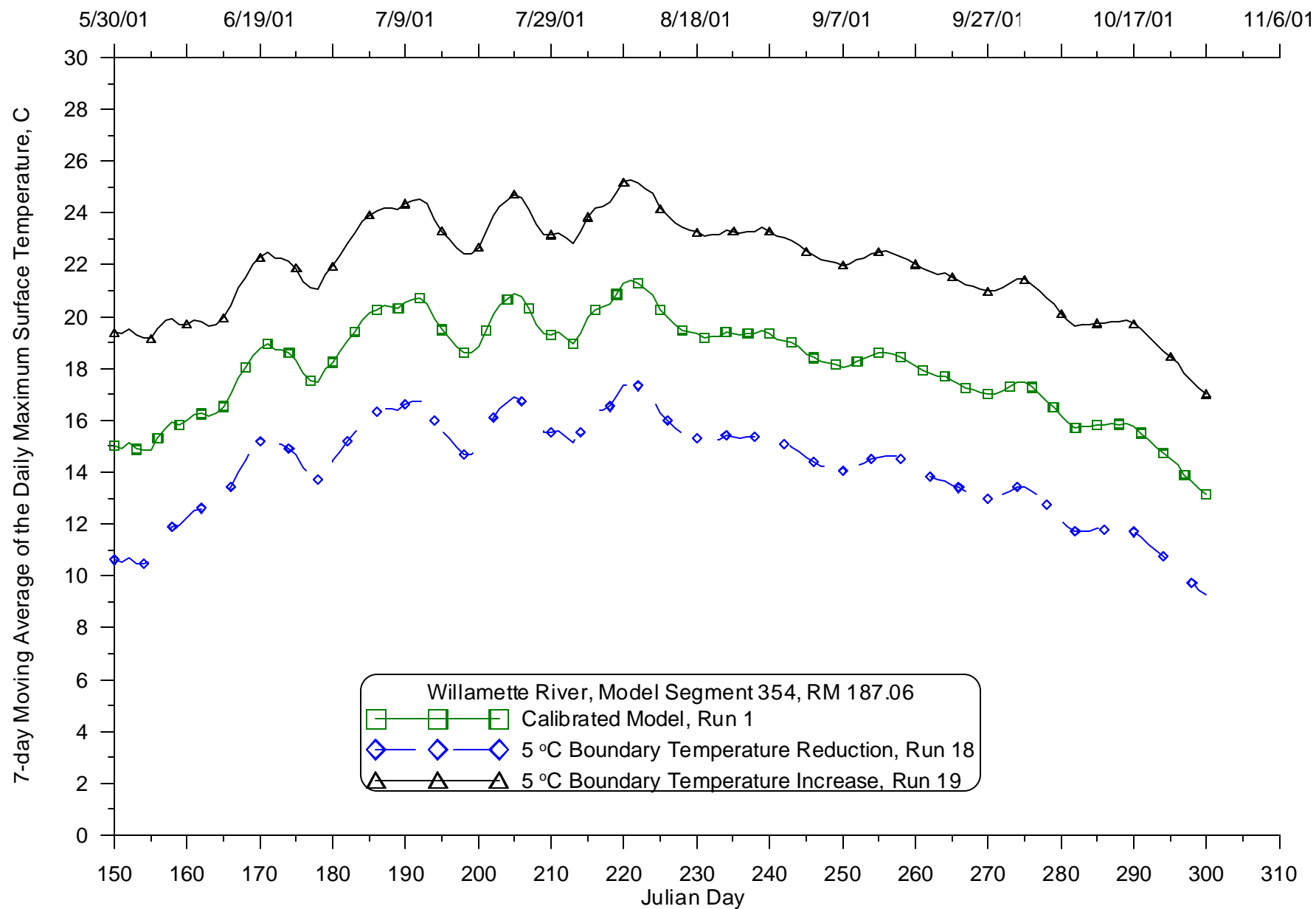


Figure 582: Calibrated model compared with varying boundary temperature (+/- 5 °C) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 187.06

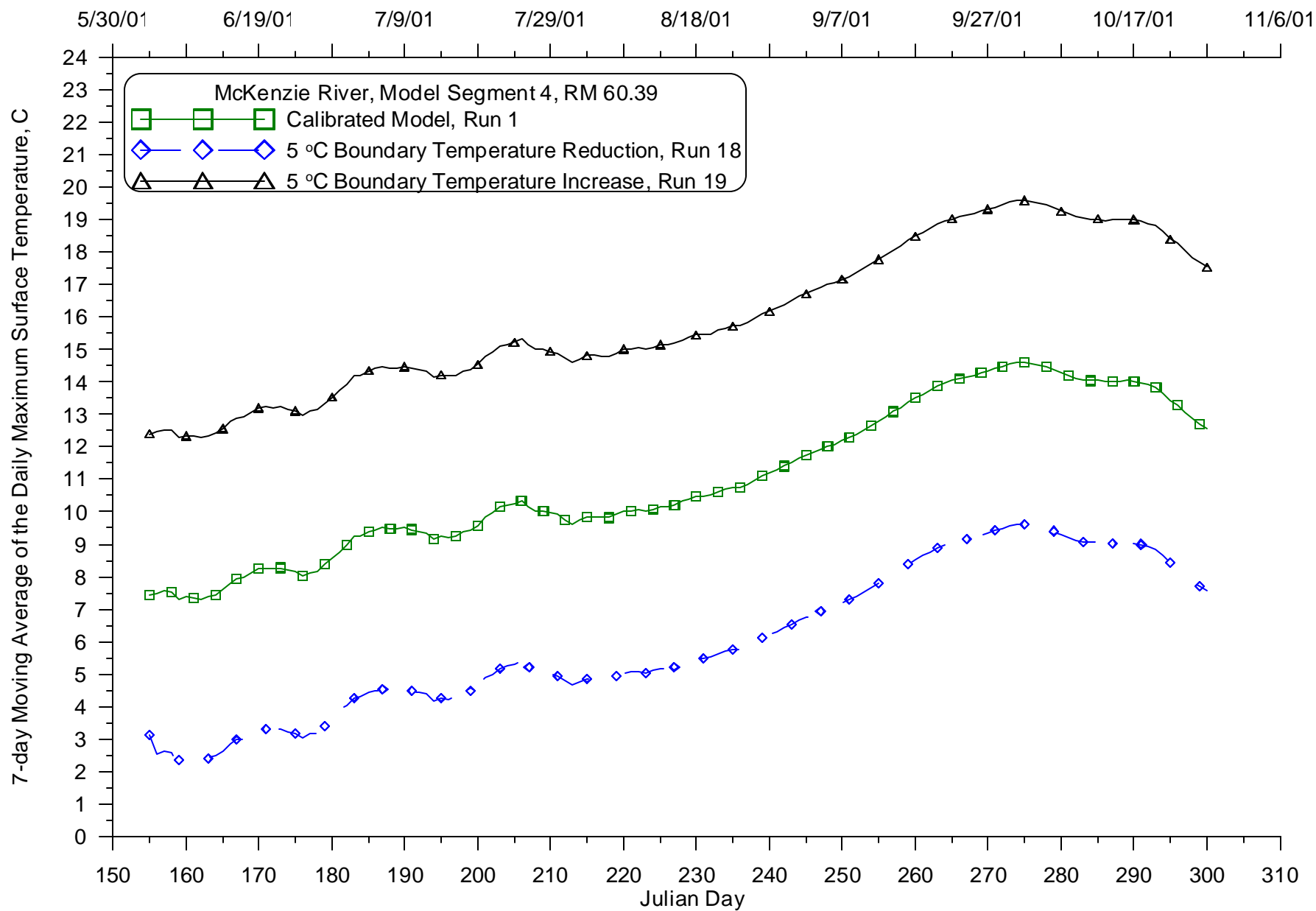
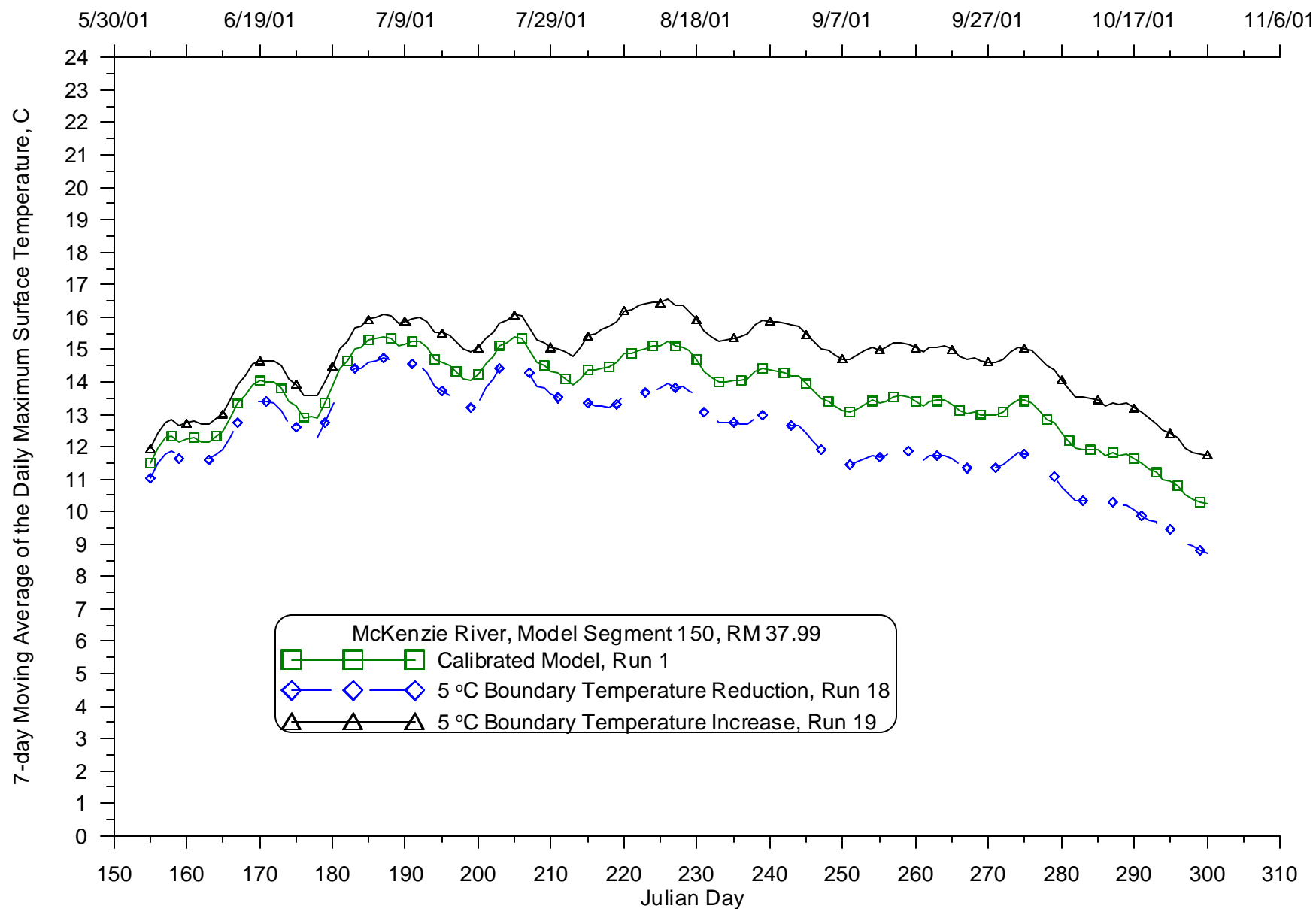
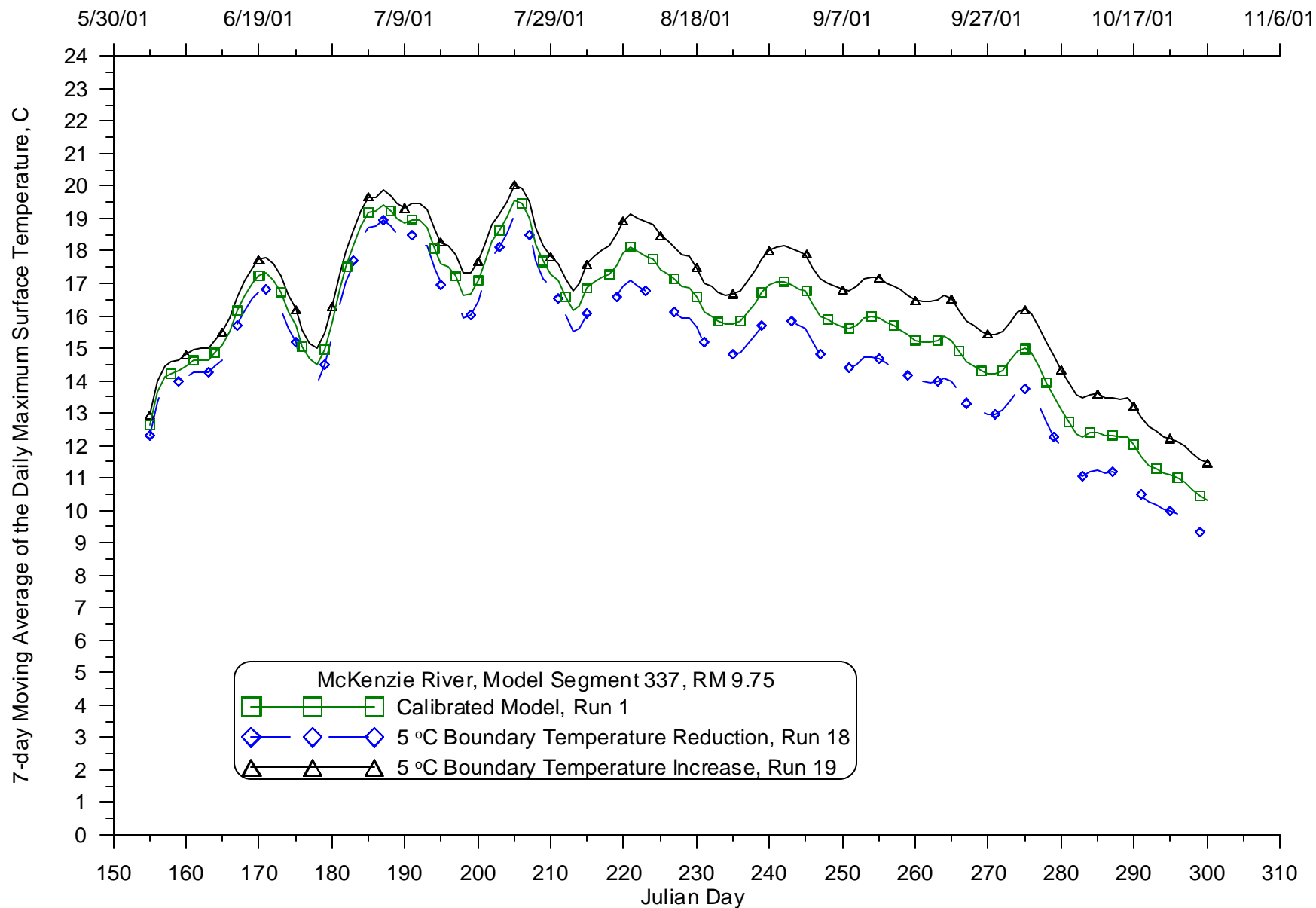


Figure 583: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 60.39



**Figure 584: Calibrated model compared with varying boundary temperature (+/- 5 °C) 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 37.99**



**Figure 585: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 9.75**



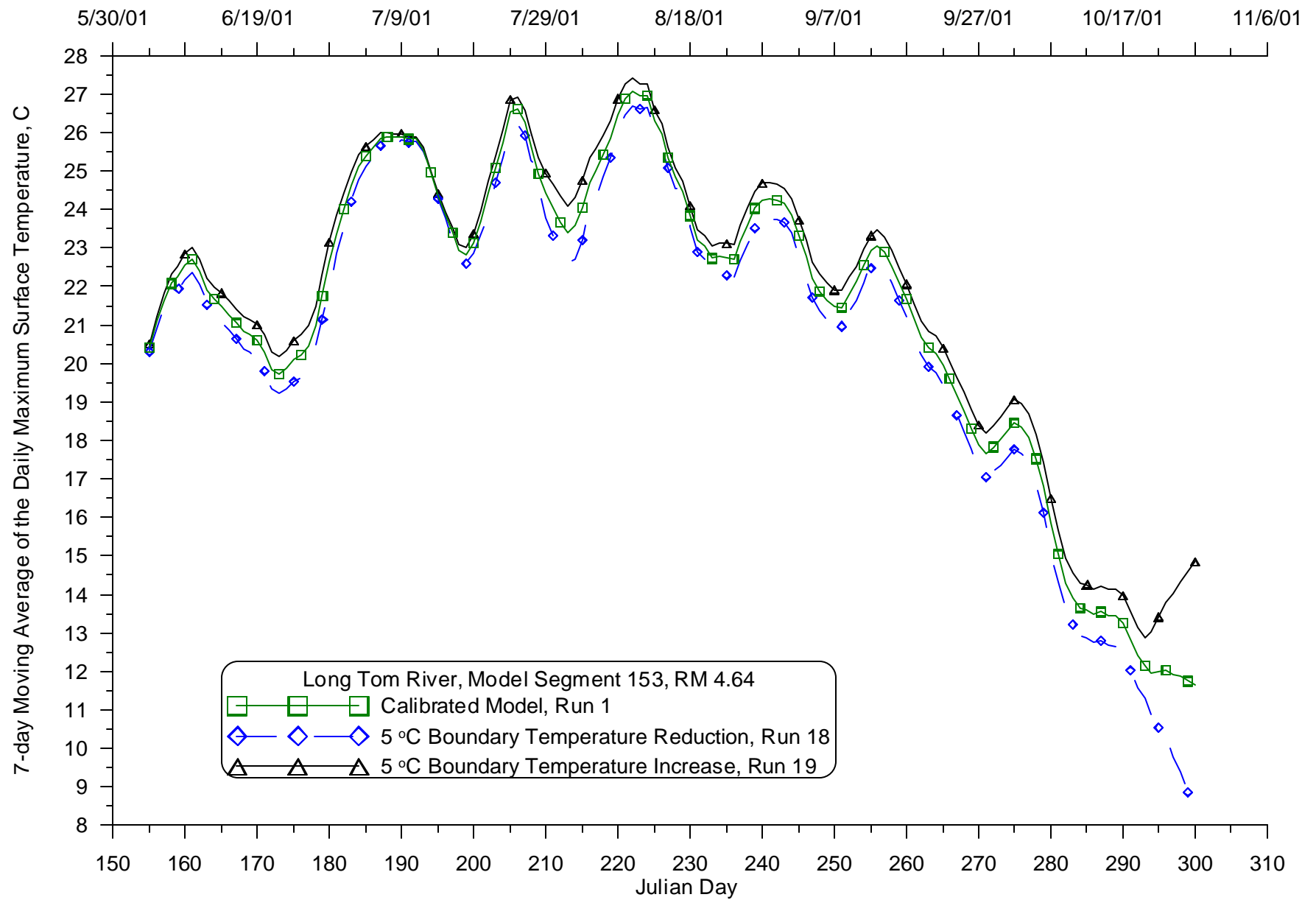


Figure 586: Calibrated model compared with varying boundary temperature (+/- 5 °C) 7-day average of the daily maximum temperature for 2001 for the Long Tom River at RM 4.64

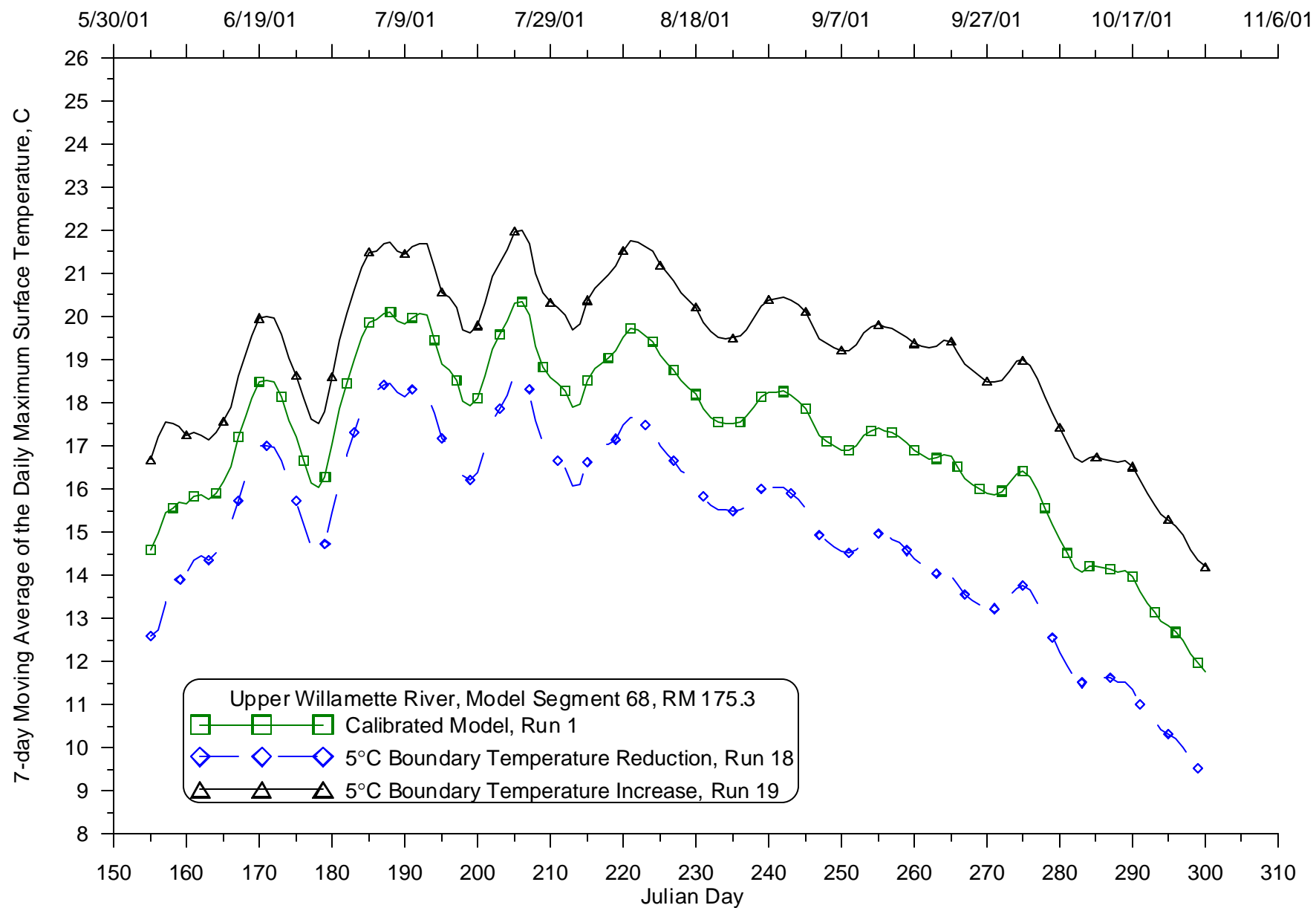


Figure 587: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 175.3

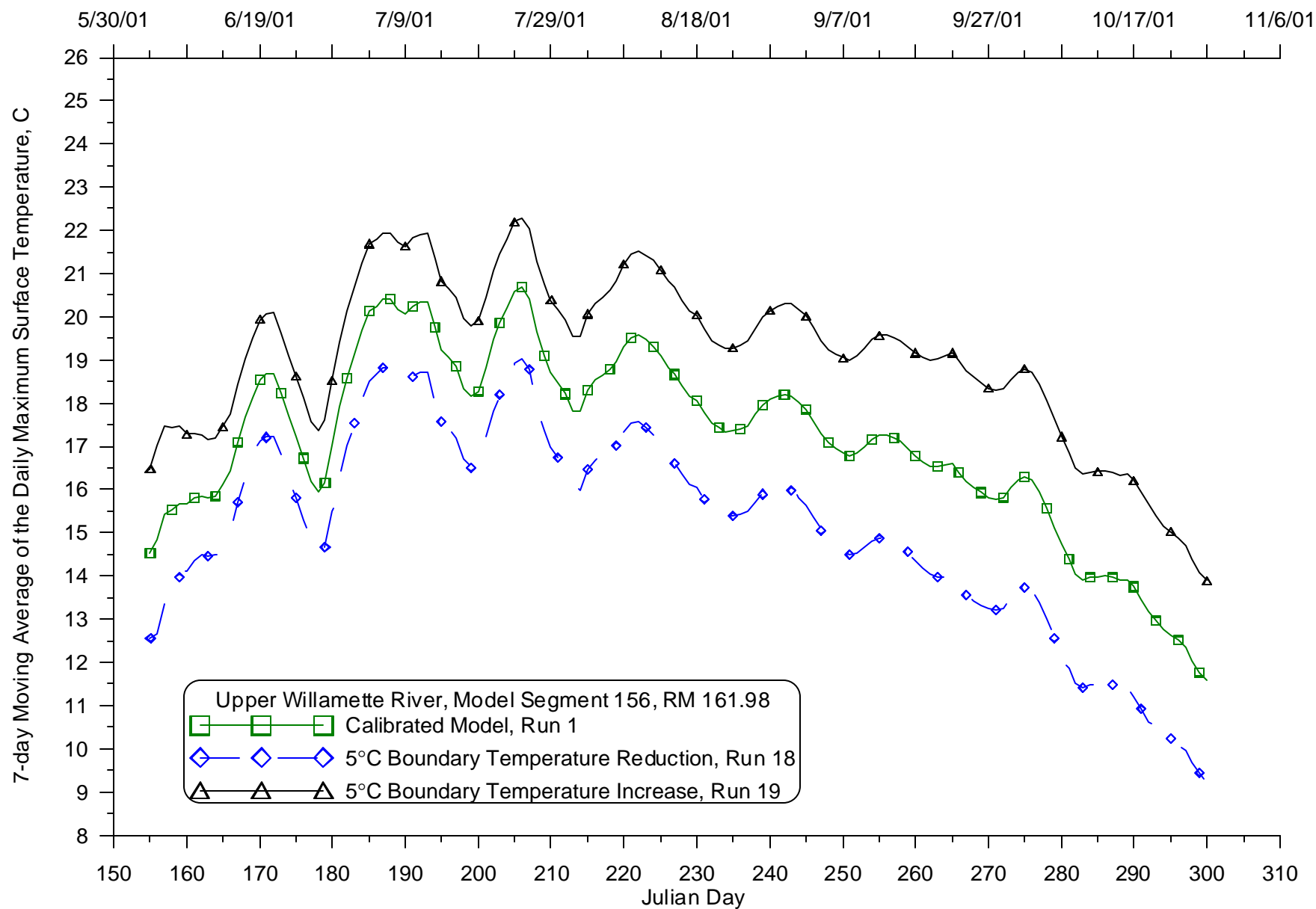
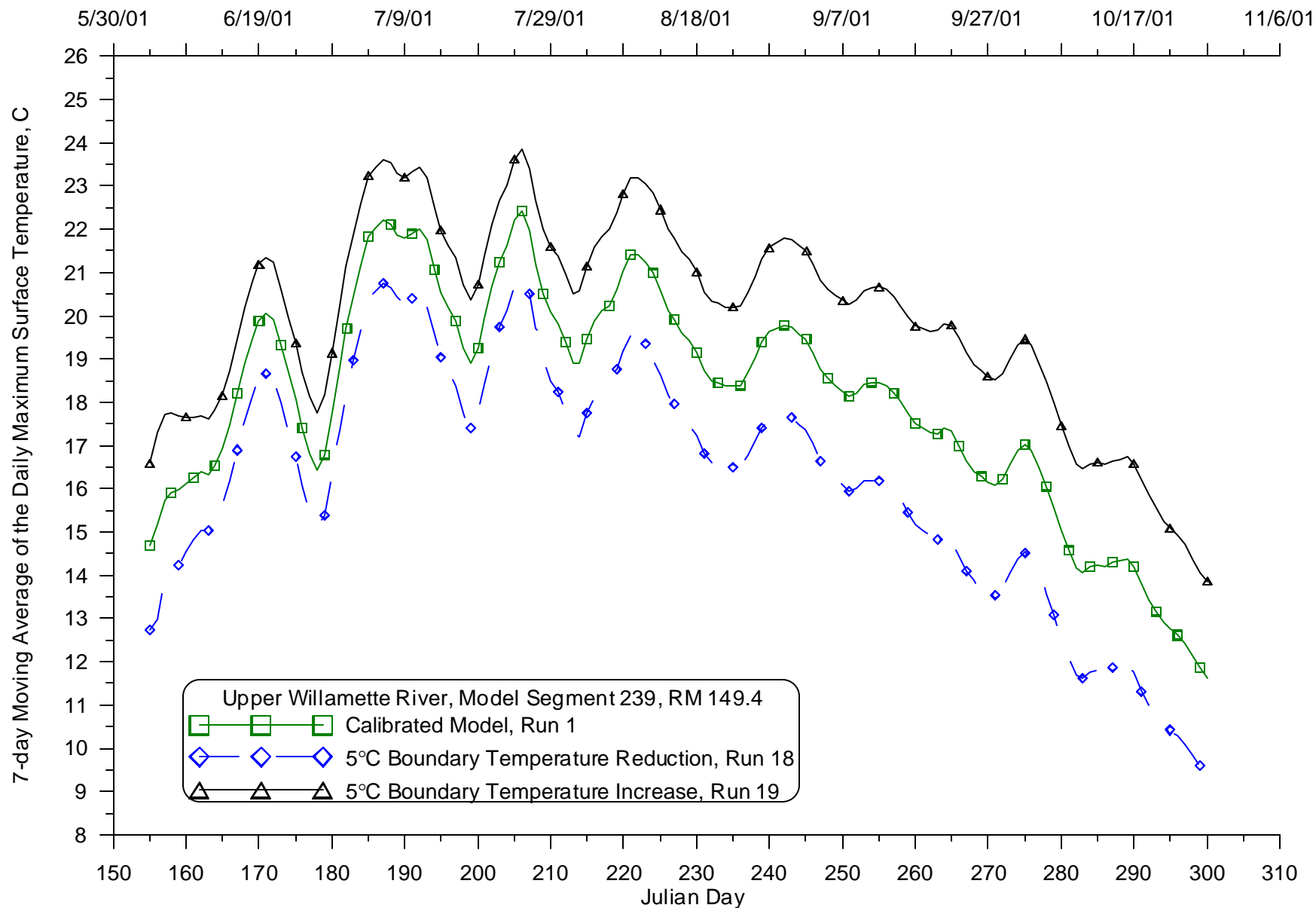
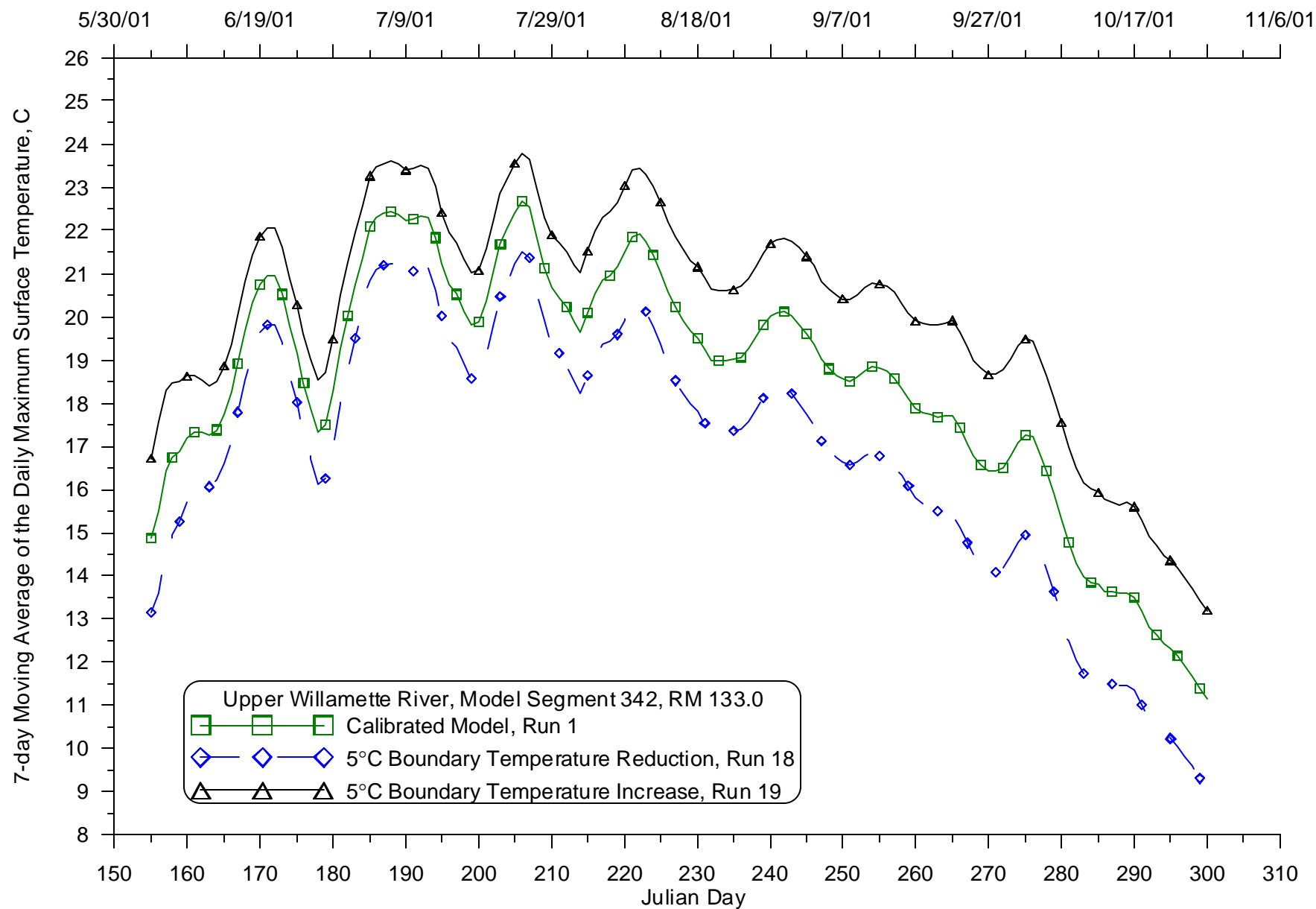


Figure 588: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 161.98



**Figure 589: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 149.4**



**Figure 590: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 133**

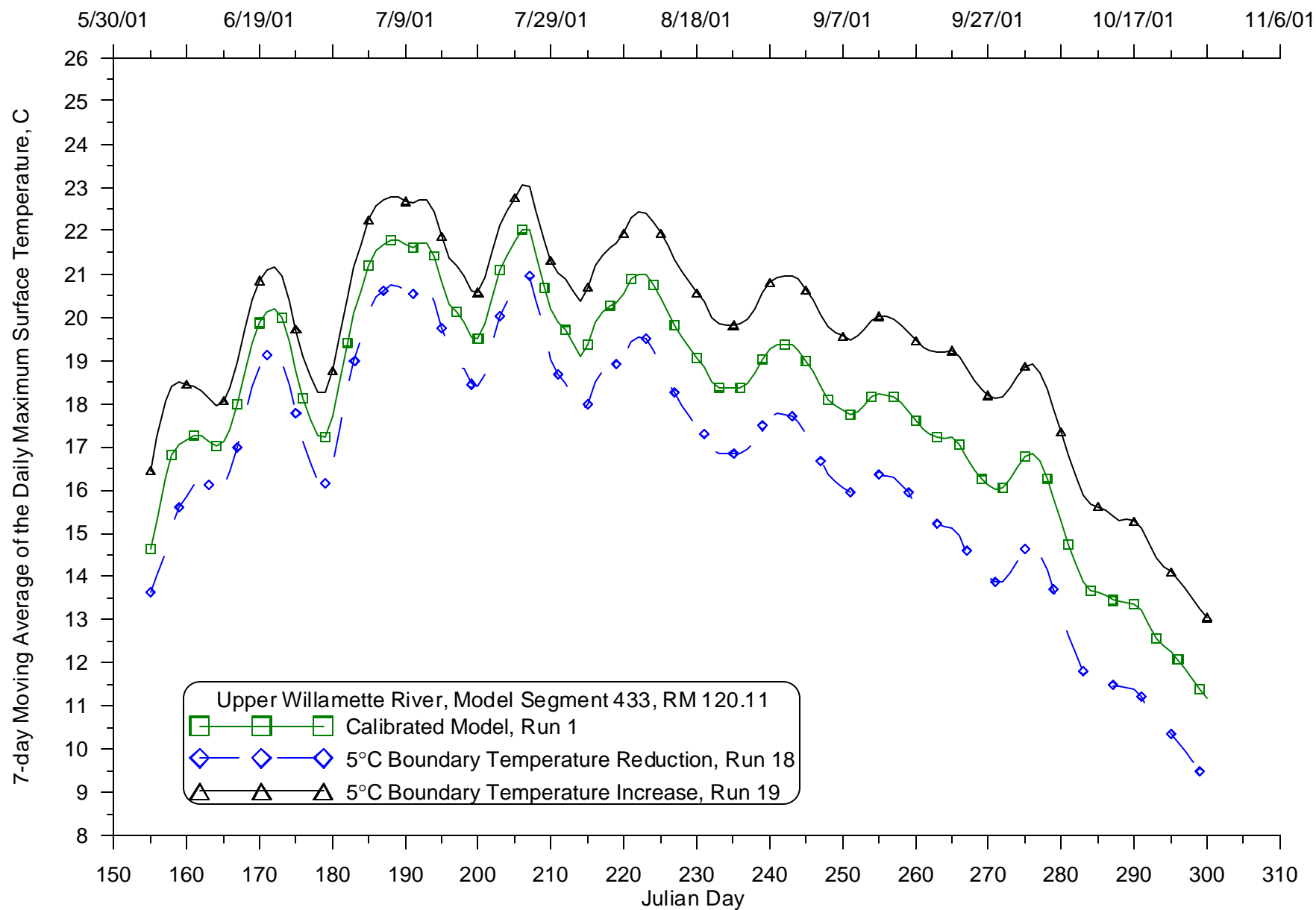


Figure 591: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 120.11

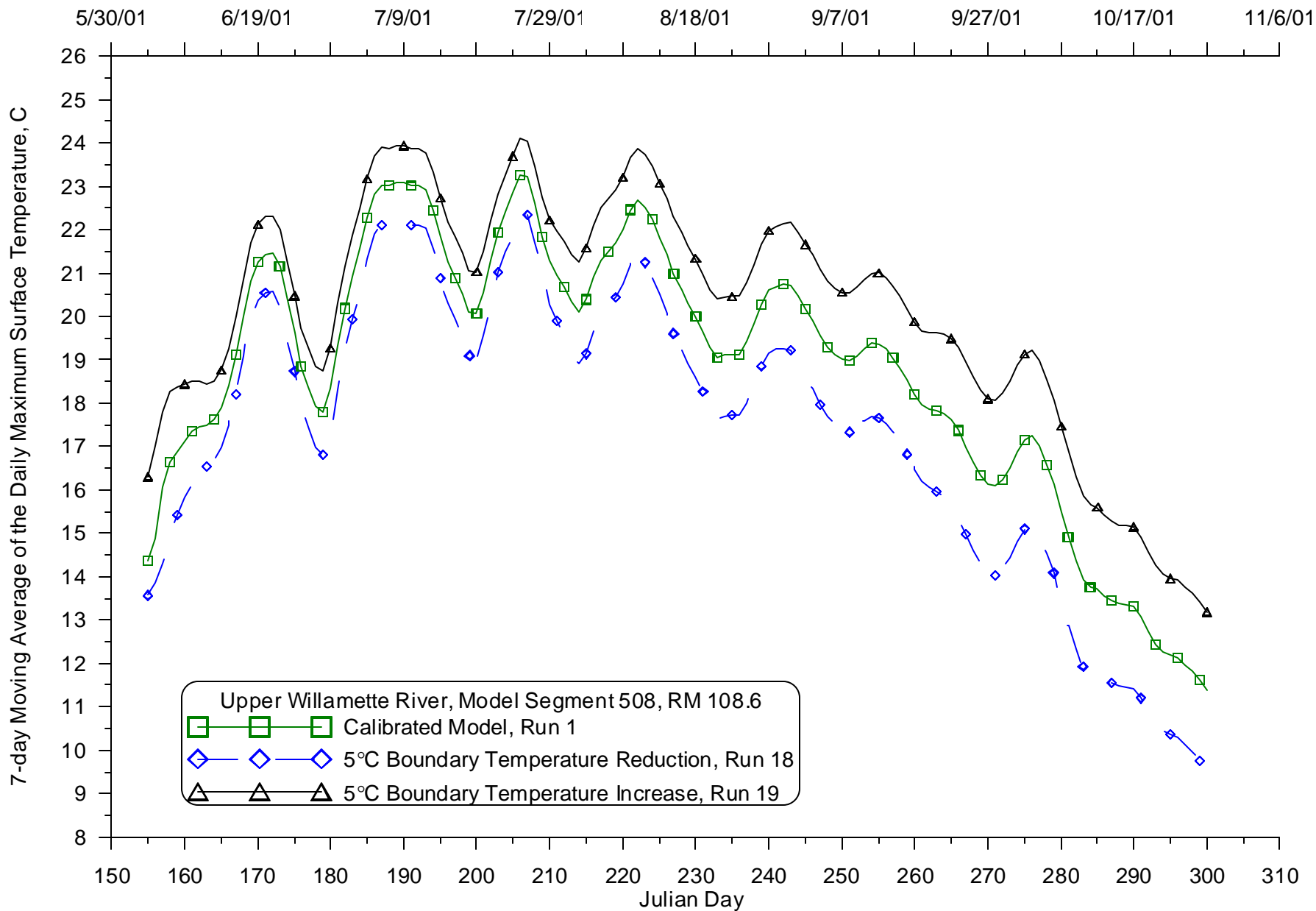
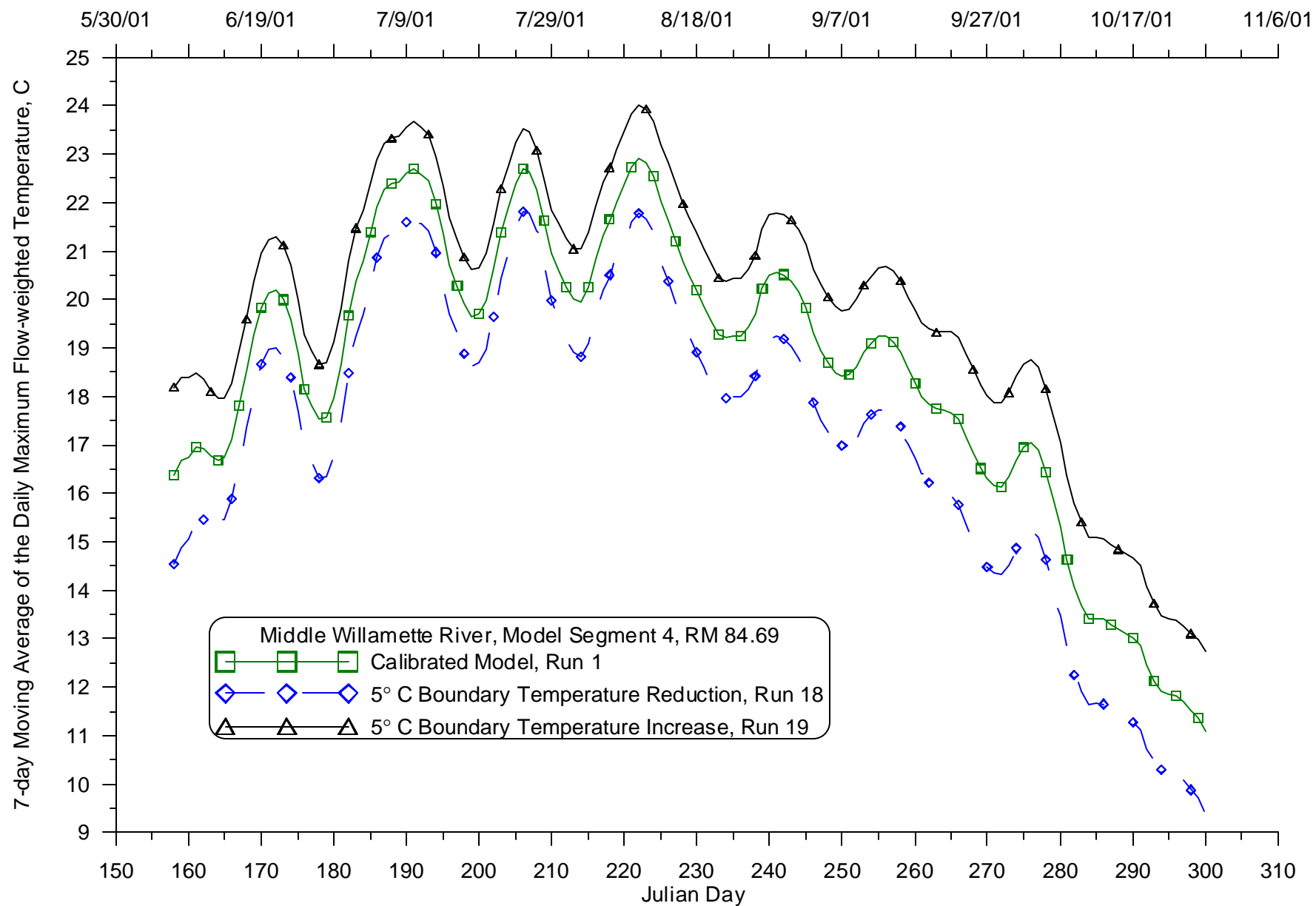
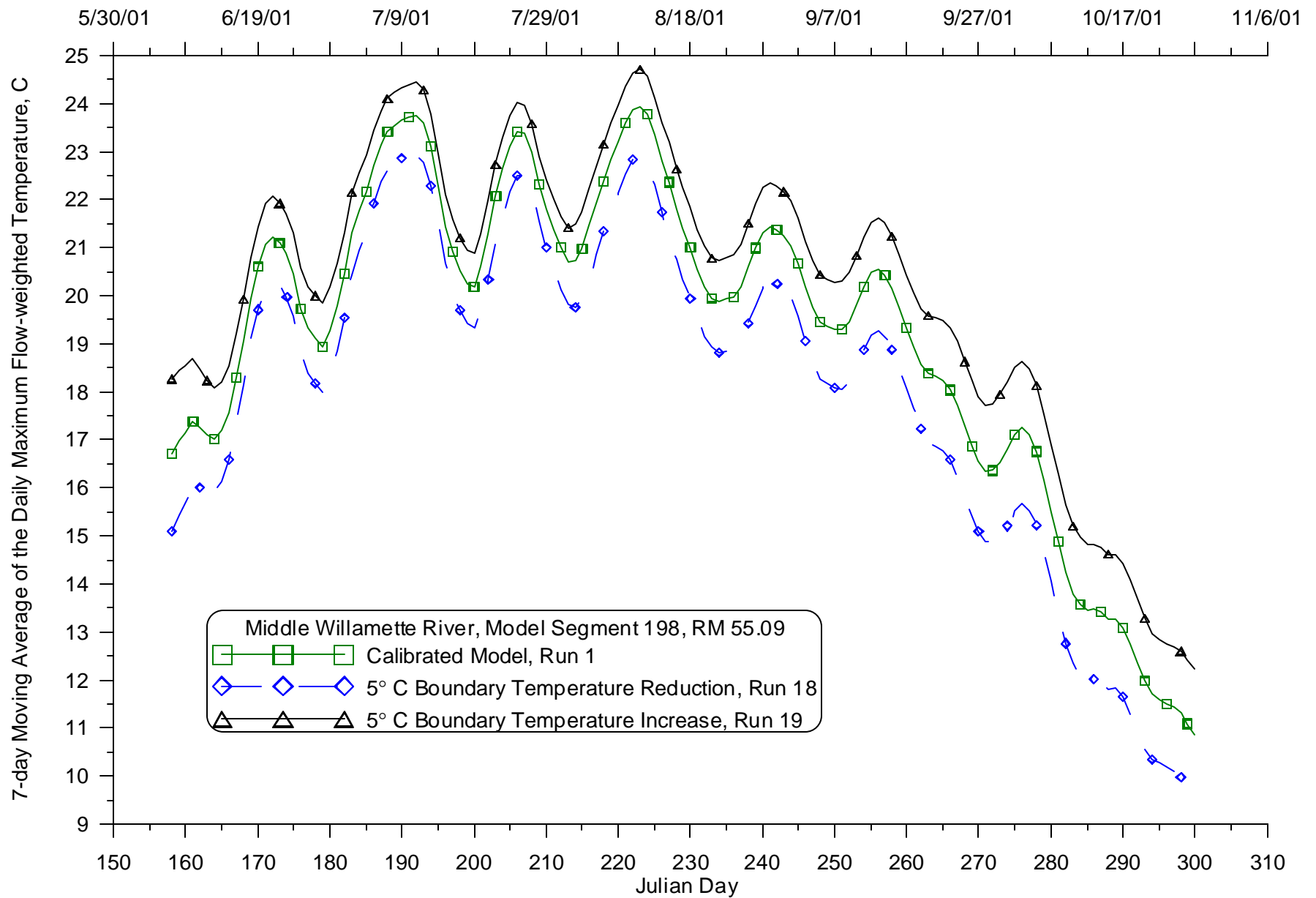


Figure 592: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 108.6

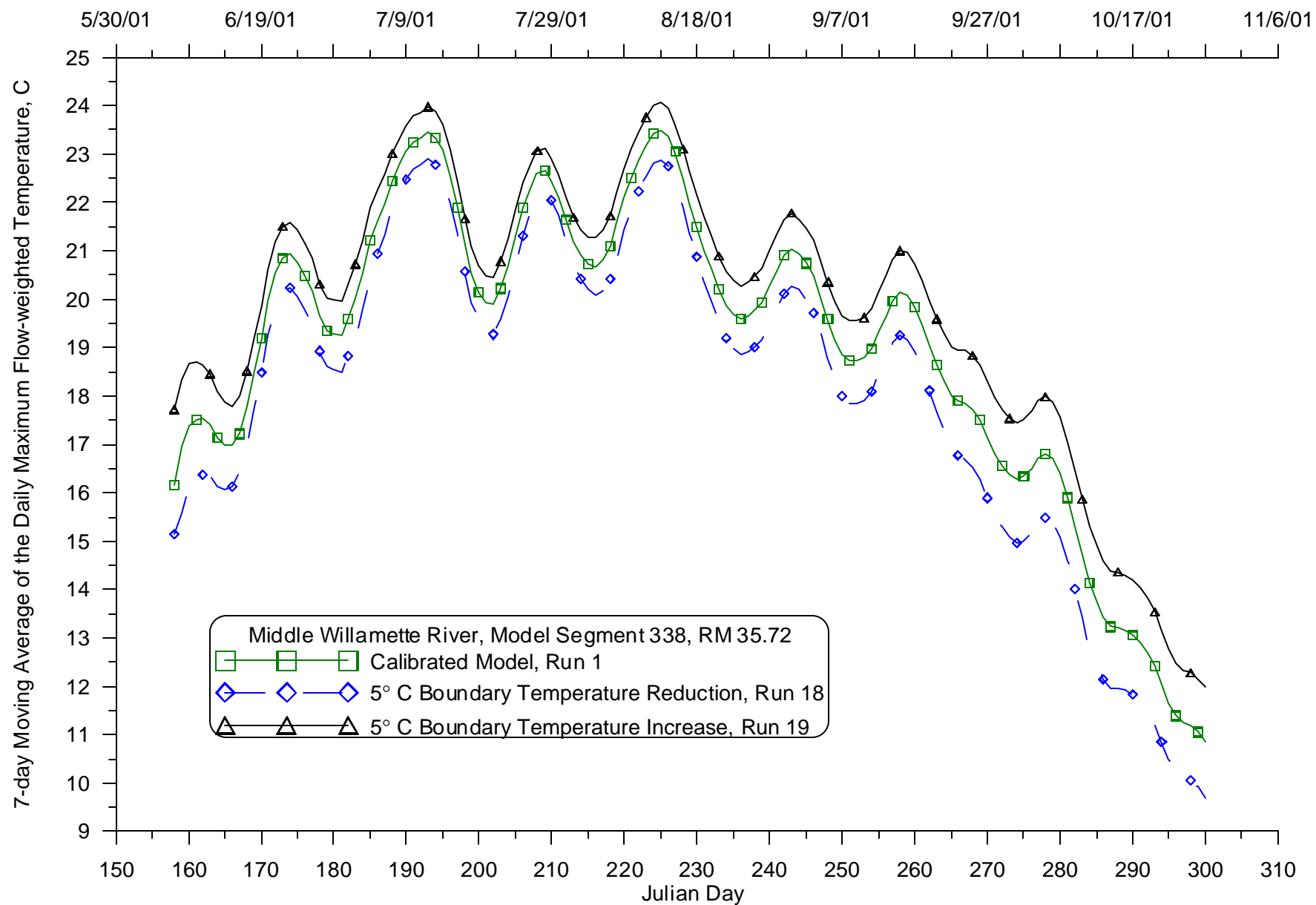


**Figure 593: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 84.69**





**Figure 594: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 55.09**



**Figure 595: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 35.72**

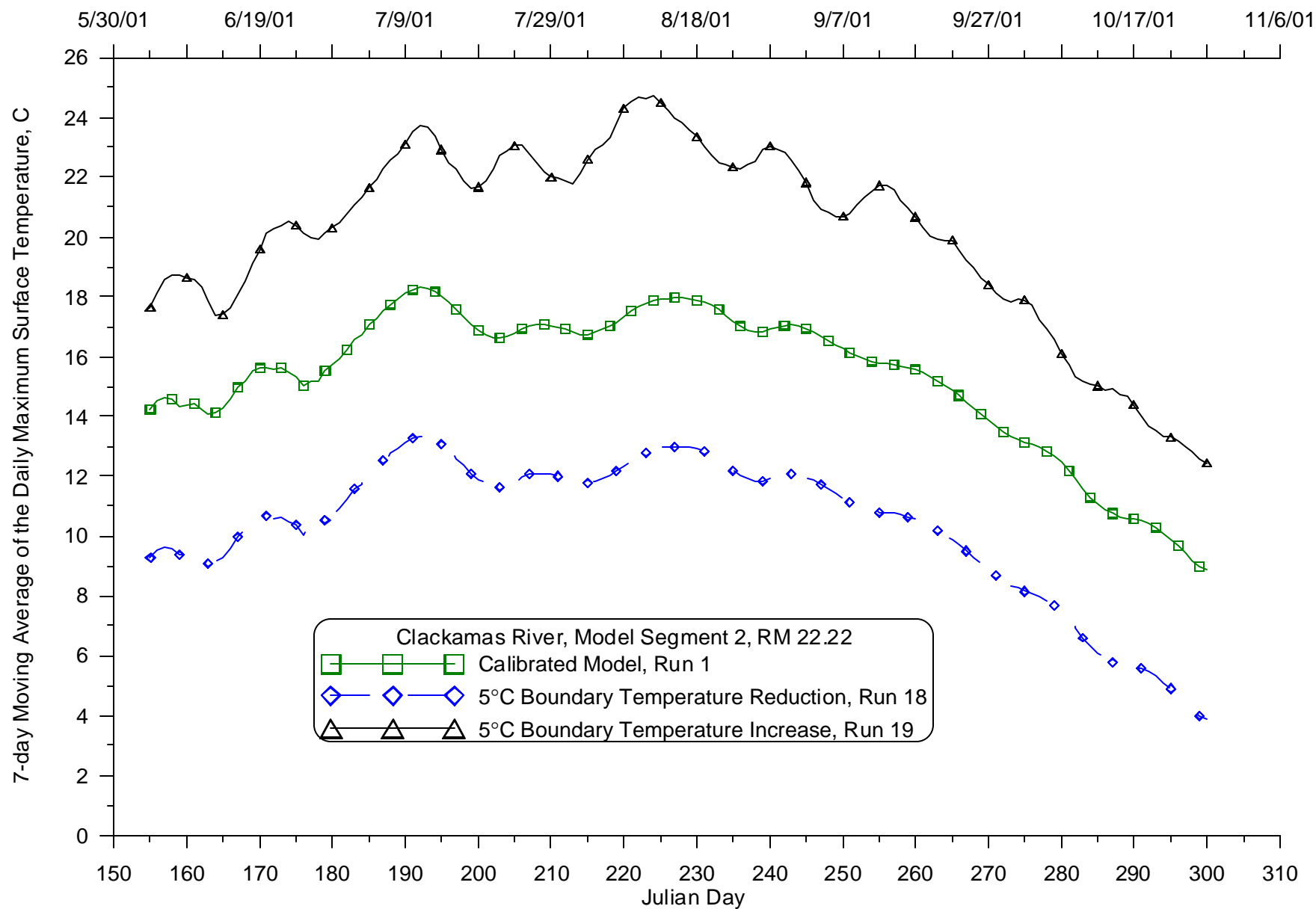


Figure 596: Calibrated model compared with varying boundary temperature (+/- 5 °C) 7-day average of the daily maximum temperature for 2001 for the Clackamas River at RM 22.22

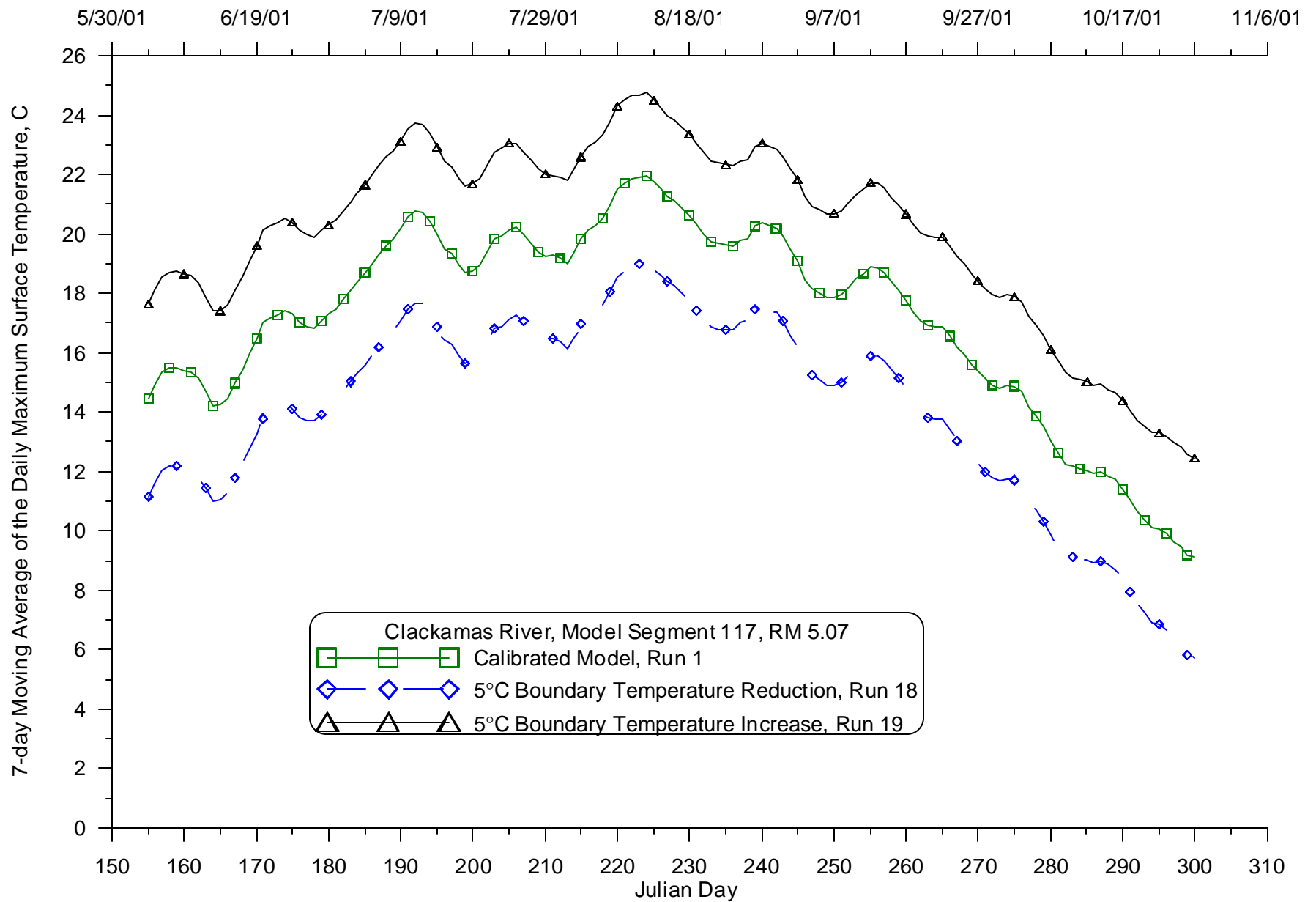


Figure 597: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Clackamas River at RM 5.07

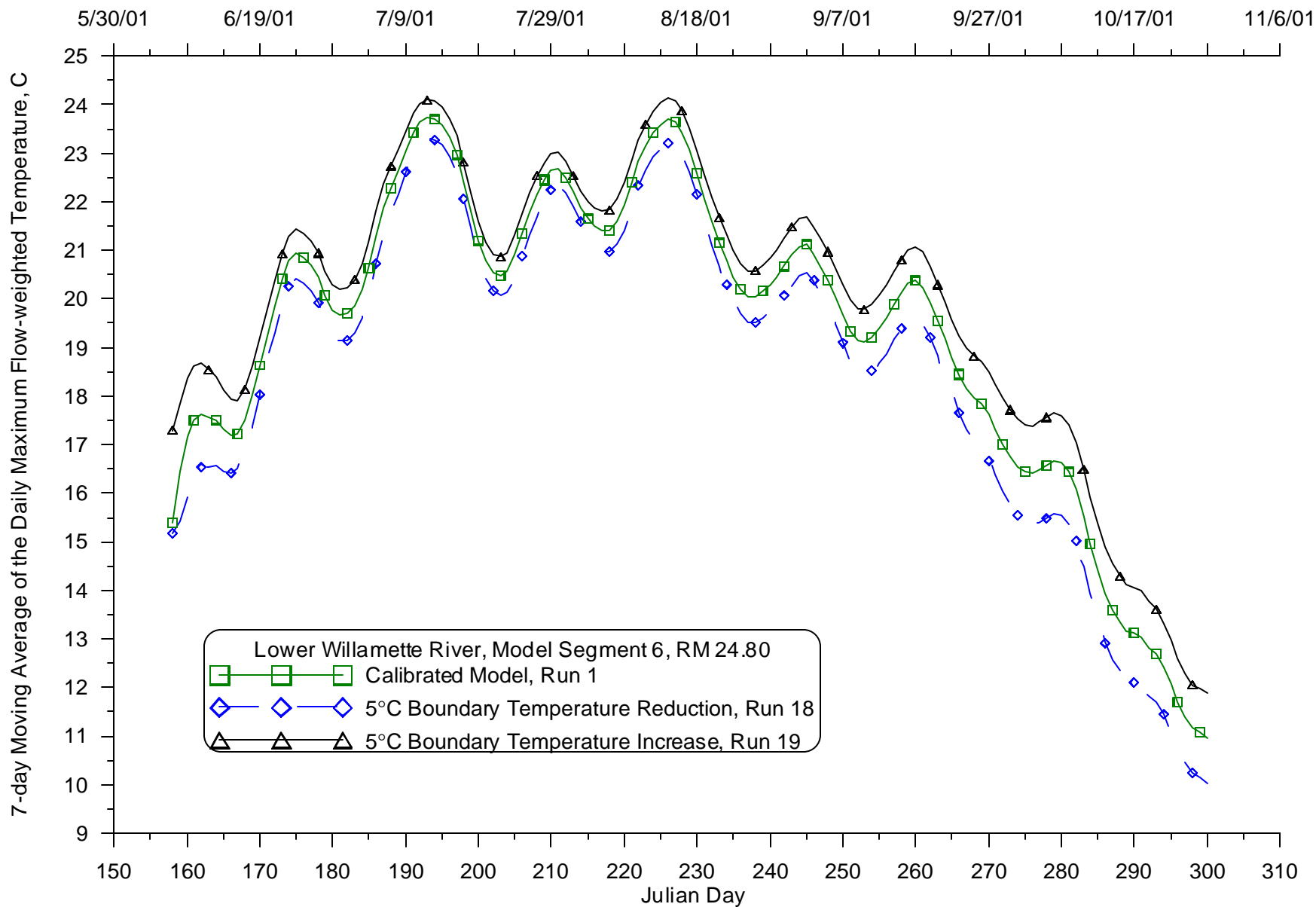
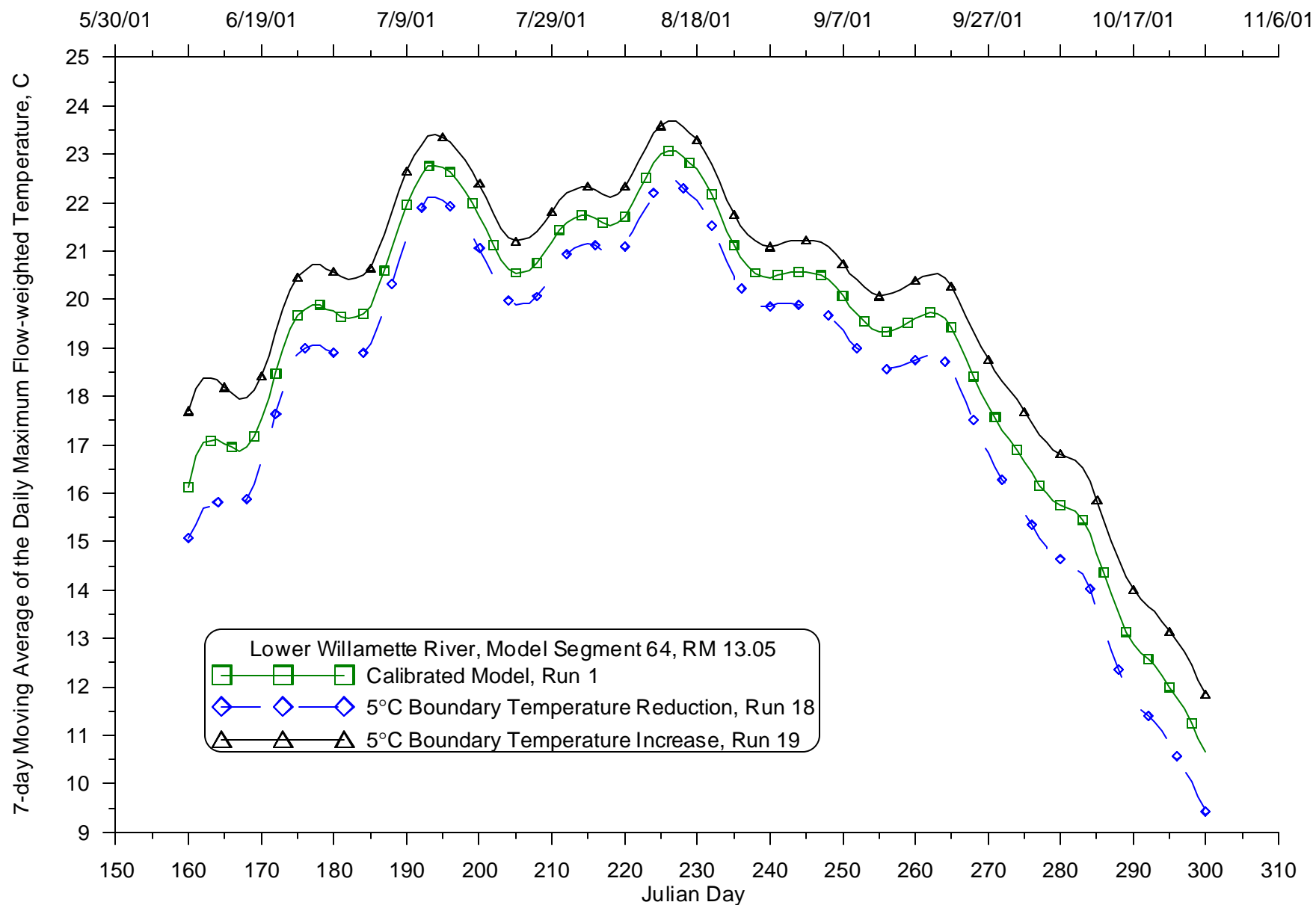
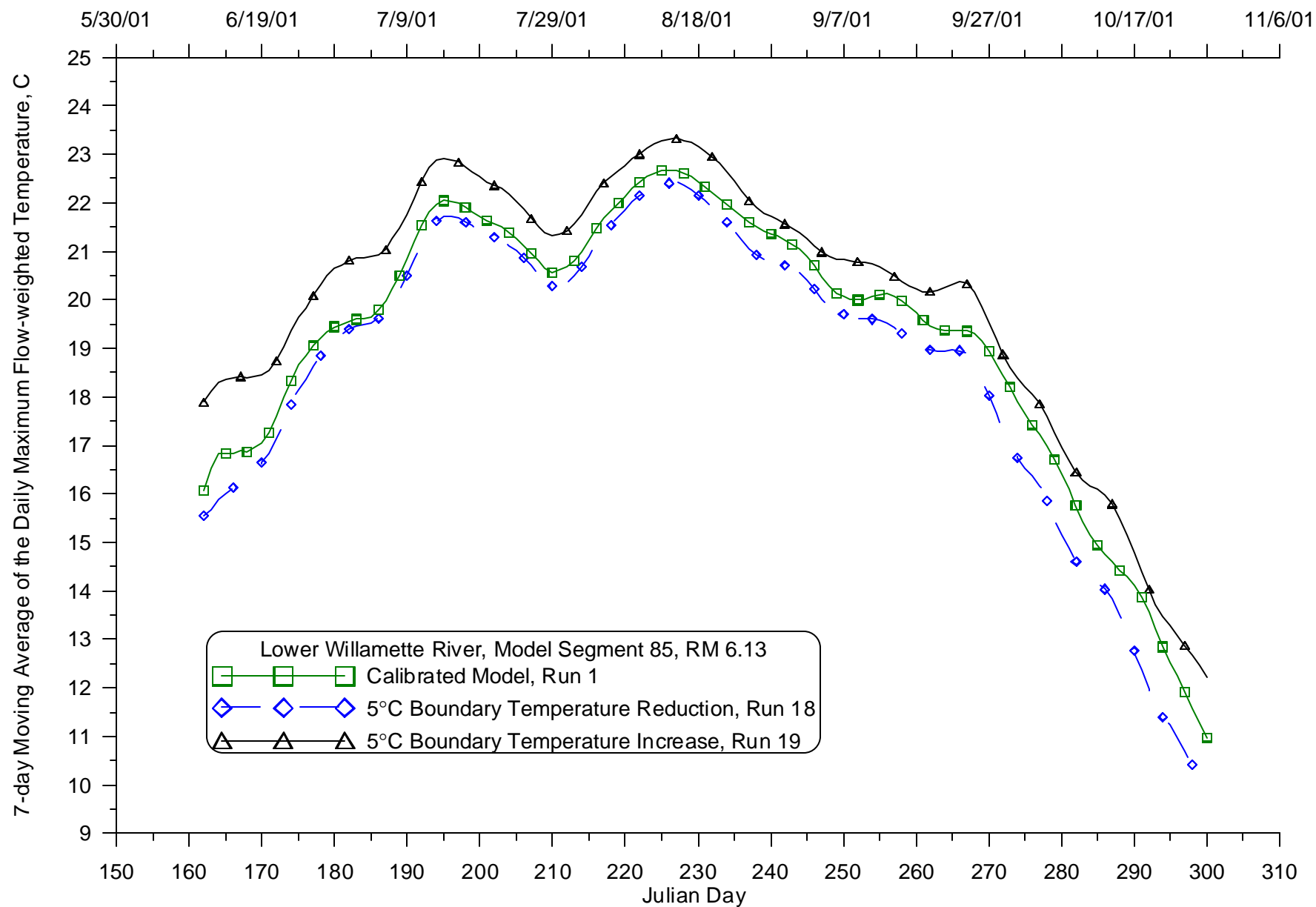


Figure 598: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 24.8



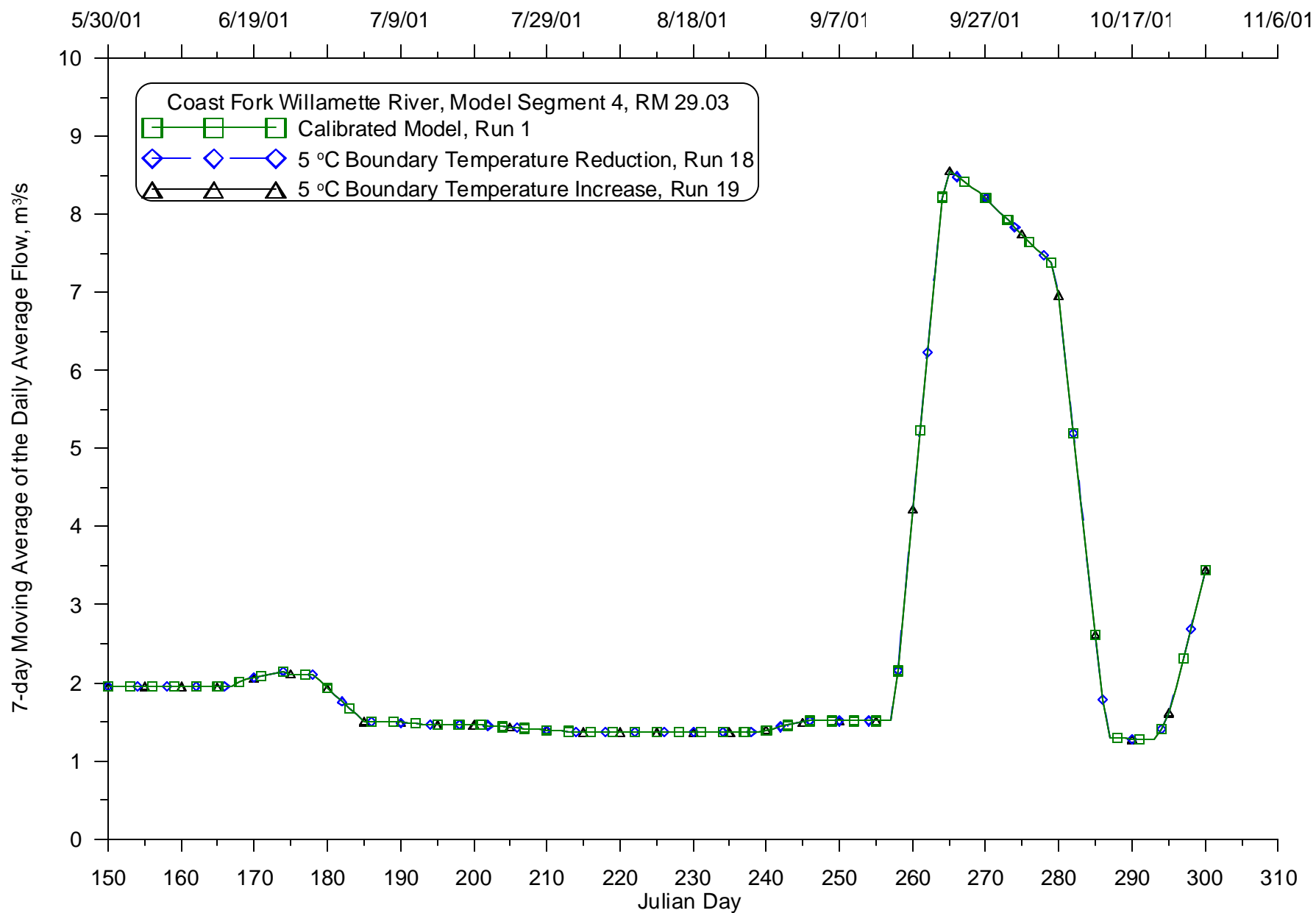
**Figure 599: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM13.05**



**Figure 600: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 6.13**

**Daily seven day average flow**





**Figure 601: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 29.03**

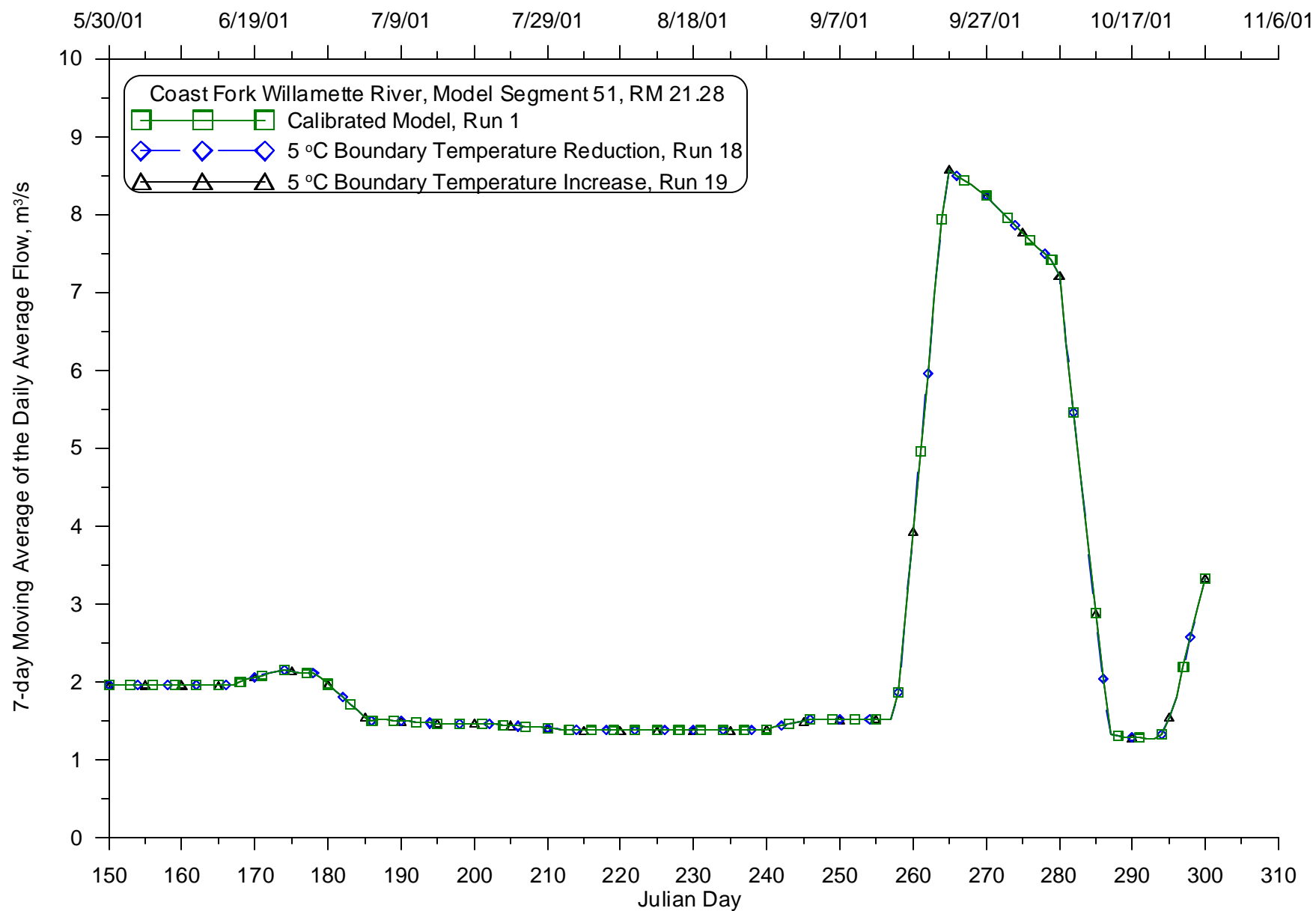
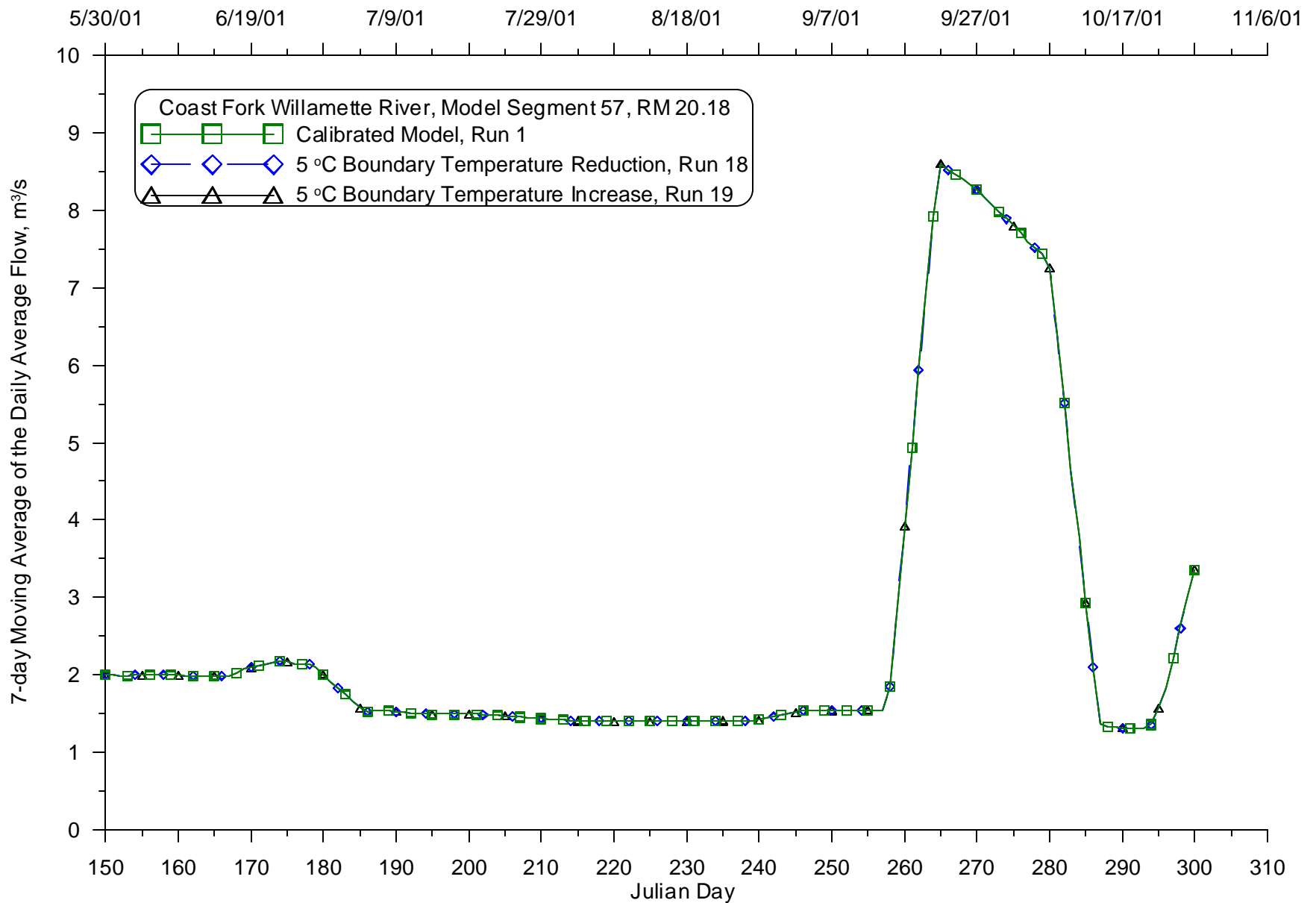


Figure 602: Calibrated model compared with varying boundary temperature ( $\pm 5$  °C) 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 21.28



**Figure 603: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 20.18**

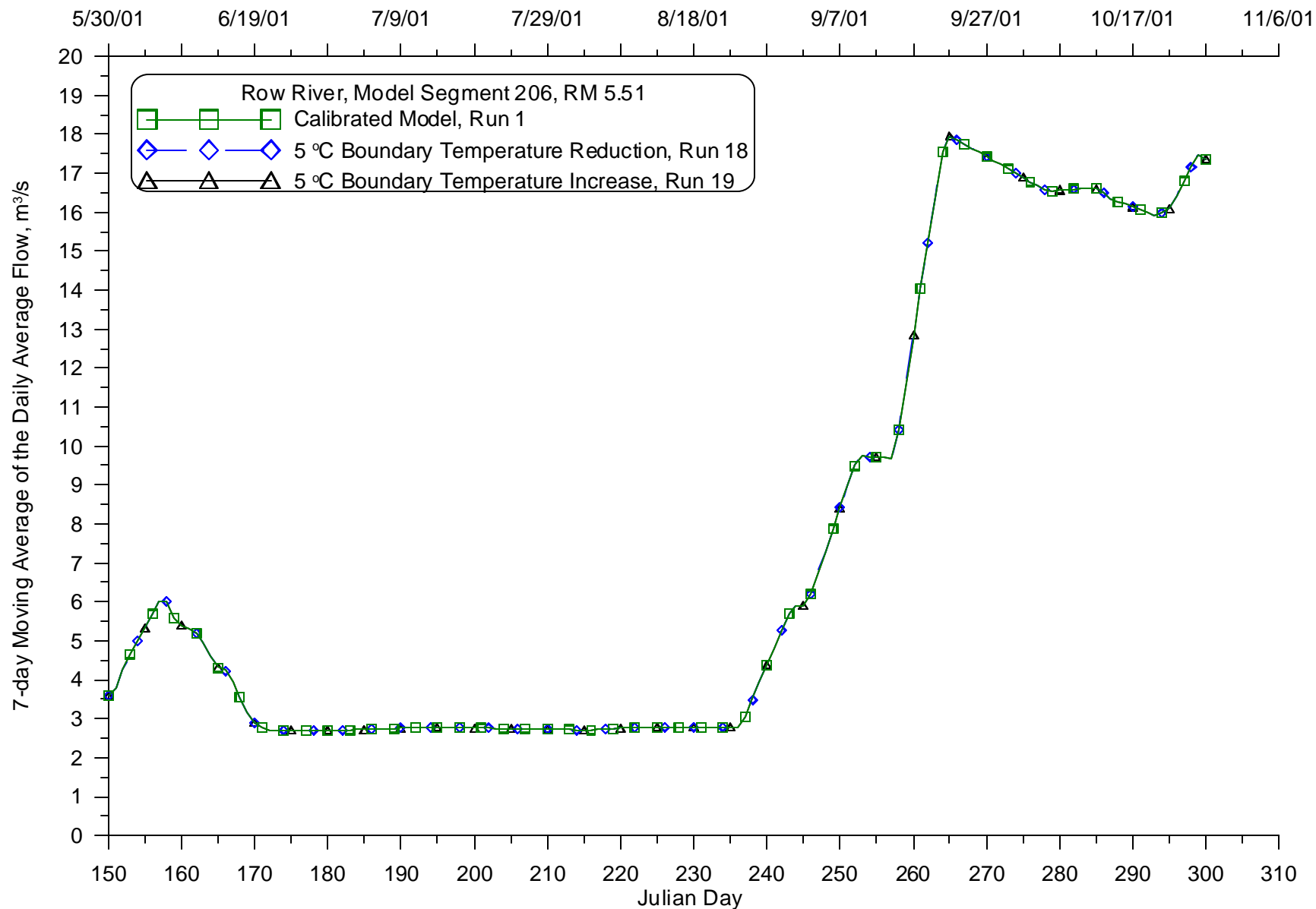
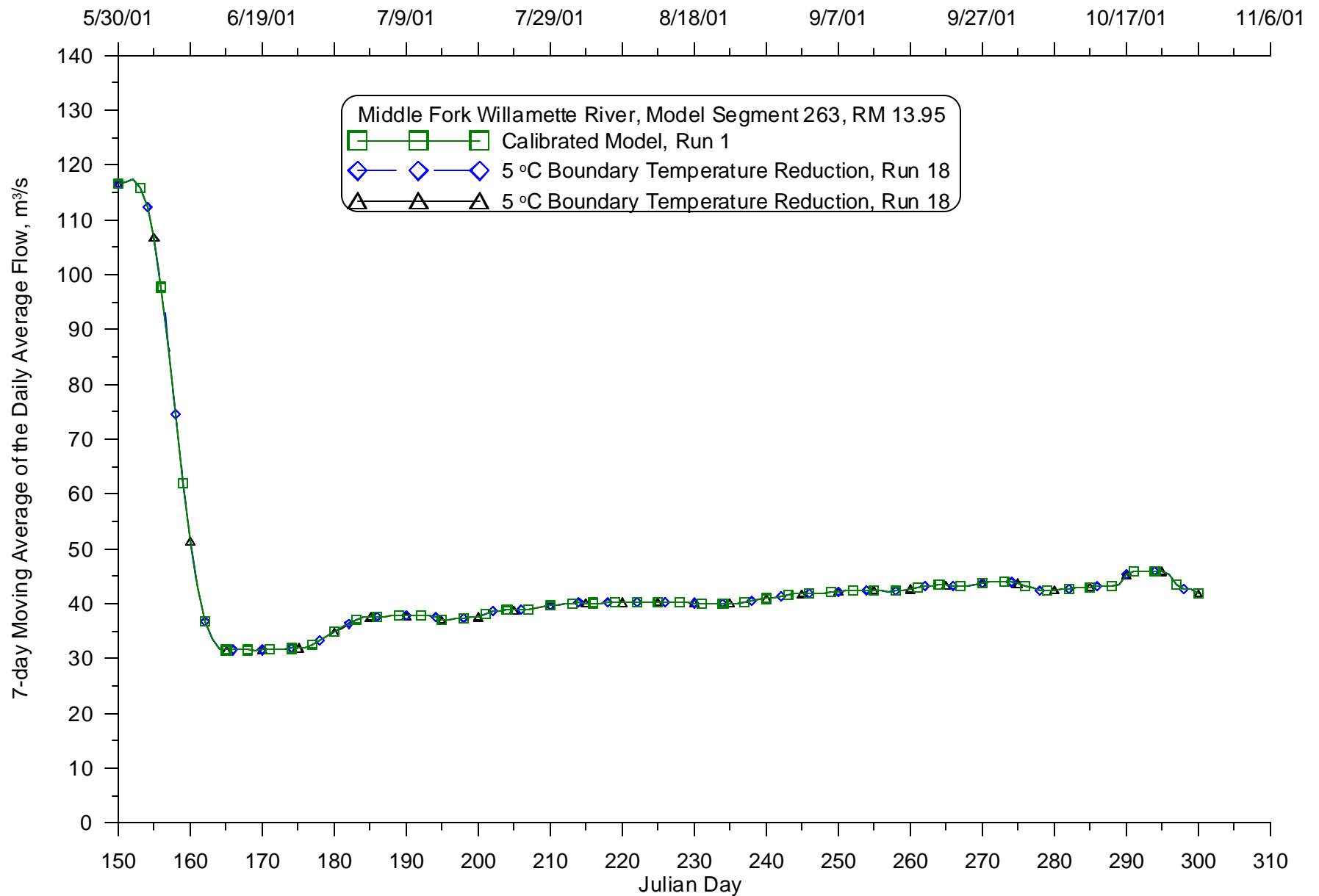
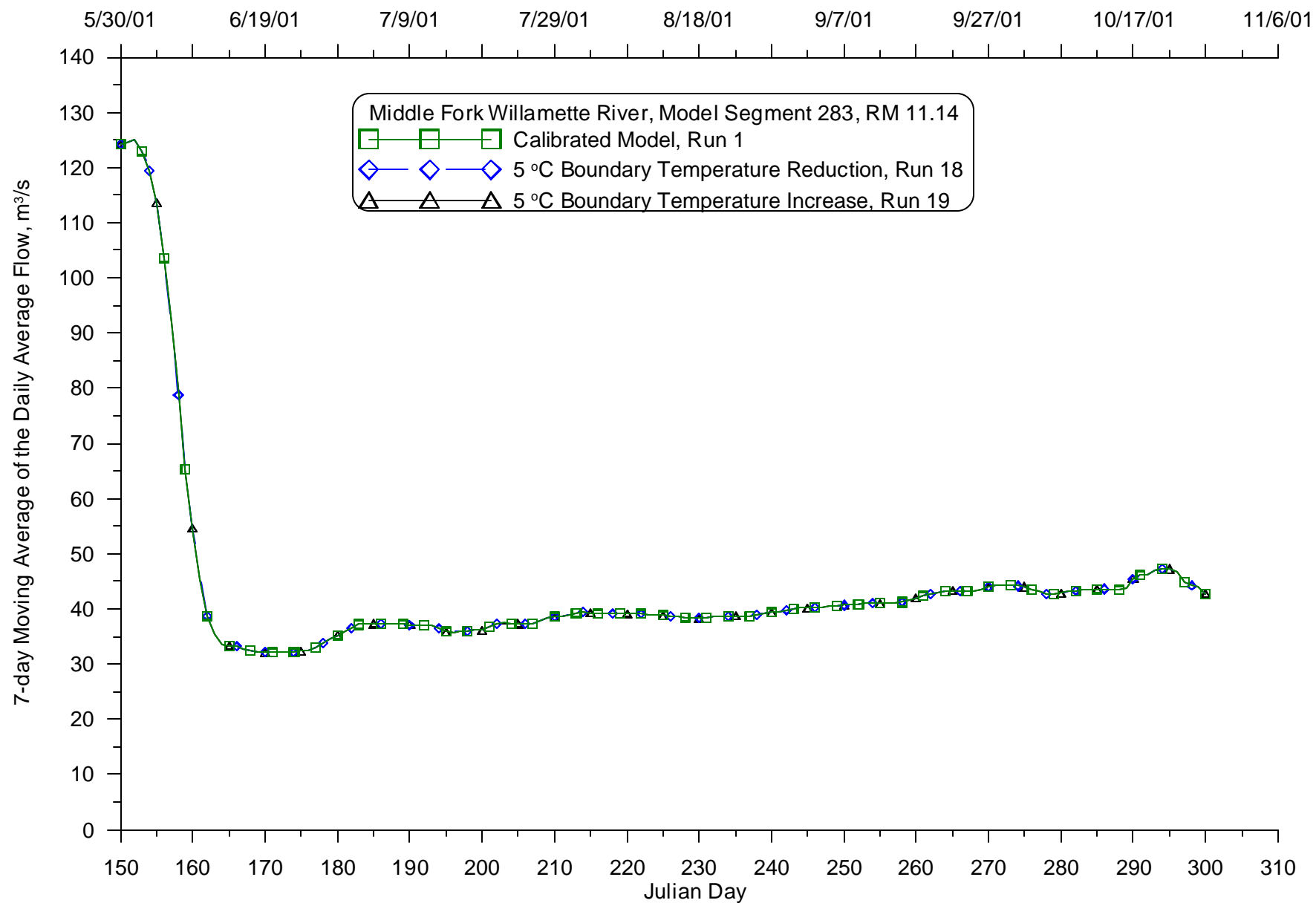


Figure 604: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 5.51



**Figure 605: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 606: Calibrated model compared with varying boundary temperature (+/- 5 °C) 7-day average of the daily average flow for 2001 for the Middle Fork Willamette River at RM 11.14**

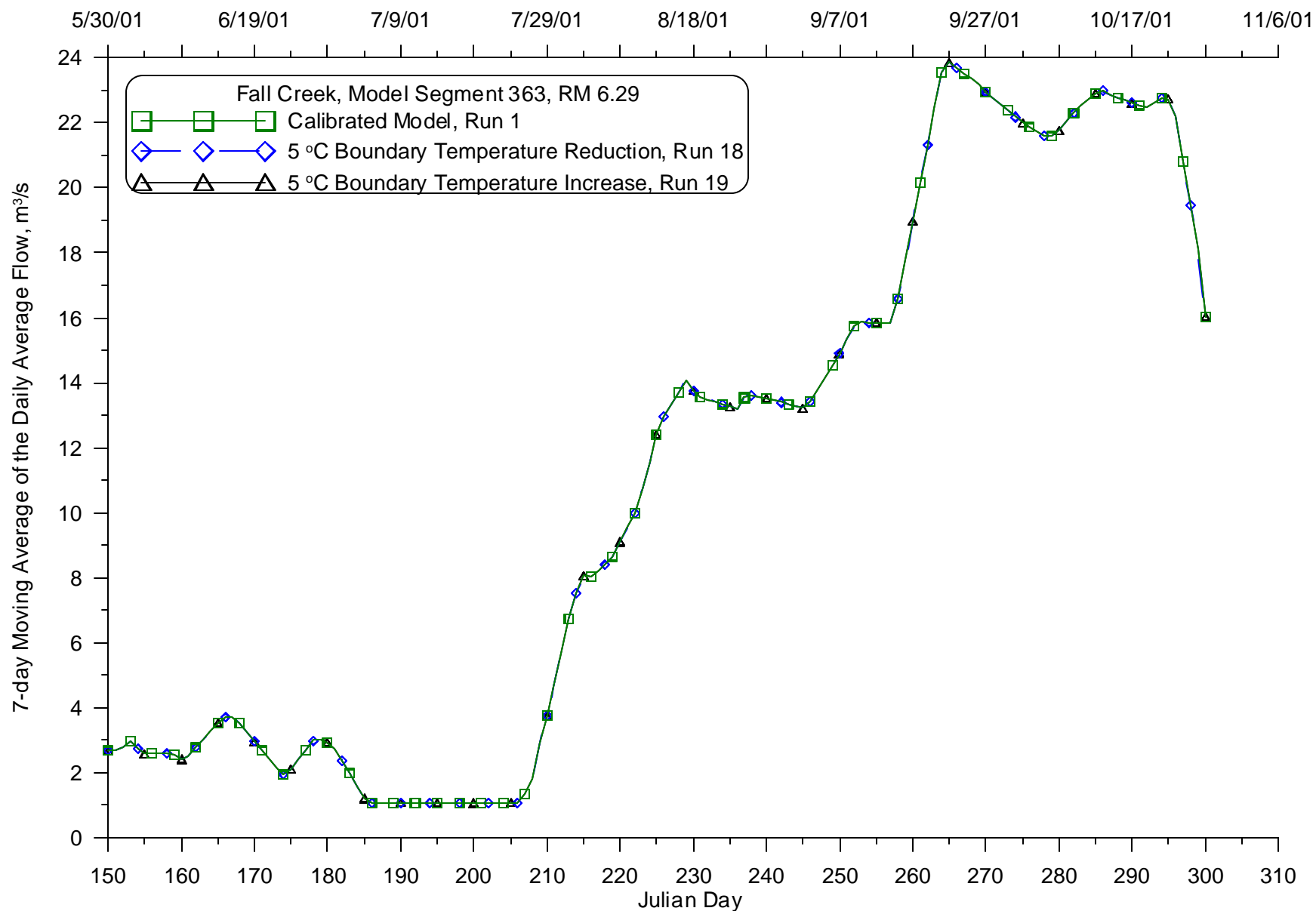
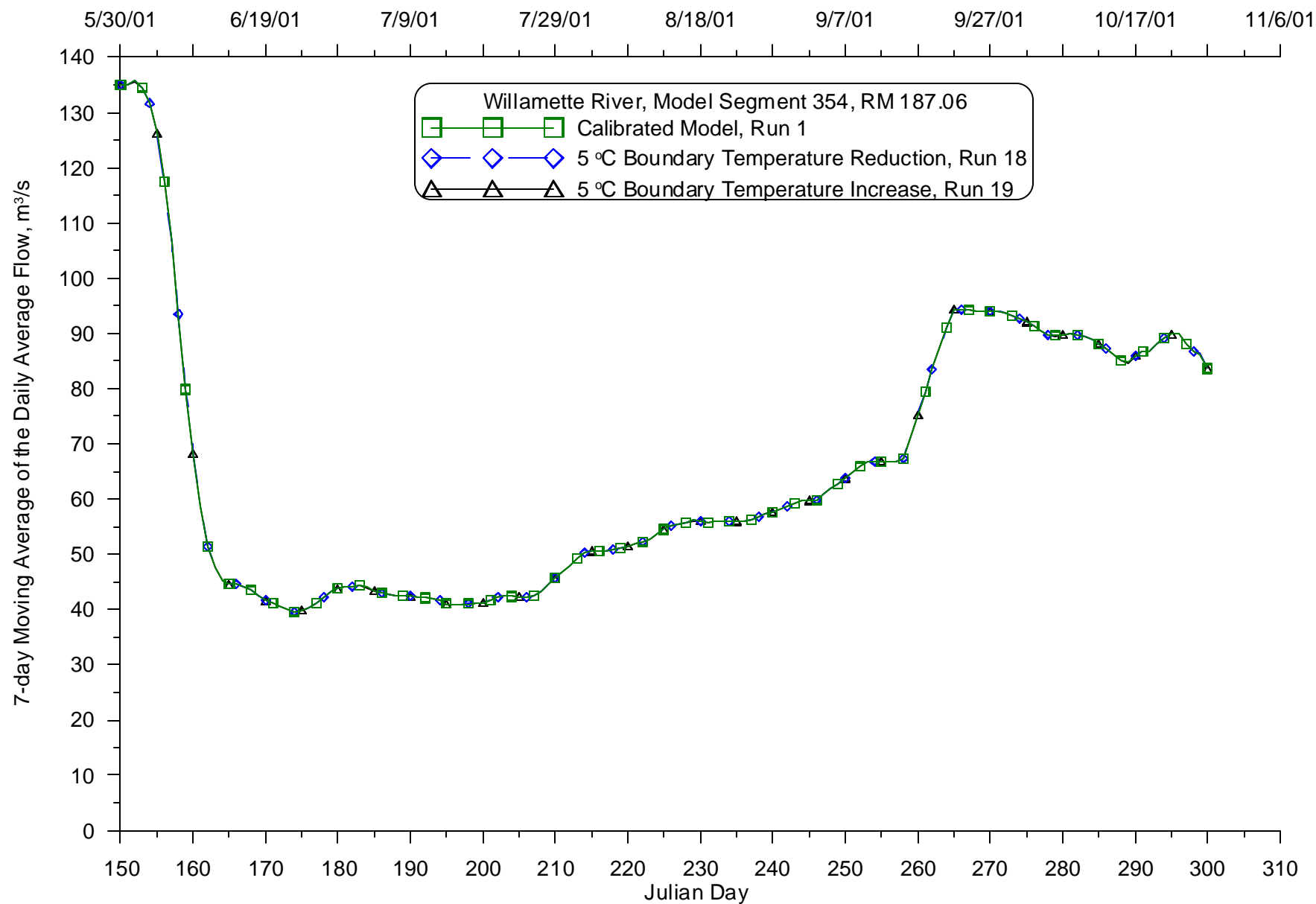


Figure 607: Calibrated model compared with varying boundary temperature ( $\pm 5$  °C) 7-day average of the daily average flow for 2001 for Fall Creek at RM 6.29



**Figure 608: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 187.06**



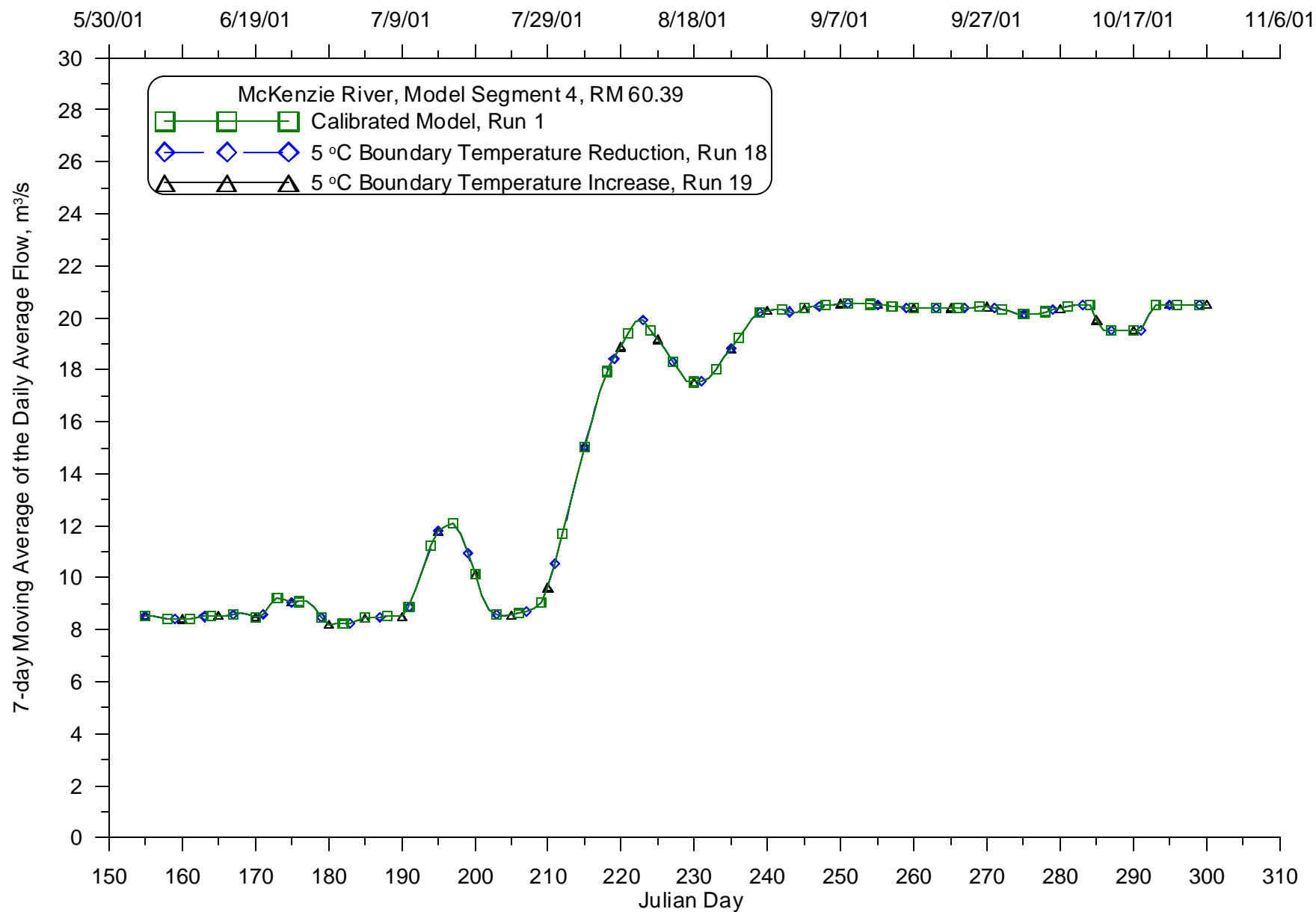
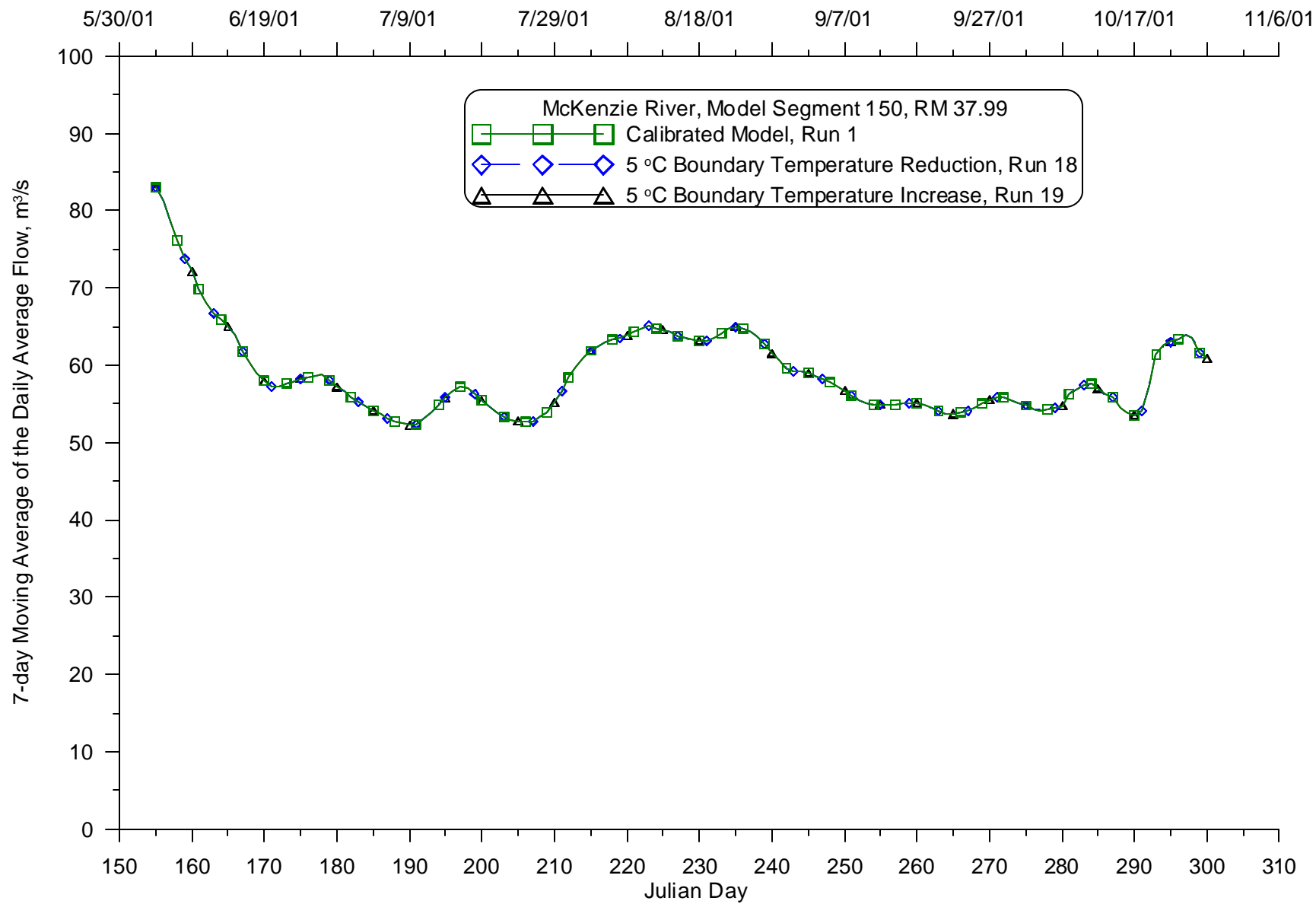


Figure 609: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the McKenzie River at RM 60.39



**Figure 610: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the McKenzie River at RM 37.99**

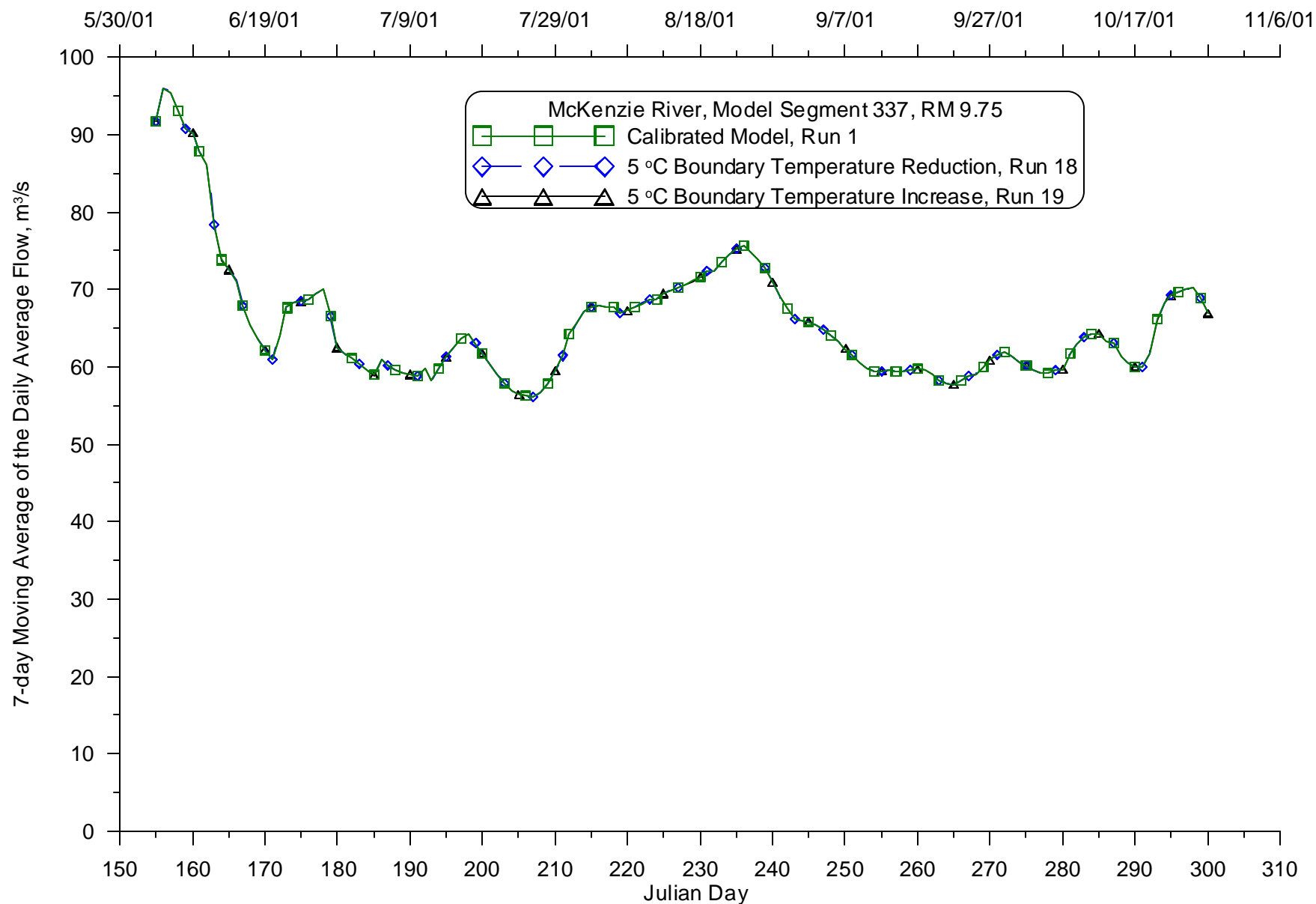


Figure 611: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the McKenzie River at RM 9.75

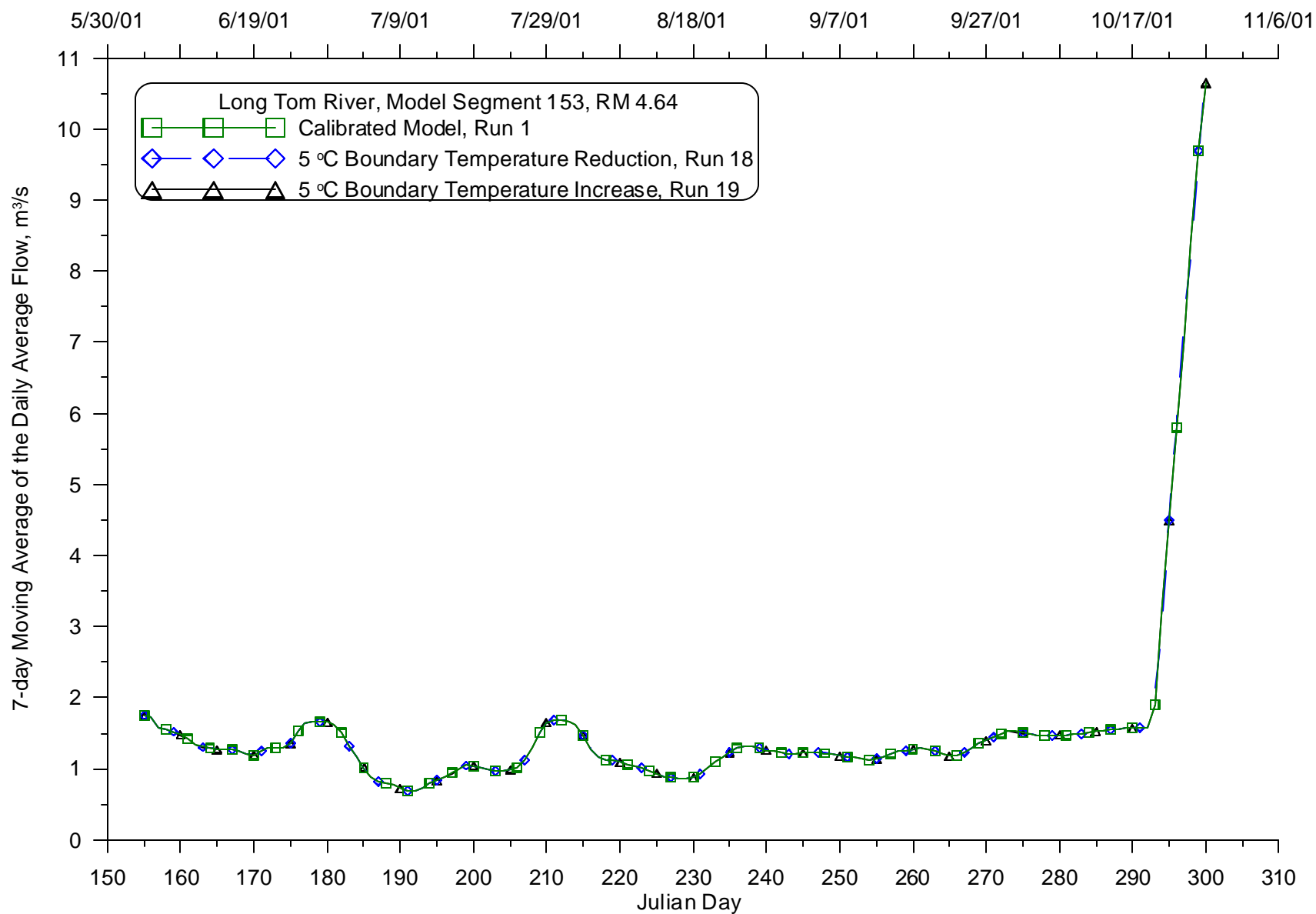


Figure 612: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Long Tom River at RM 4.64

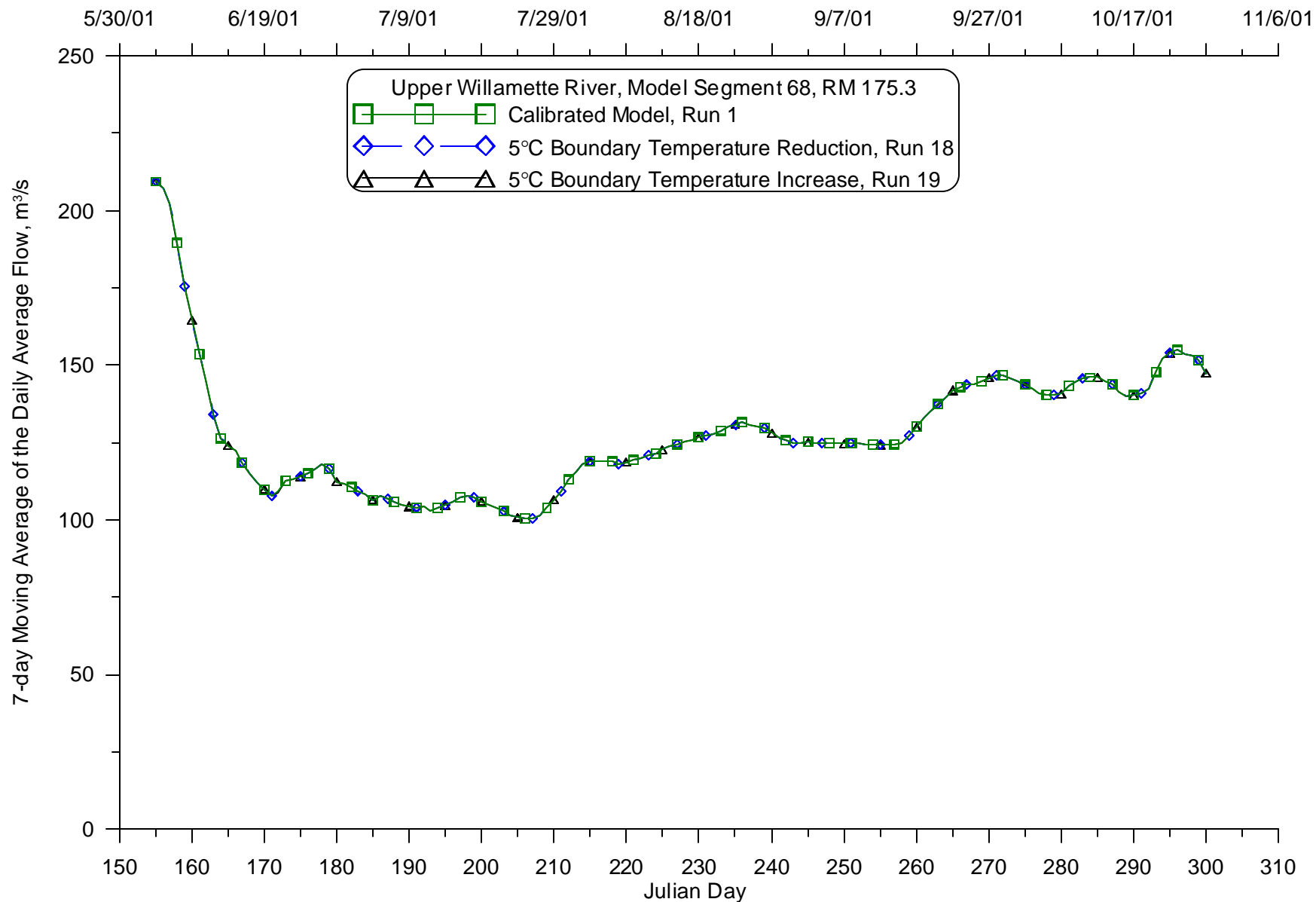
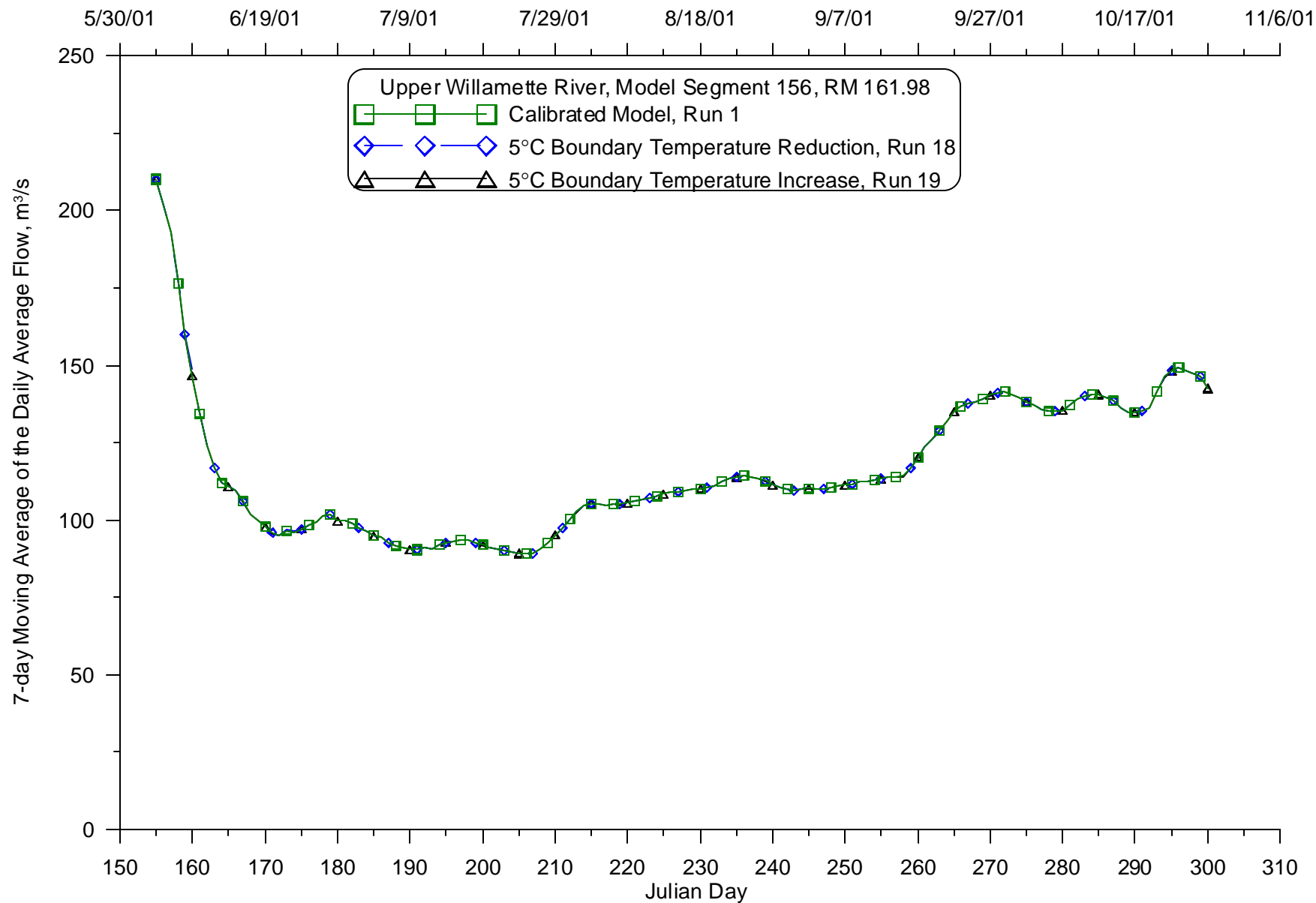
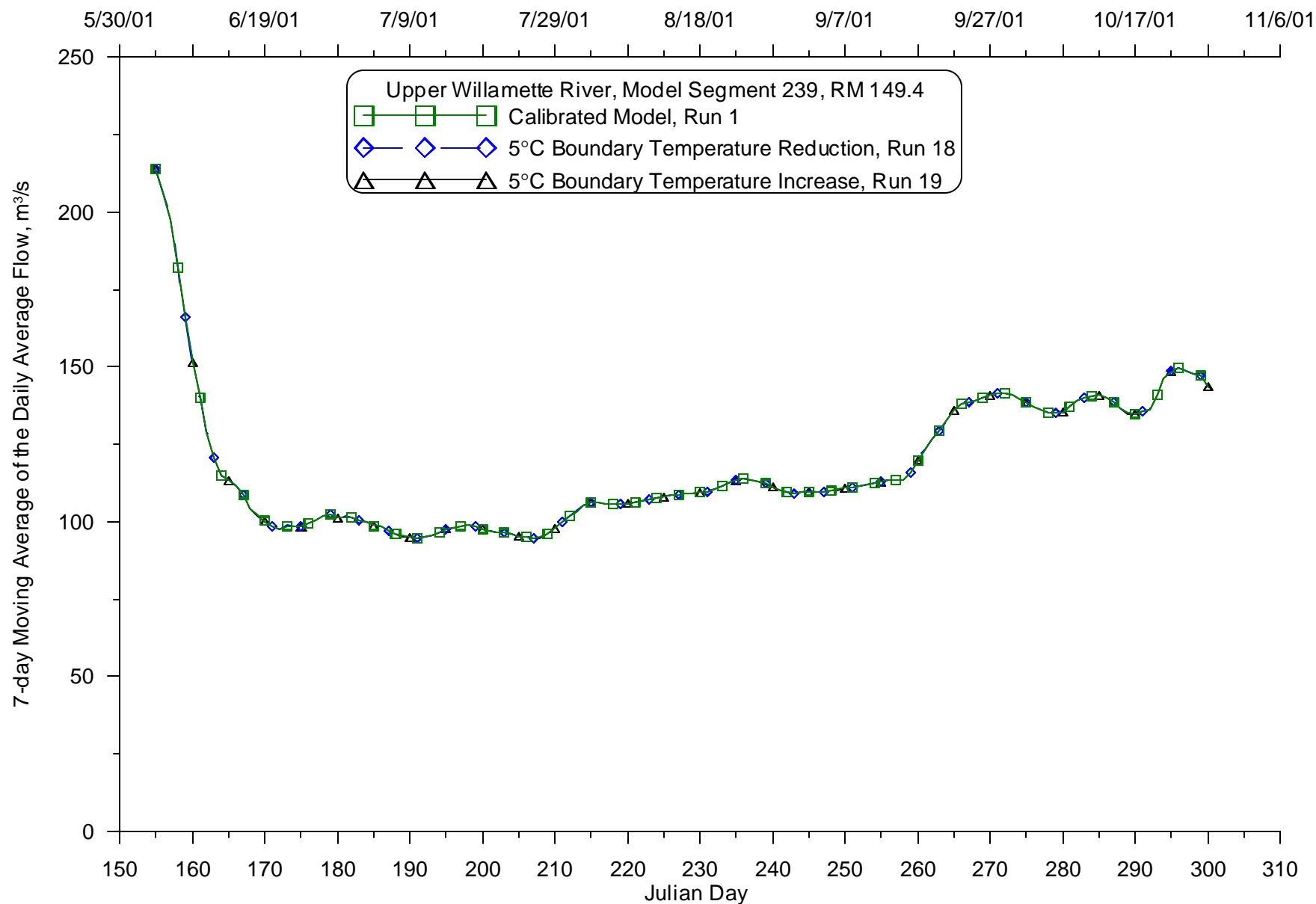


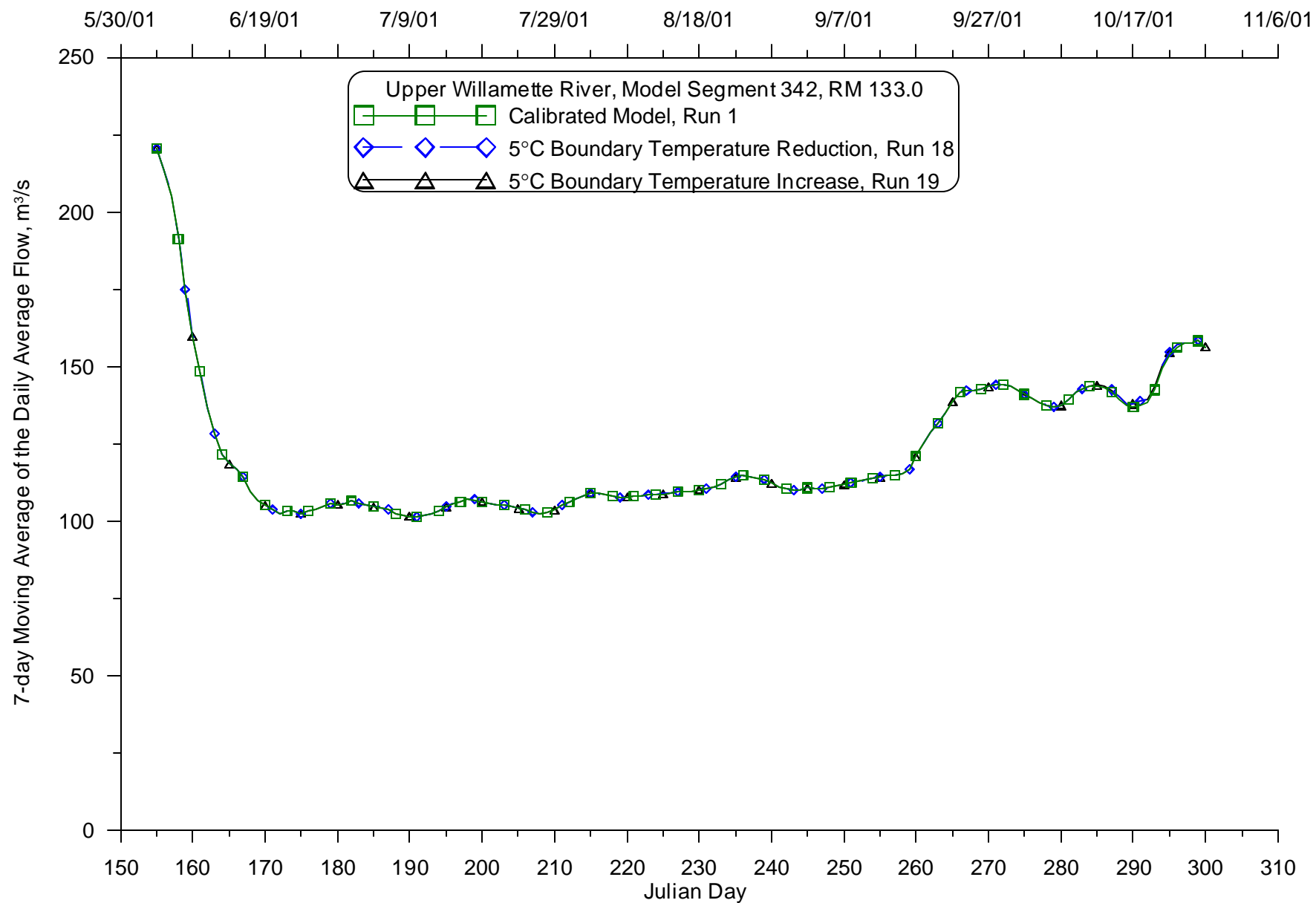
Figure 613: Calibrated model compared with varying boundary temperature ( $\pm 5$  oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 175.3



**Figure 614: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 161.98**

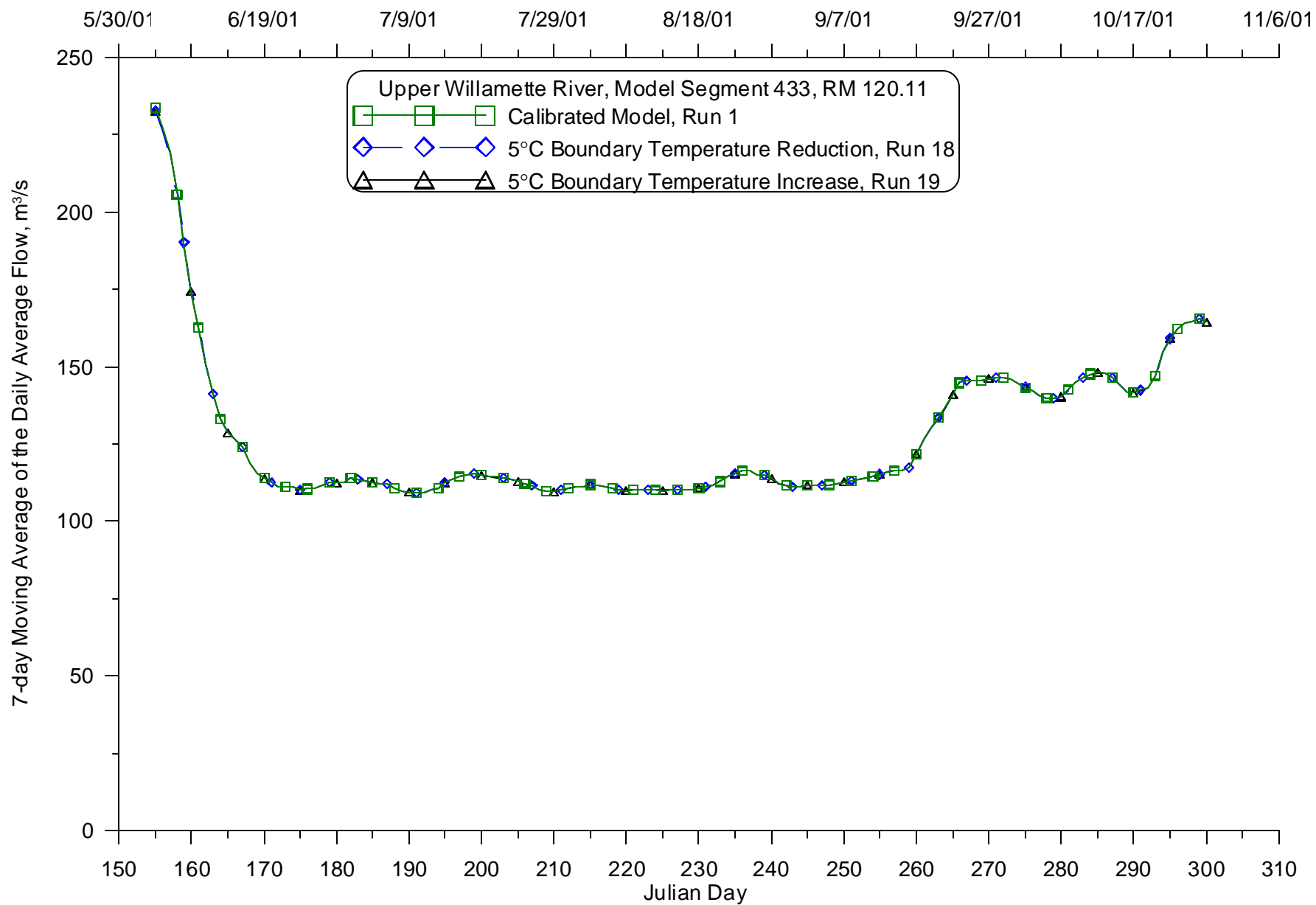


**Figure 615: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 149.4**

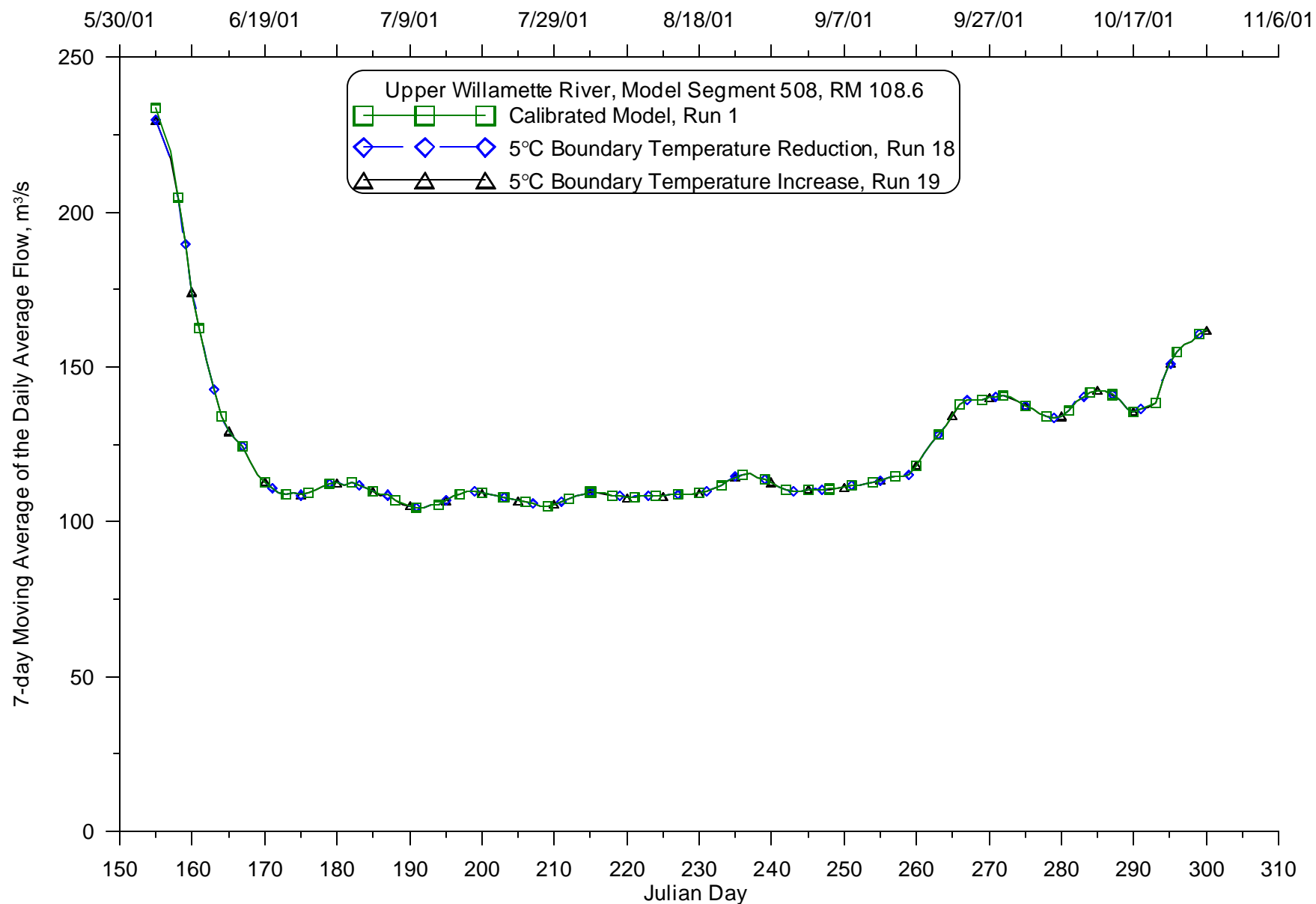


**Figure 616: Calibrated model compared with varying boundary temperature ( $\pm 5$  oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 133**

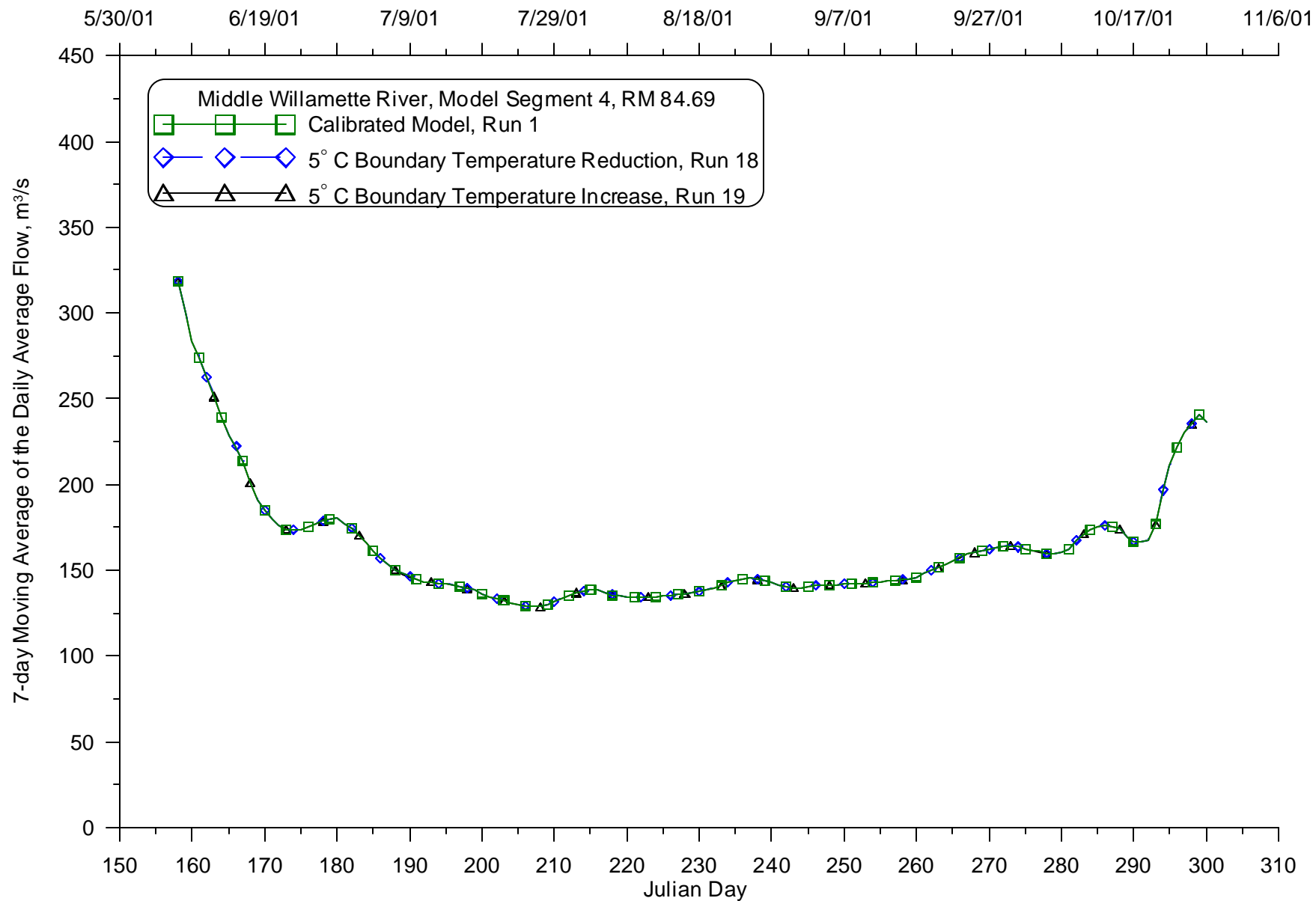




**Figure 617: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 120.11**



**Figure 618: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 108.6**



**Figure 619: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 84.69**

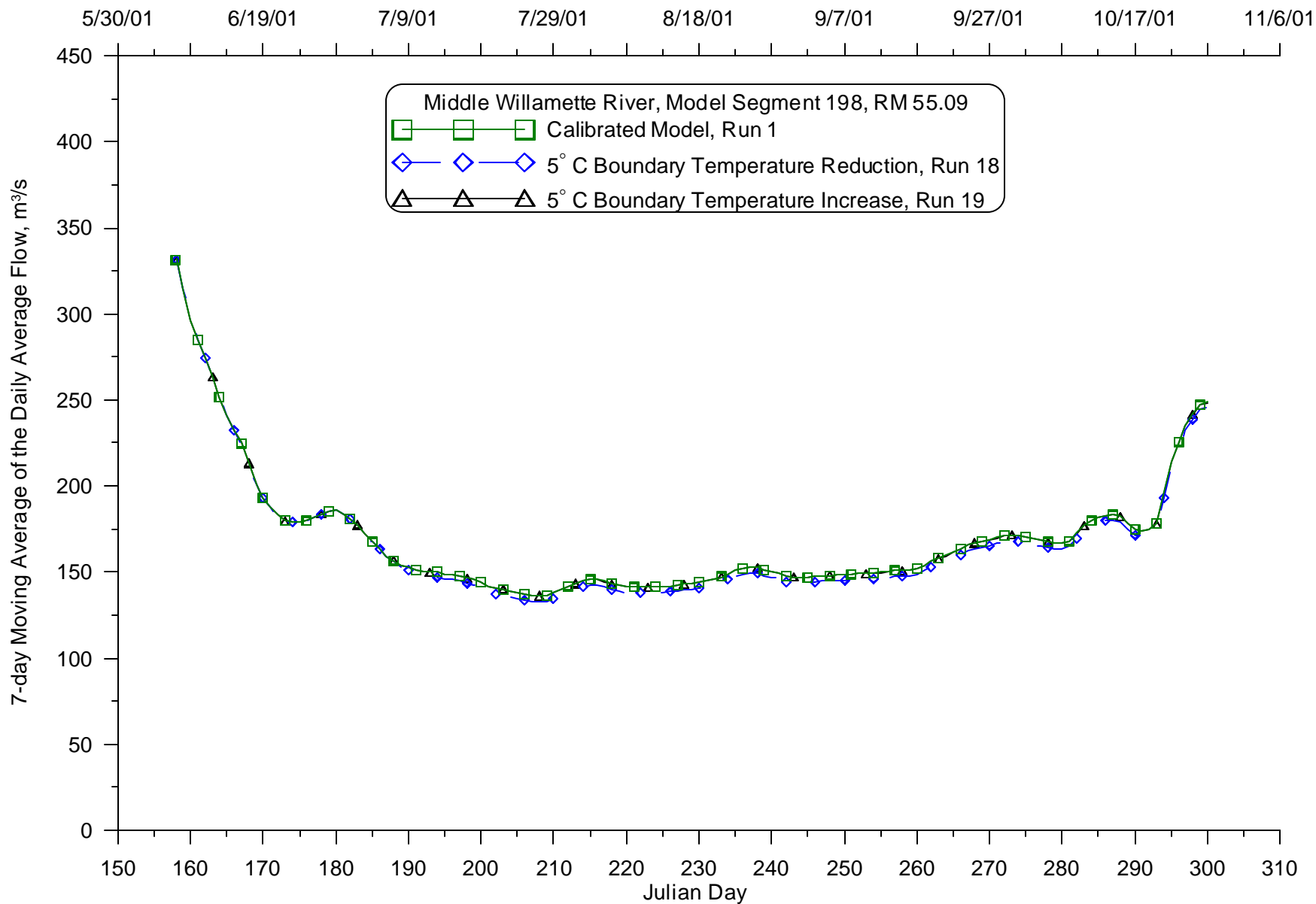


Figure 620: Calibrated model compared with varying boundary temperature ( $\pm 5$  oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 55.09

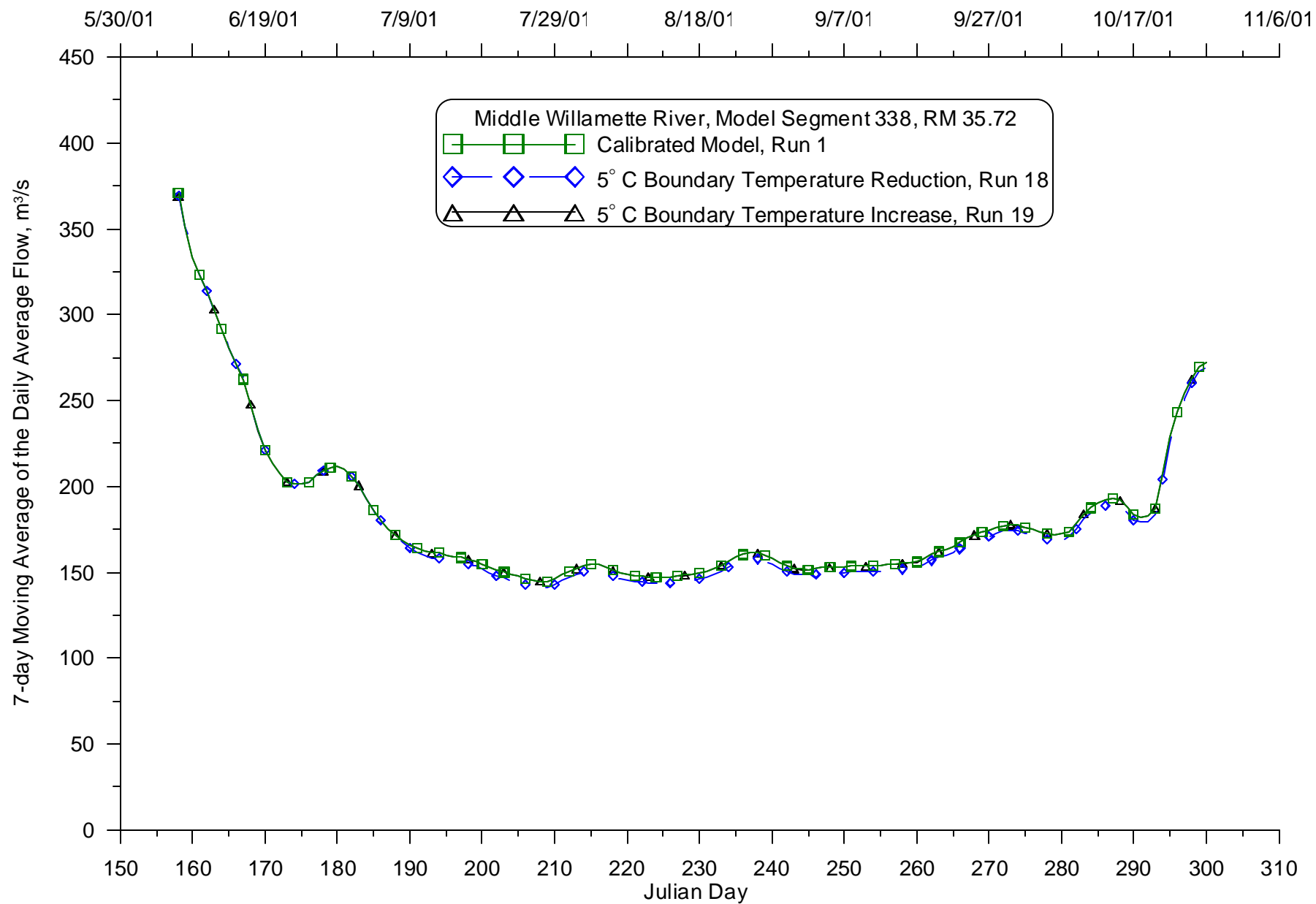
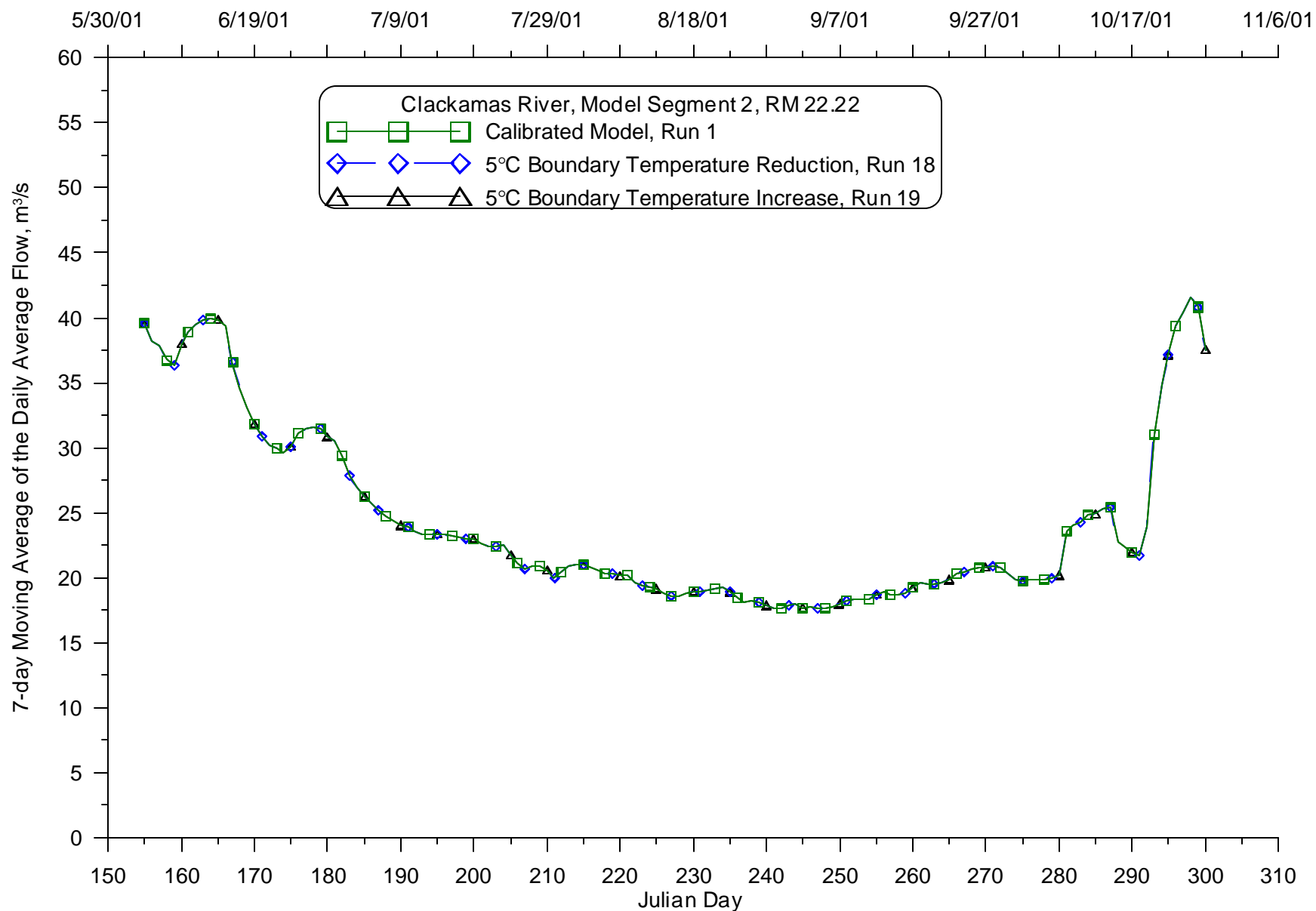


Figure 621: Calibrated model compared with varying boundary temperature ( $\pm 5^\circ\text{C}$ ) 7-day average of the daily average flow for 2001 for the Willamette River at RM 35.72



**Figure 622: Calibrated model compared with varying boundary temperature ( $\pm 5$  oC) 7-day average of the daily average flow for 2001 for the Clackamas River at RM 22.22**

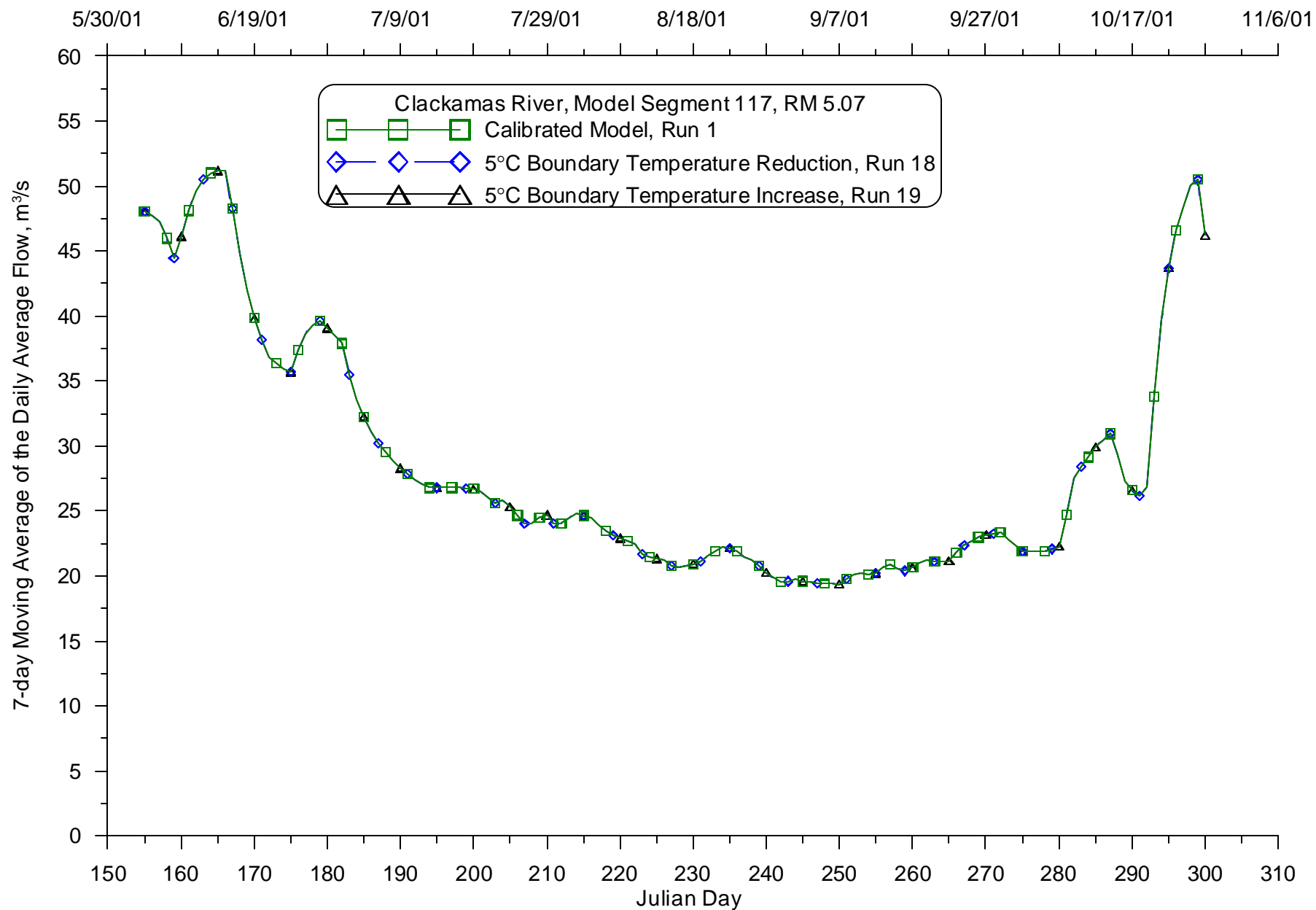
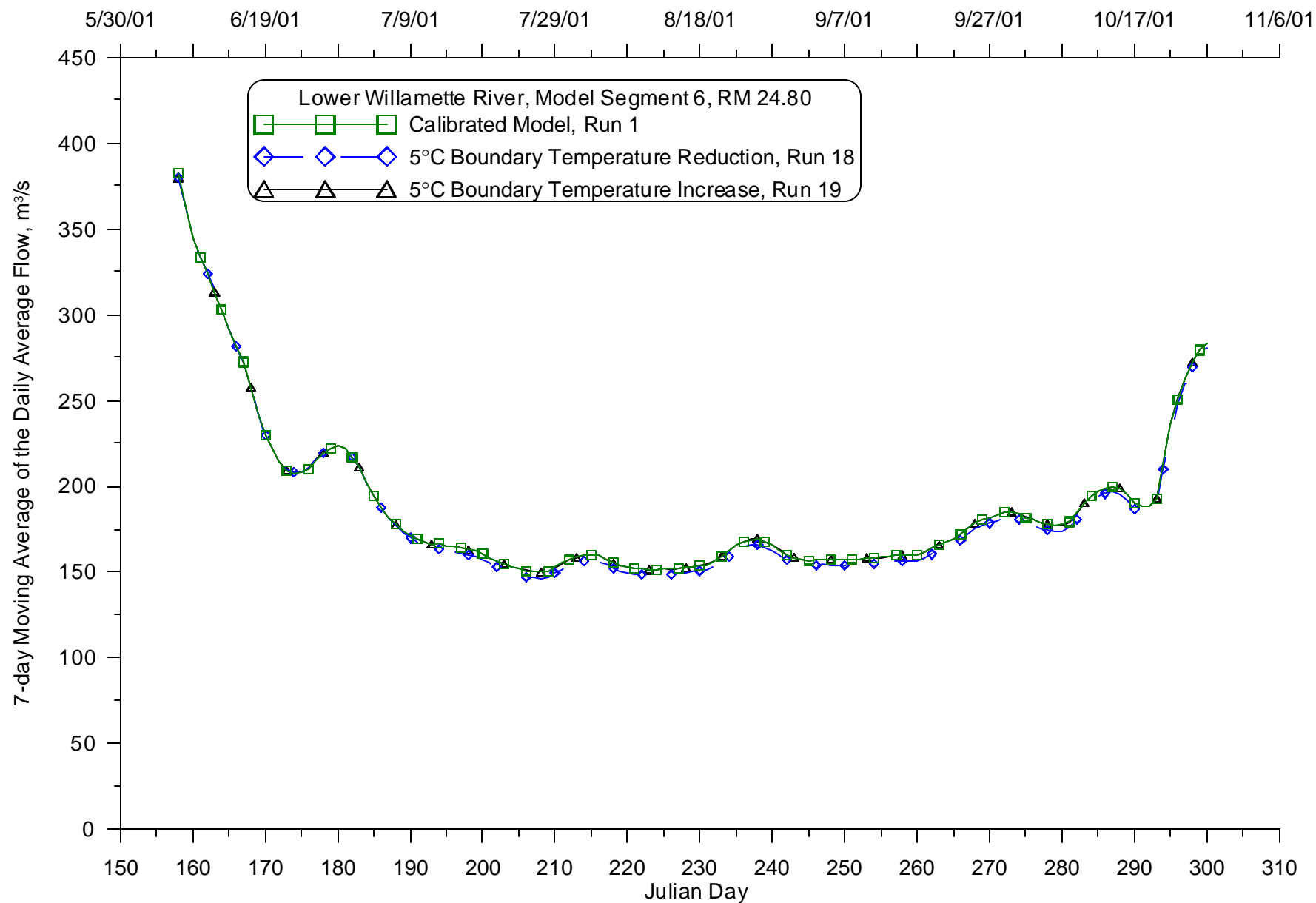
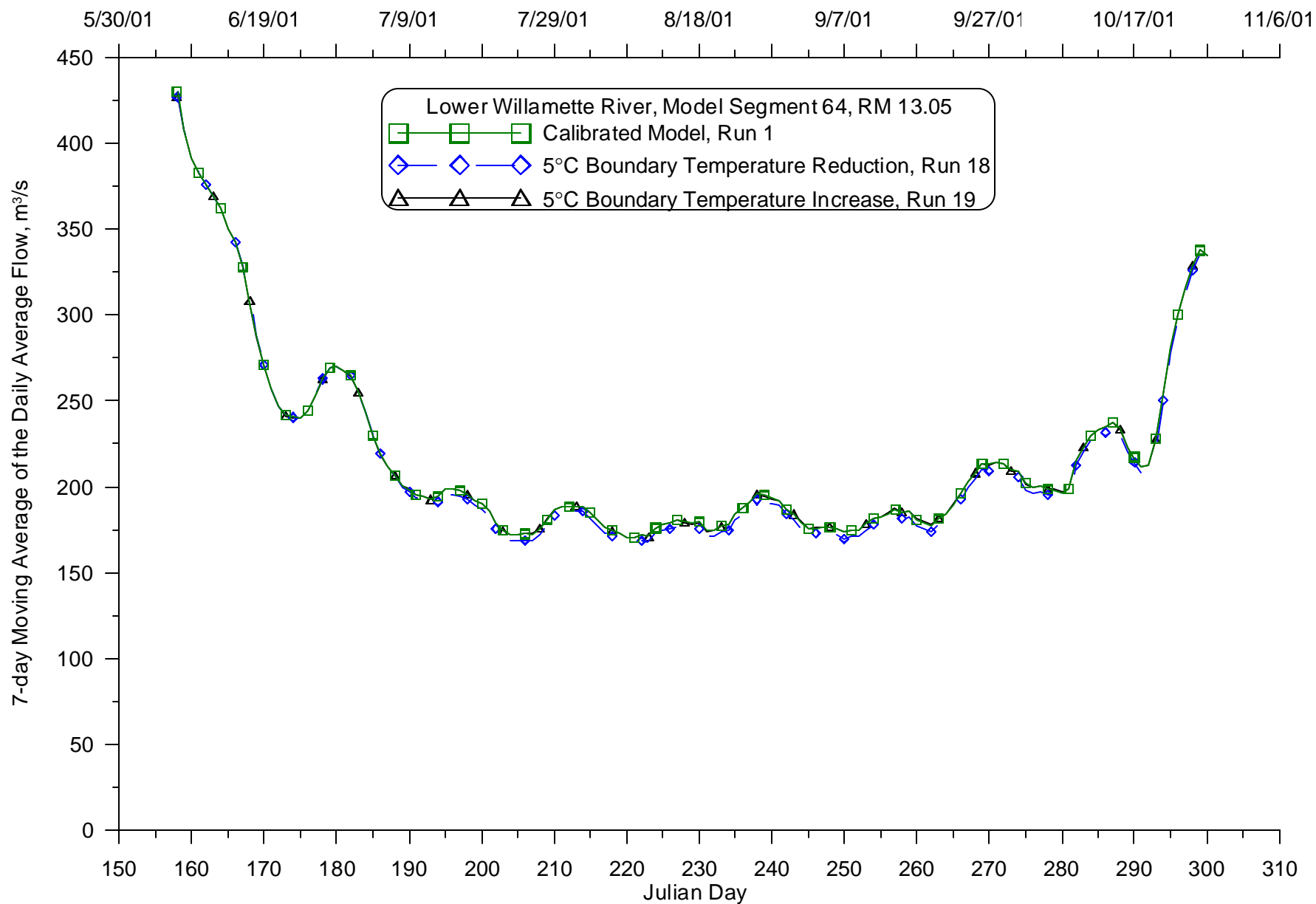


Figure 623: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Clackamas River at RM 5.07

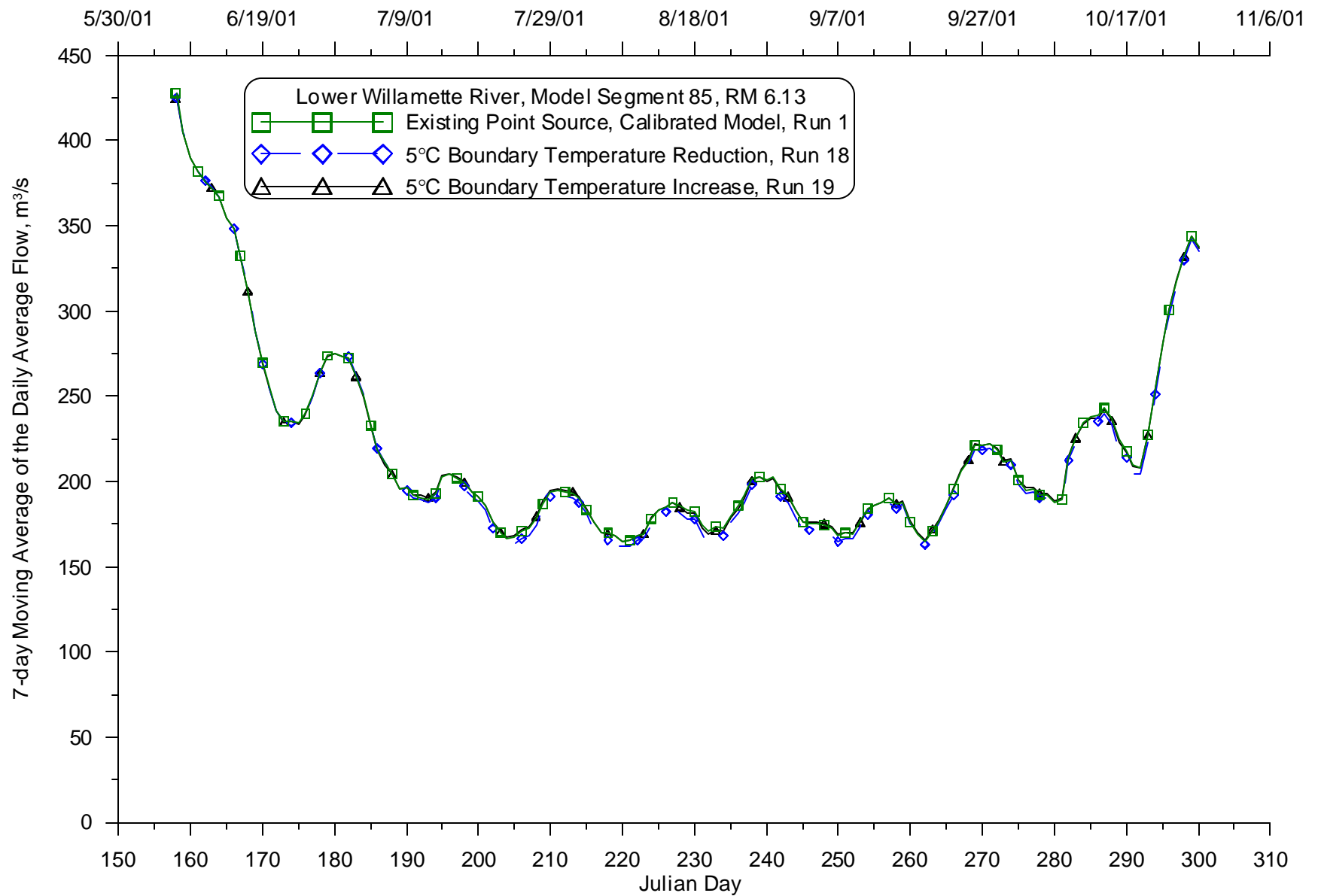


**Figure 624: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 24.8**





**Figure 625: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 13.05**

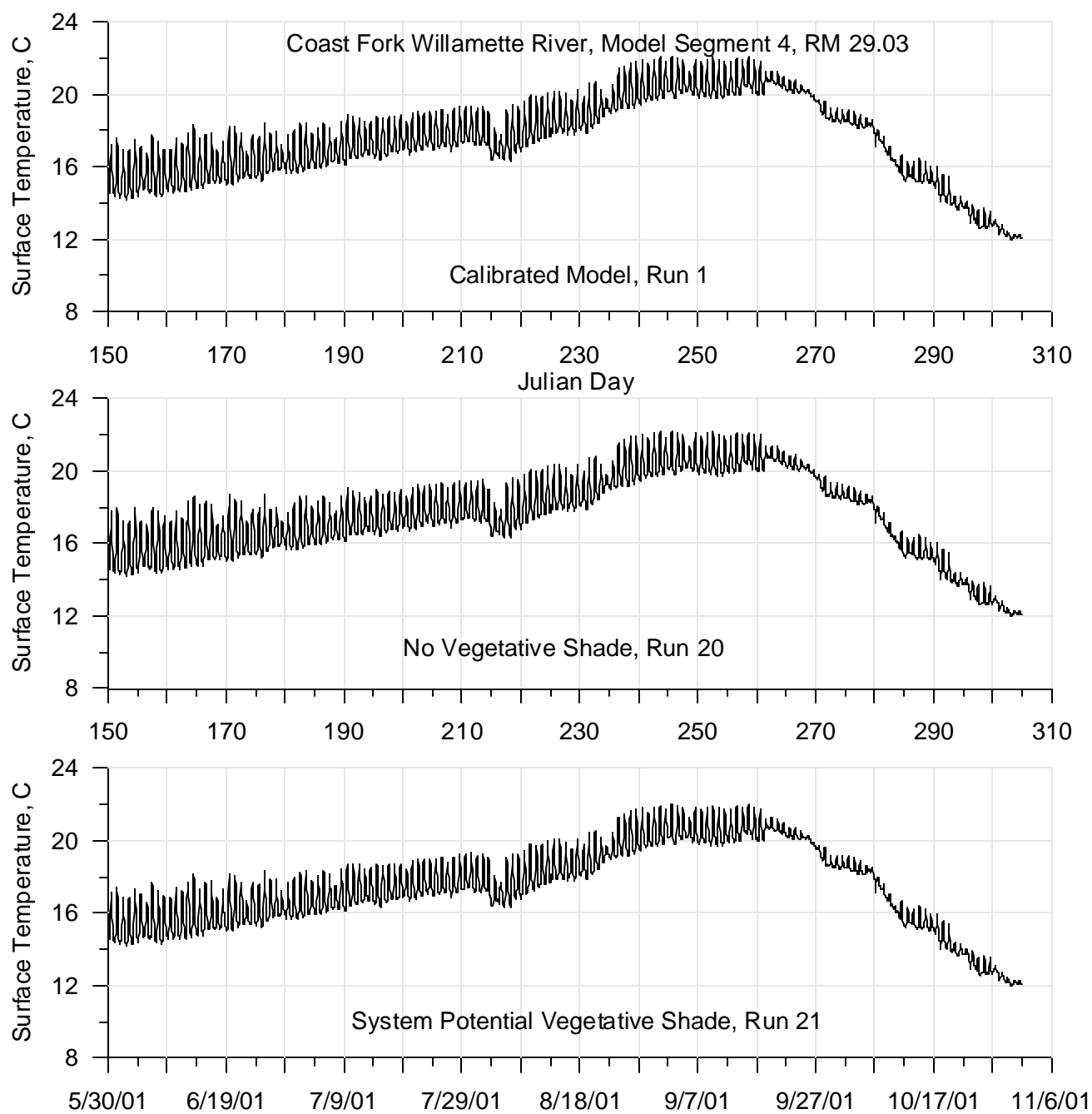


**Figure 626: Calibrated model compared with varying boundary temperature (+/- 5 oC) 7-day average of the daily average flow for 2001 for the Willamette River at RM 6.13**

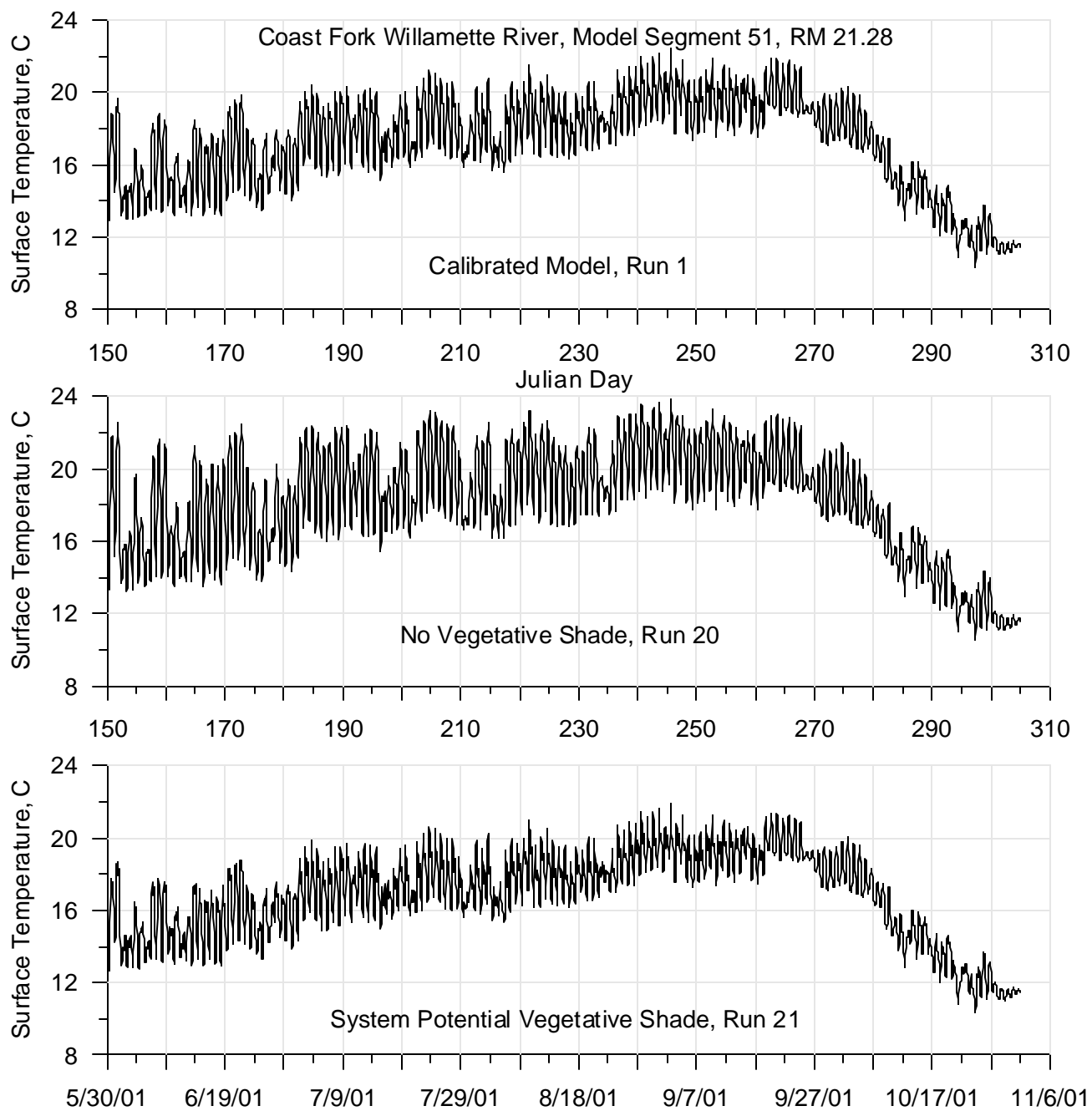
## ***Sensitivity to vegetative shade***

The sensitivity of the model to the varying vegetative shade was examined by simulating the summer of 2001 with no vegetative shade and System Potential vegetative shade. These results were then compared with the results of the calibrated model in a series of time series plots. There are four types of time series output for each of the 21 locations identified above in Table 2: continuous temperature, continuous flow, the seven-day moving average of the daily maximum temperature, and the seven-day average of daily average flow.

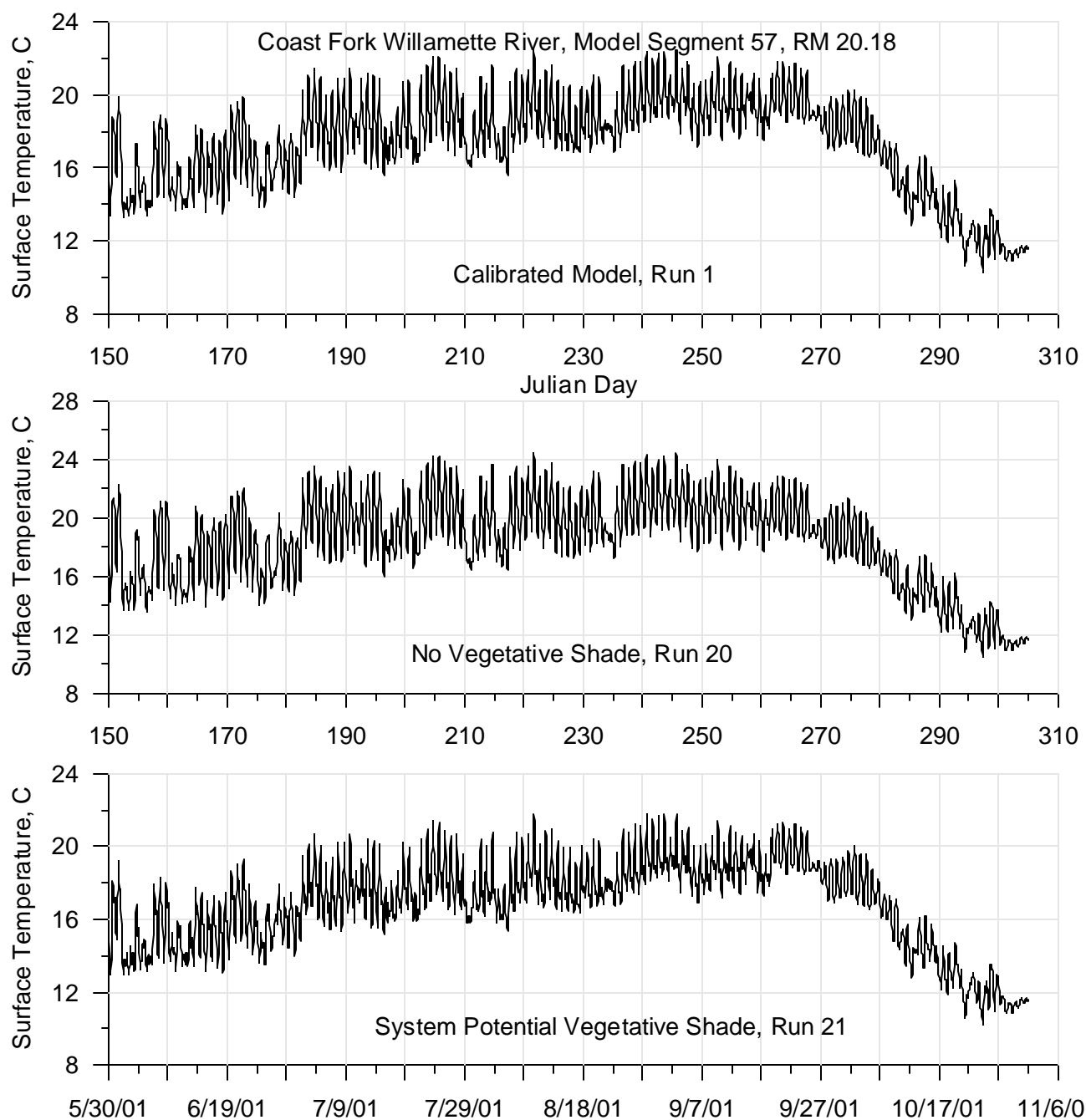
### **Continuous Temperature**



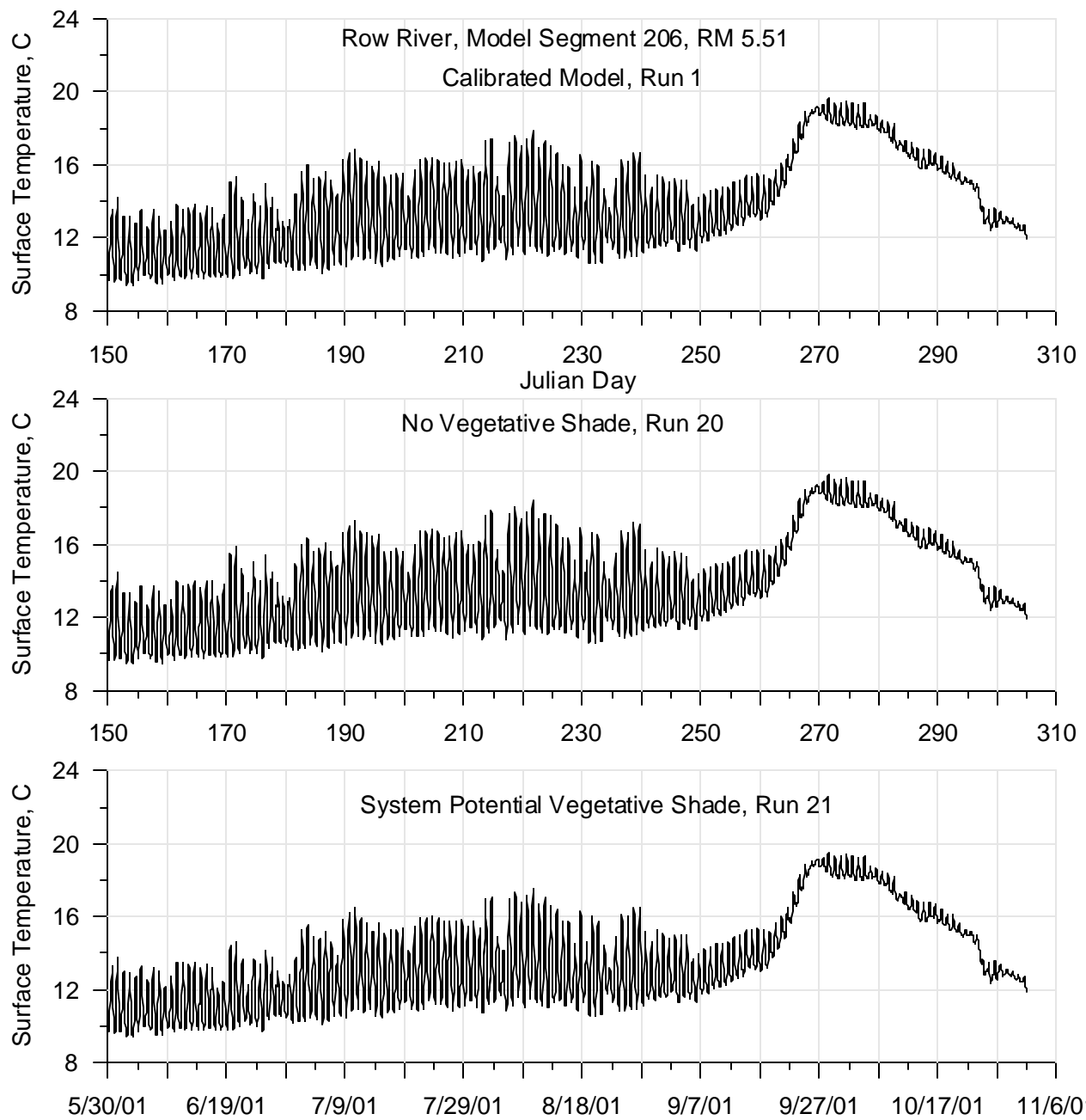
**Figure 627: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Coast Fork Willamette River at RM 29.03**



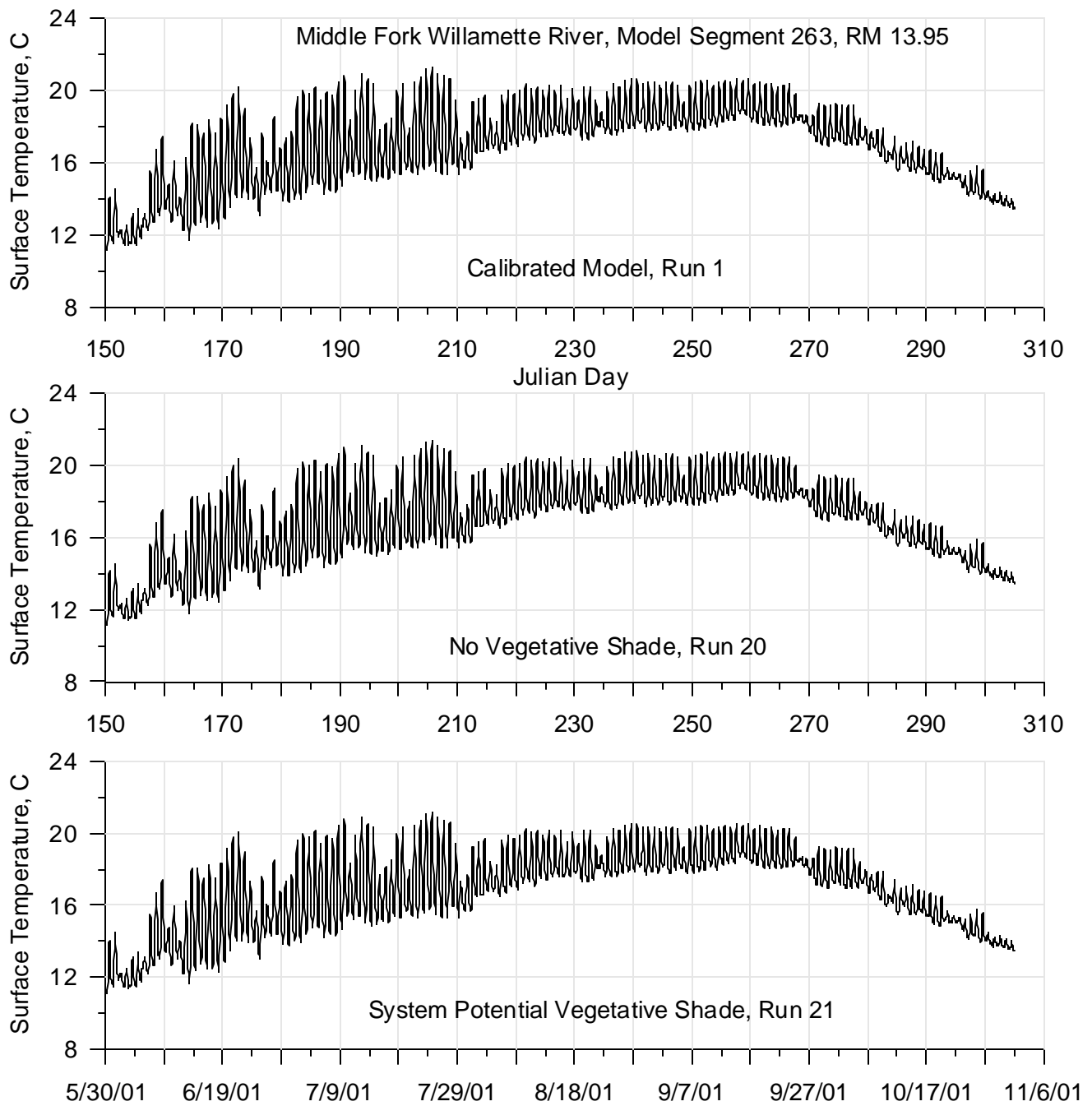
**Figure 628: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Coast Fork Willamette River at RM 21.28**



**Figure 629: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Coast Fork Willamette River at RM 20.18**

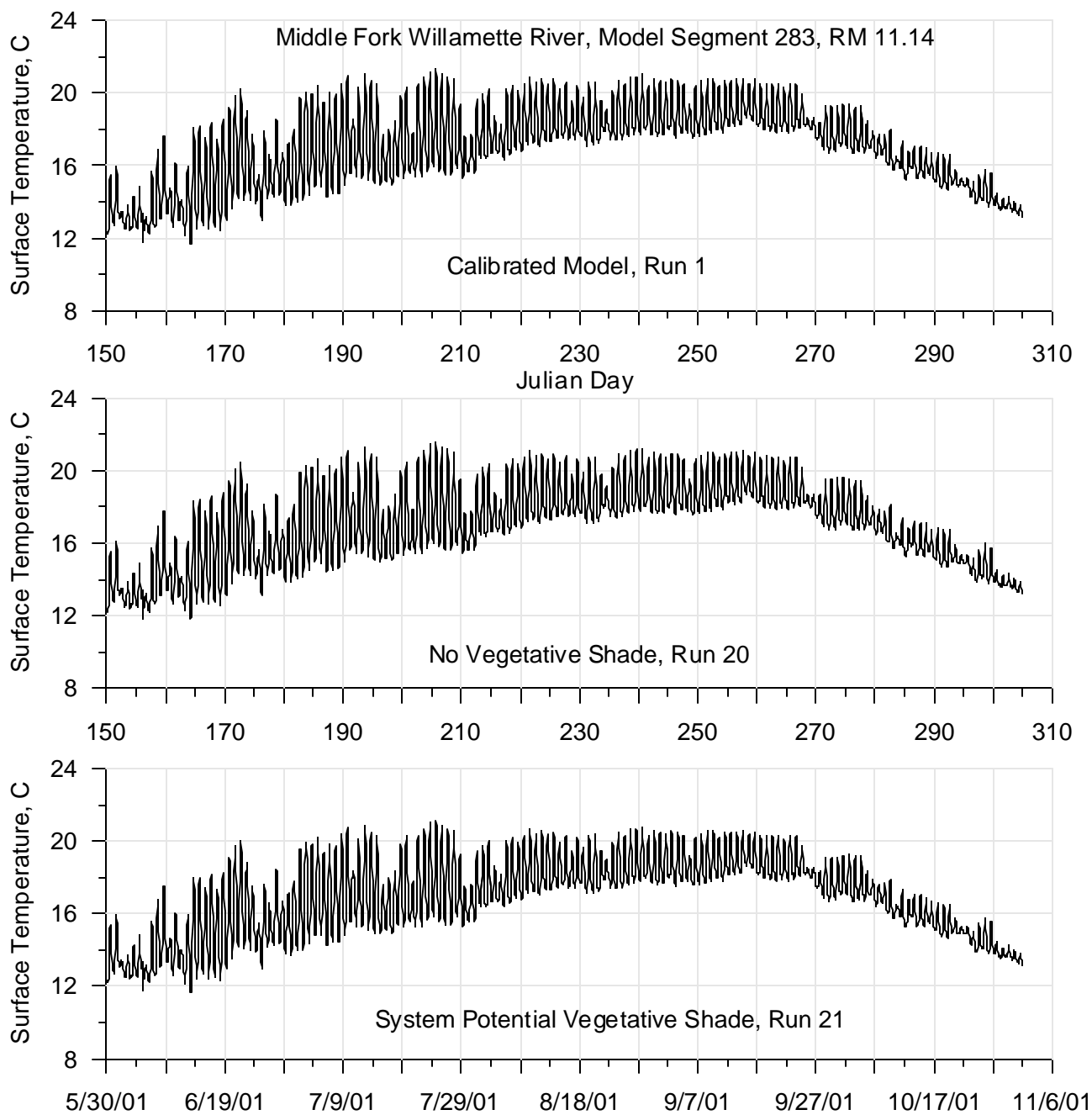


**Figure 630: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Row River at RM 5.51**

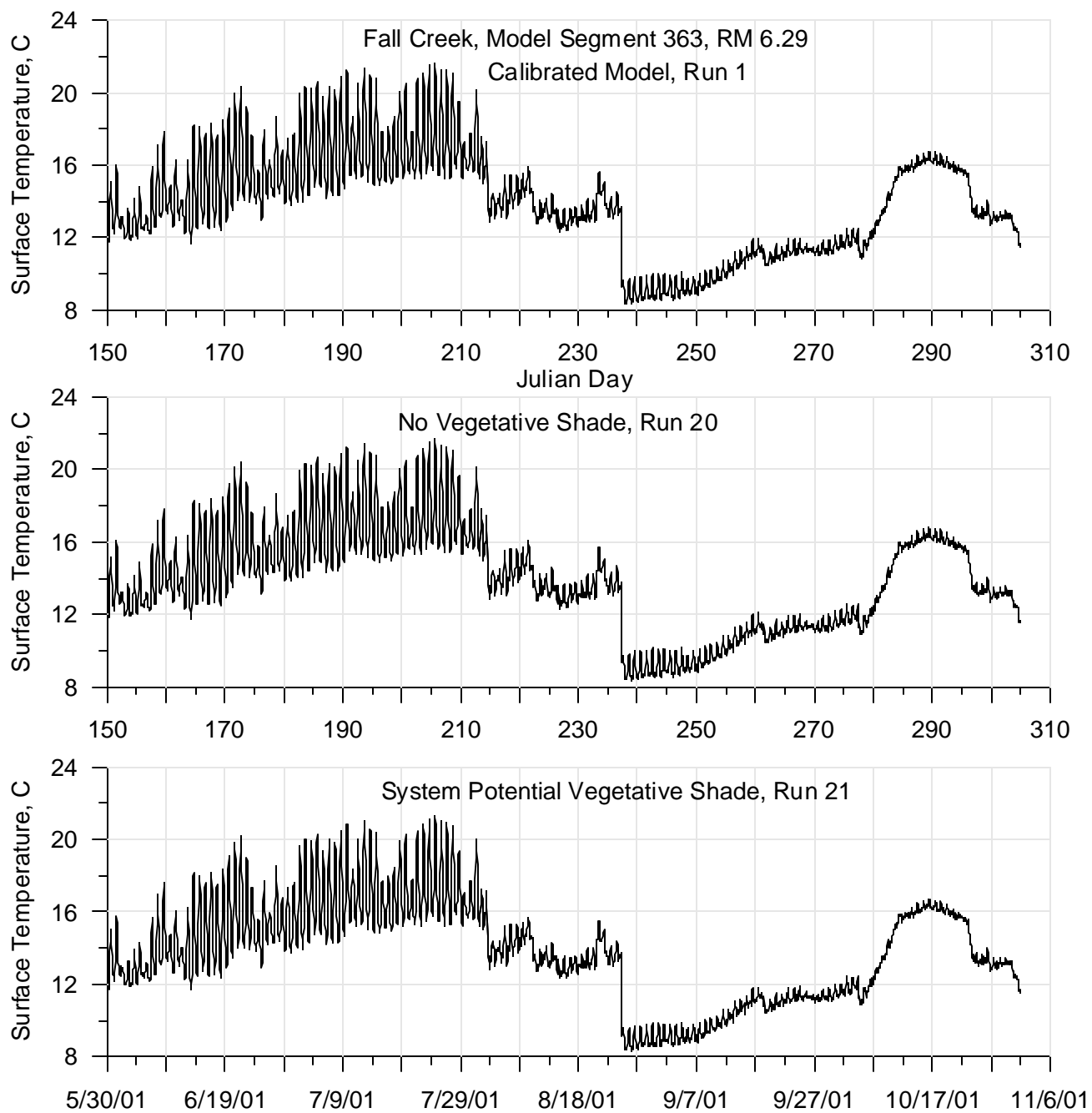


**Figure 631: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Middle Fork Willamette River at RM 13.95**

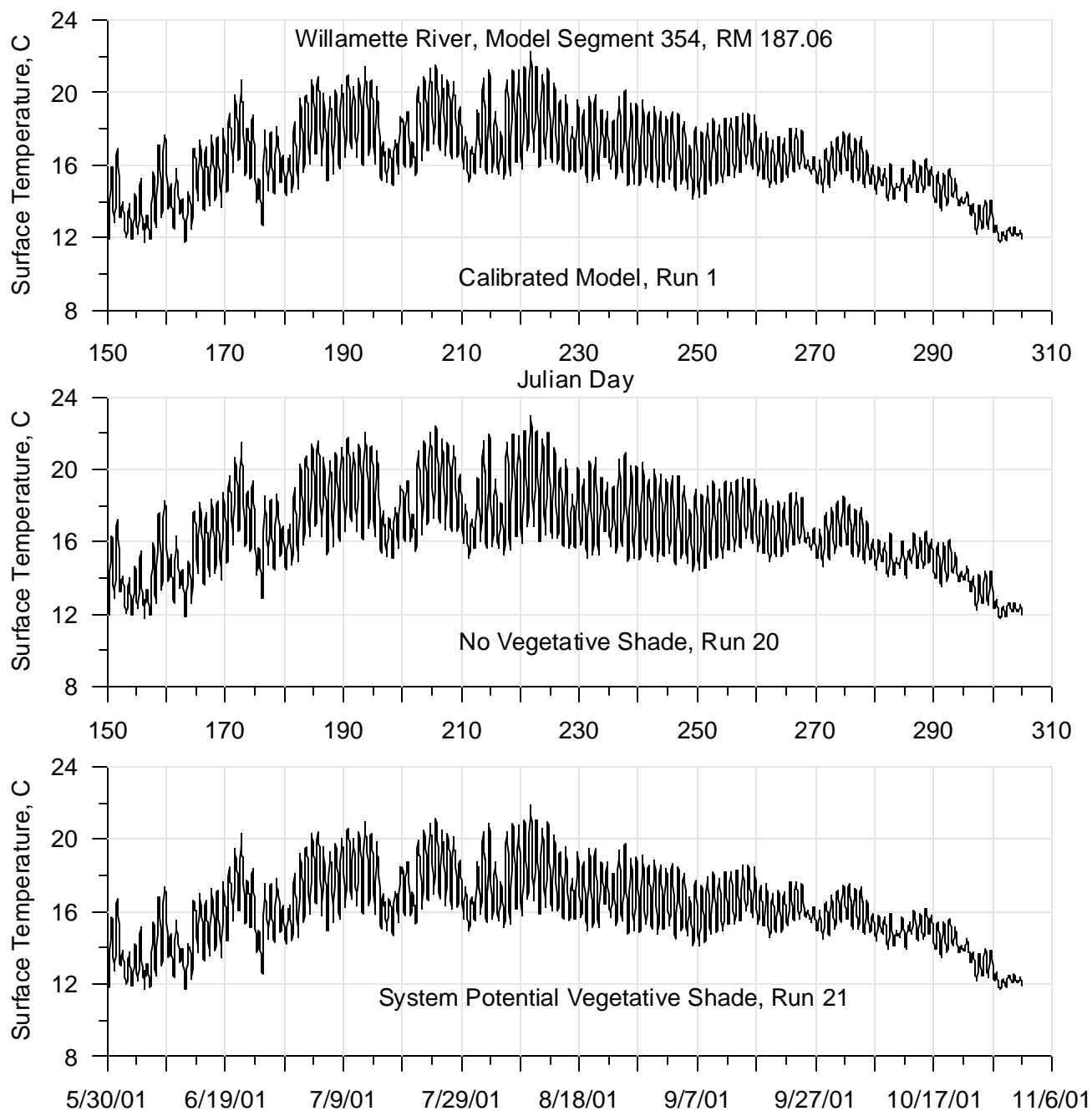




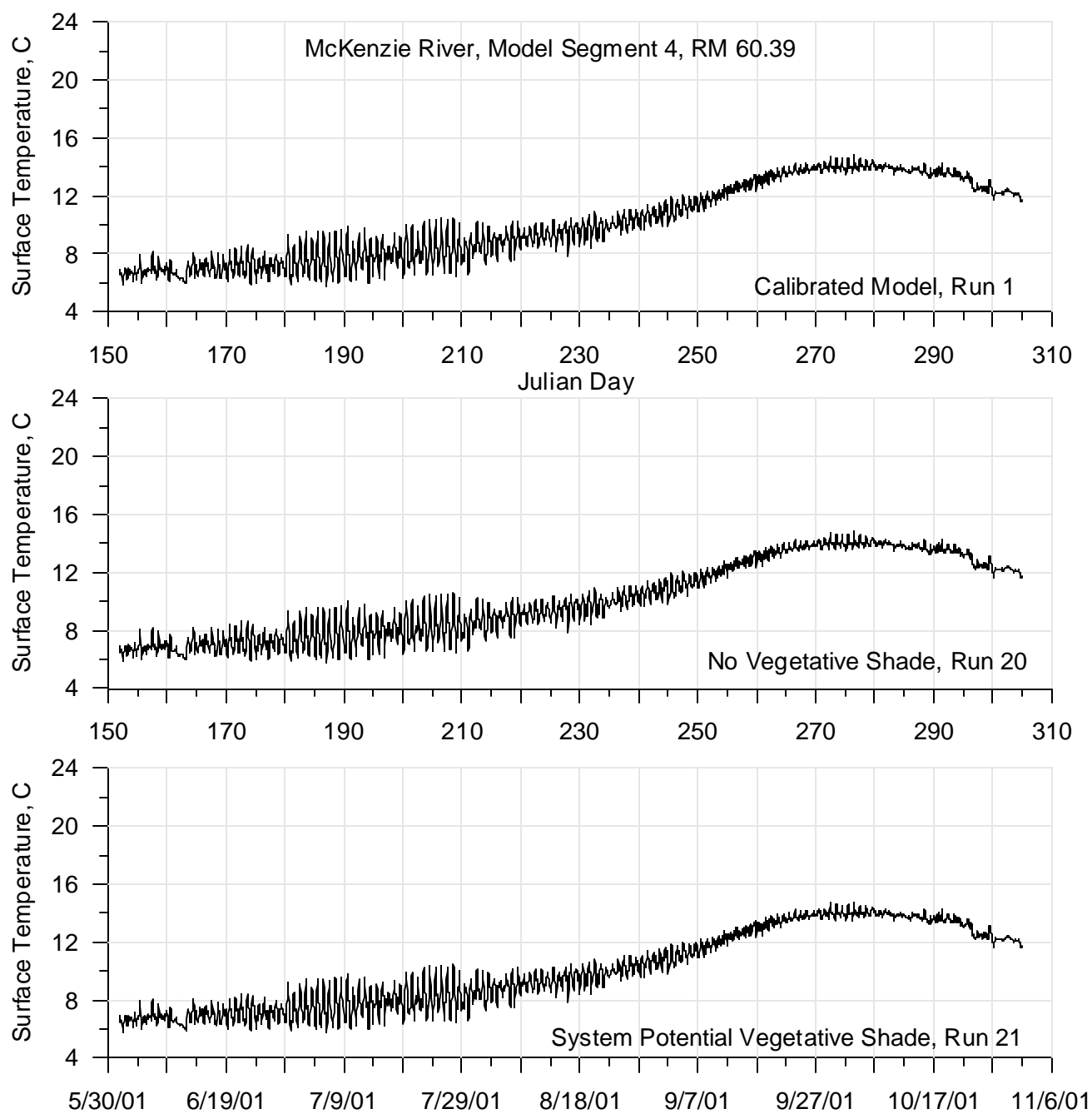
**Figure 632: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Middle Fork Willamette River at RM 11.14**



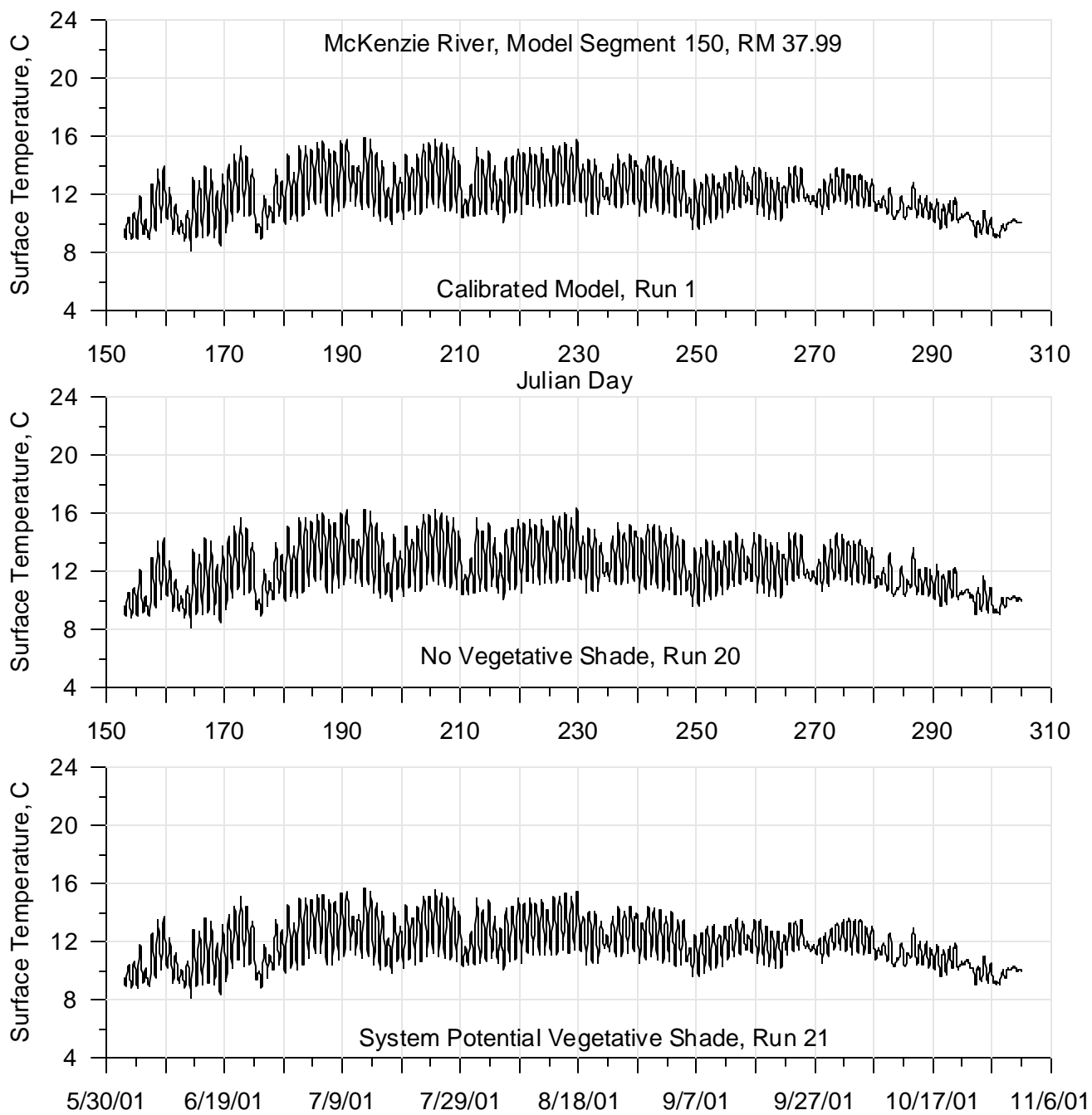
**Figure 633: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for Fall Creek at RM 6.29**



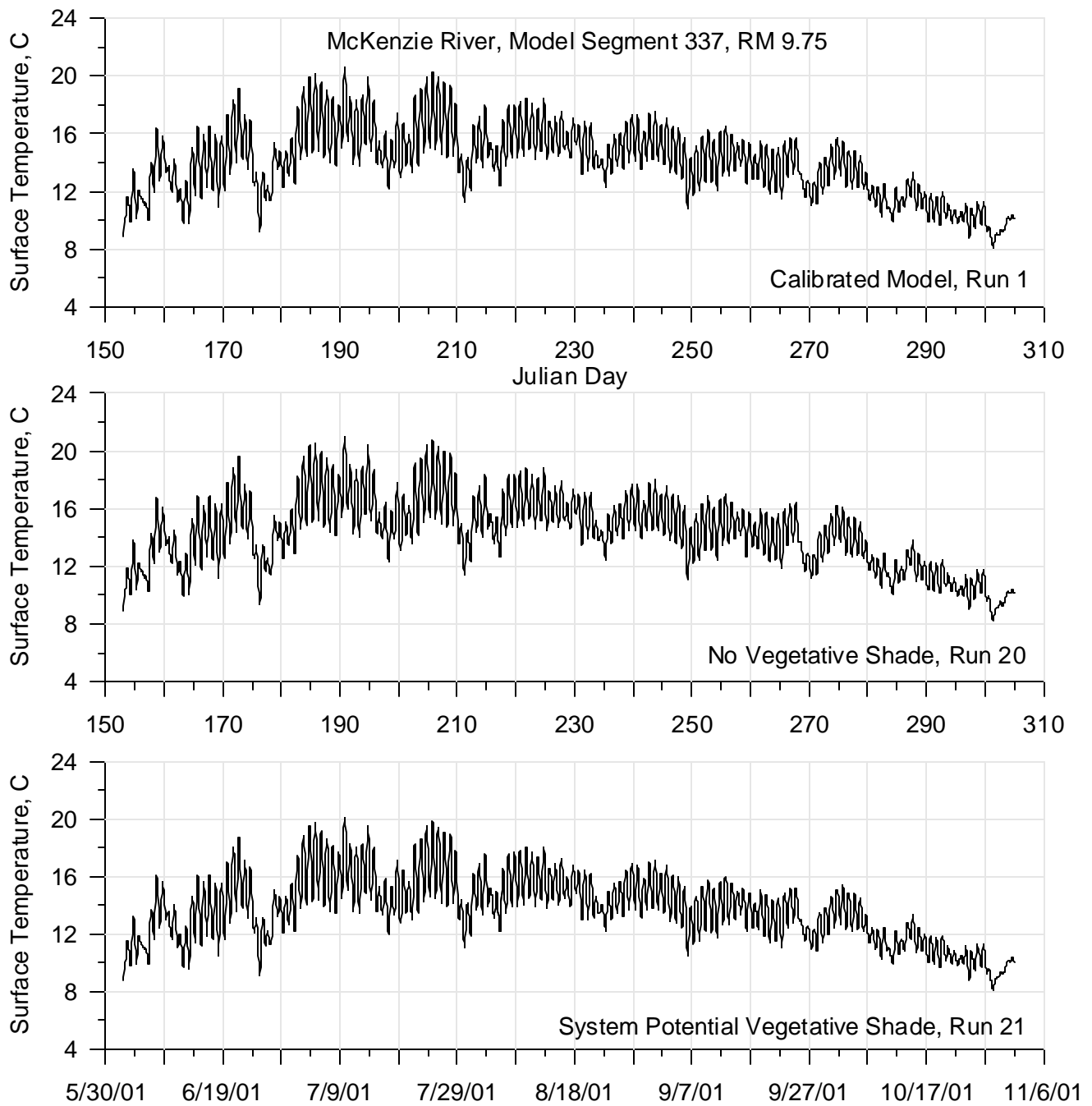
**Figure 634: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 187.06**



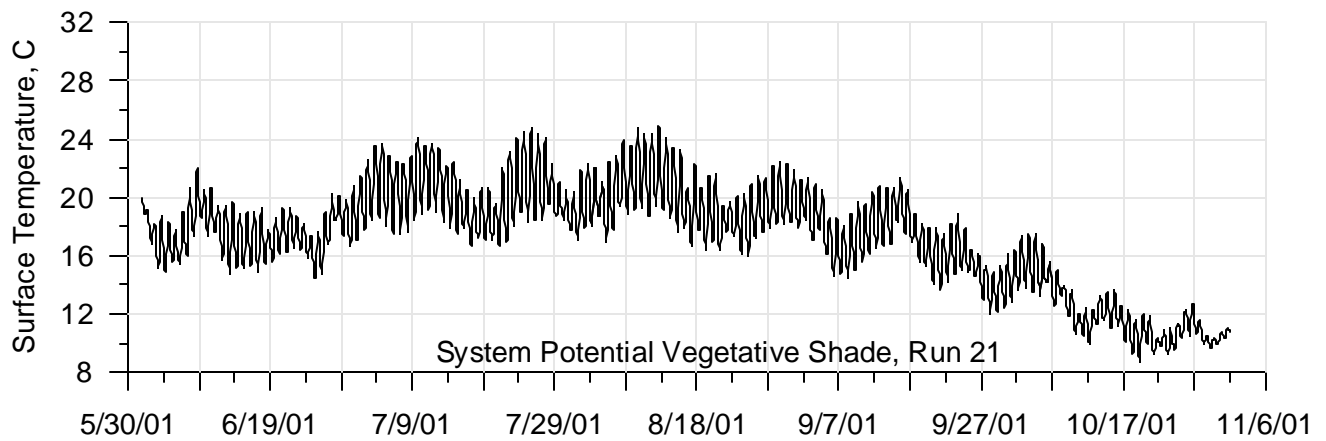
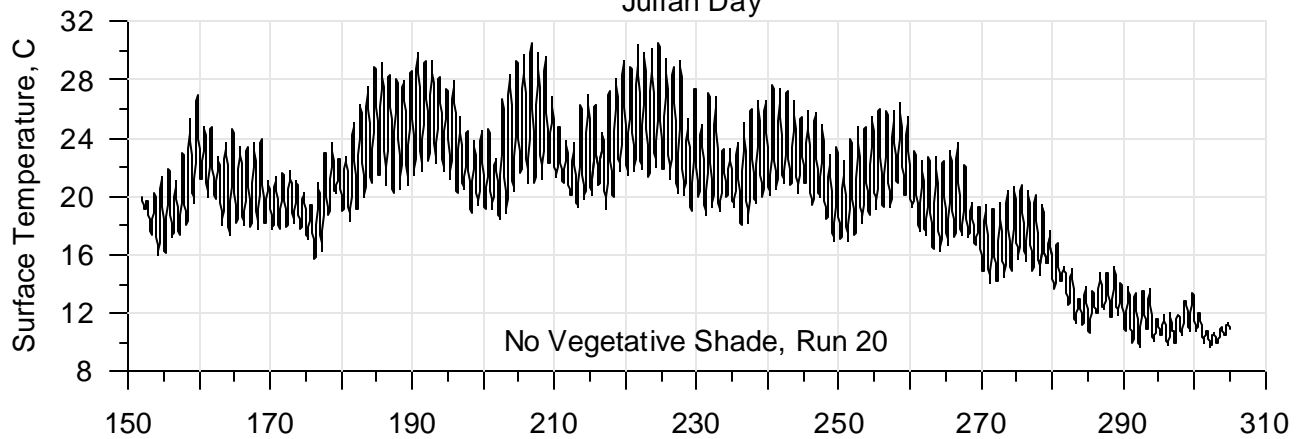
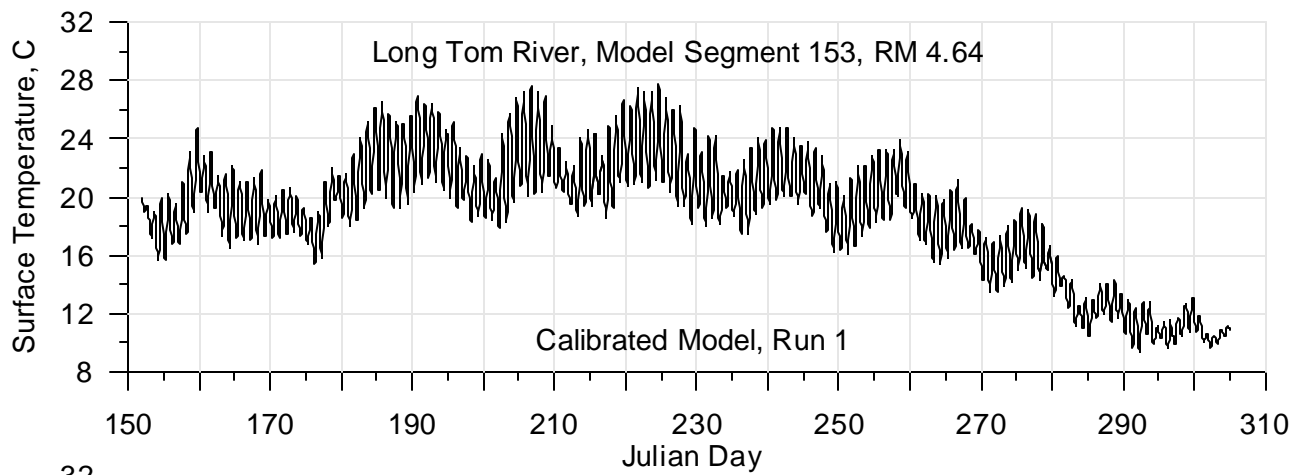
**Figure 635: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the McKenzie River at RM 60.39**



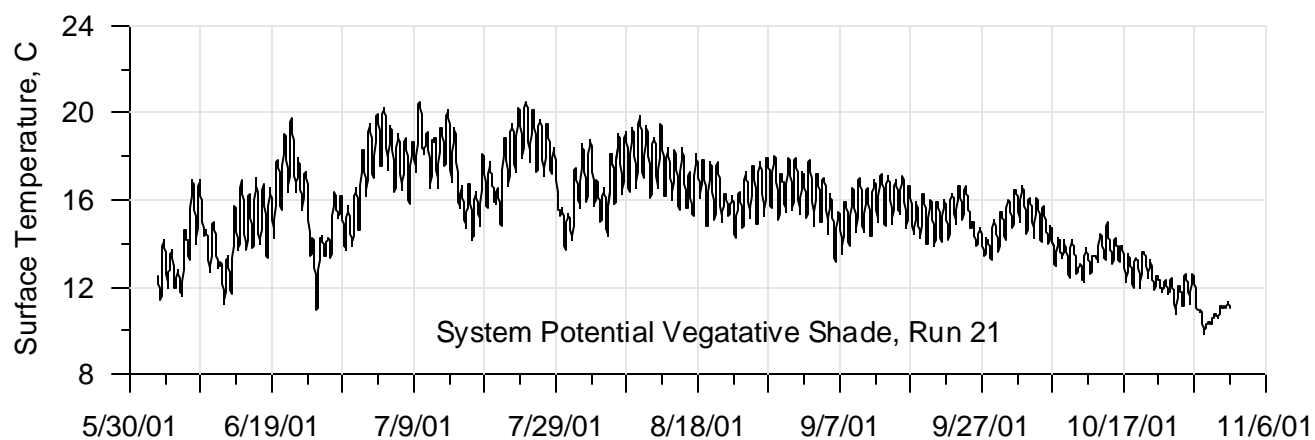
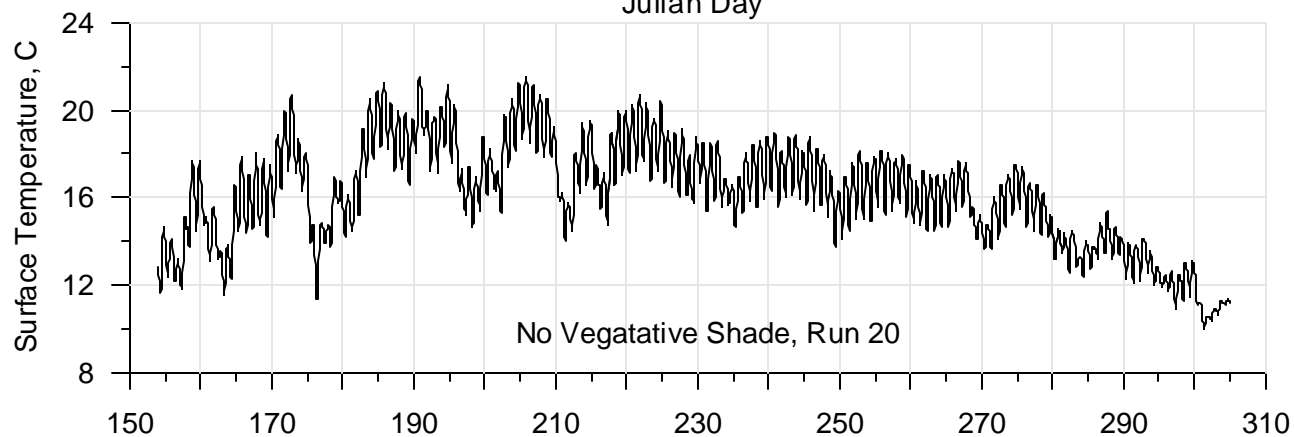
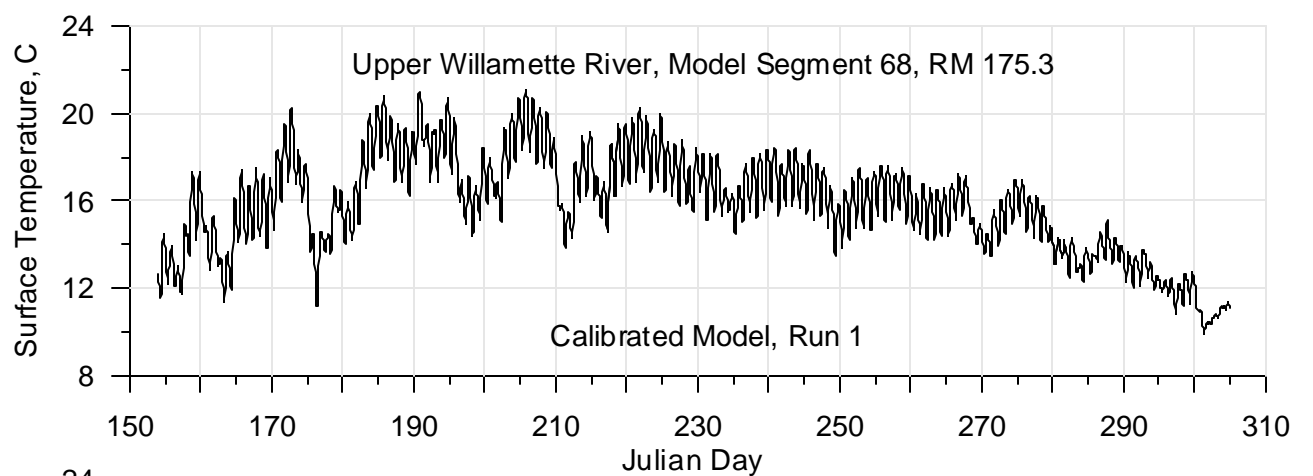
**Figure 636: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the McKenzie River at RM 37.99**



**Figure 637: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the McKenzie River at RM 9.75**

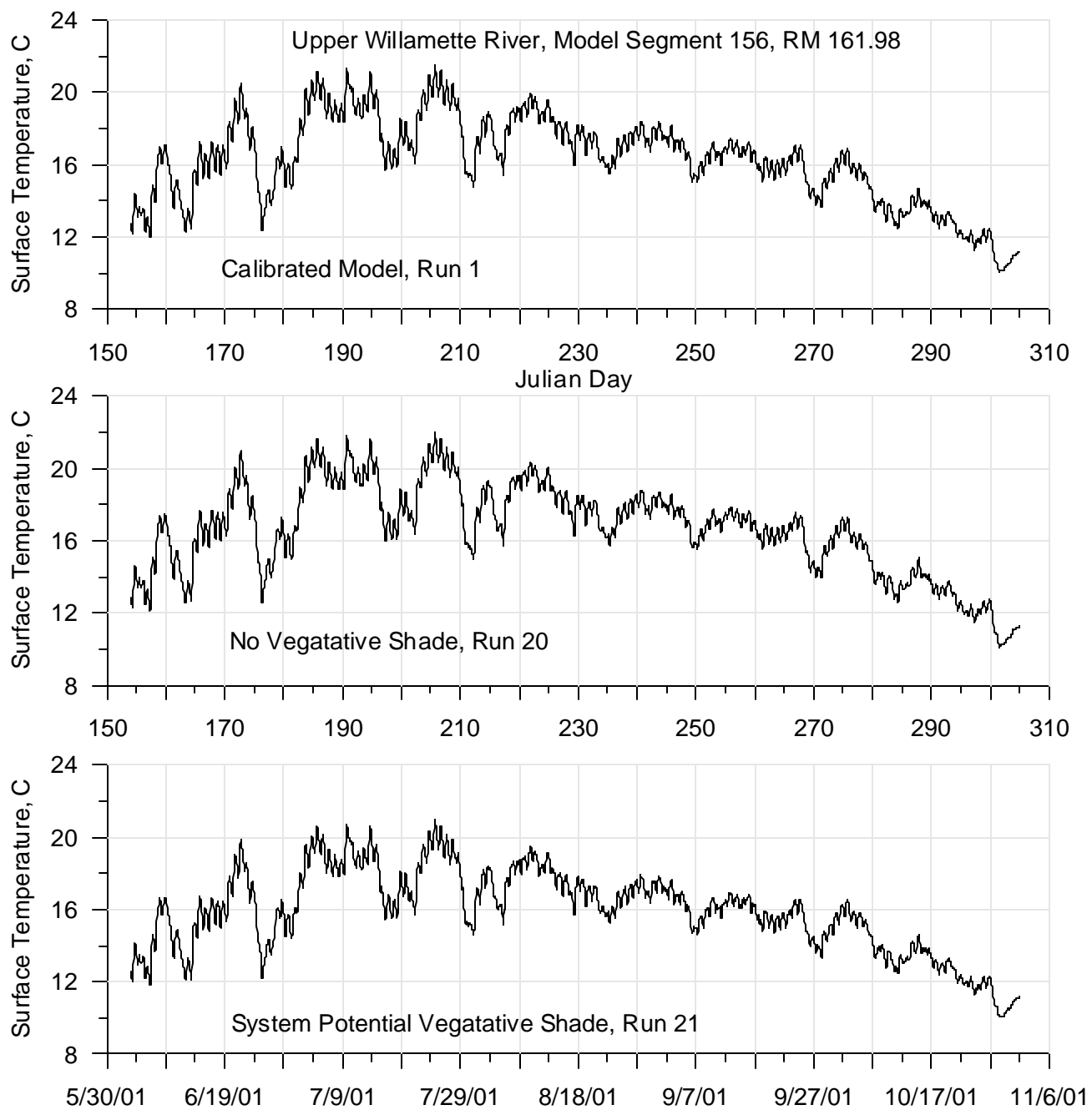


**Figure 638: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Long Tom River at RM 4.64**

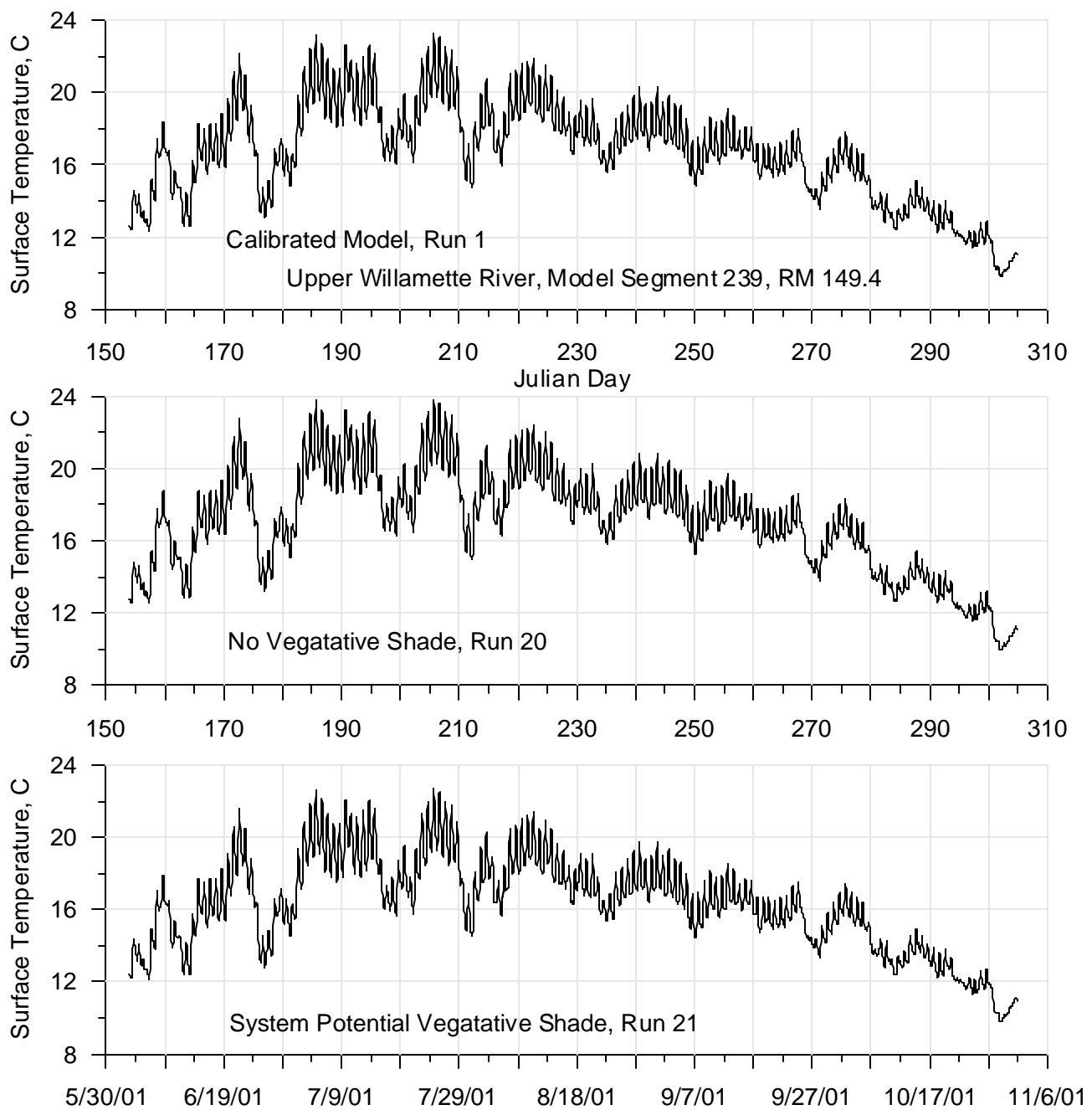


**Figure 639: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 175.3**

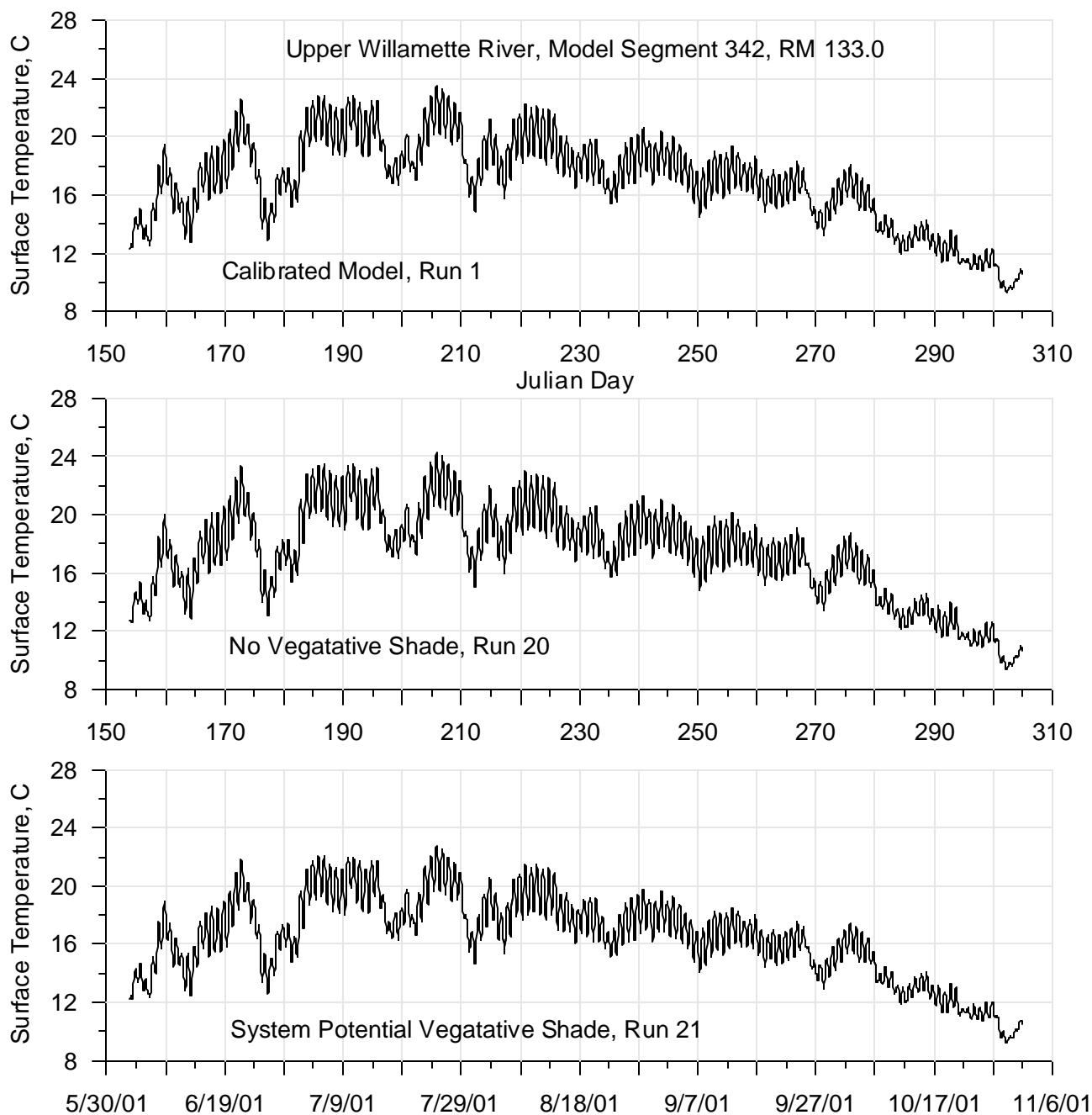




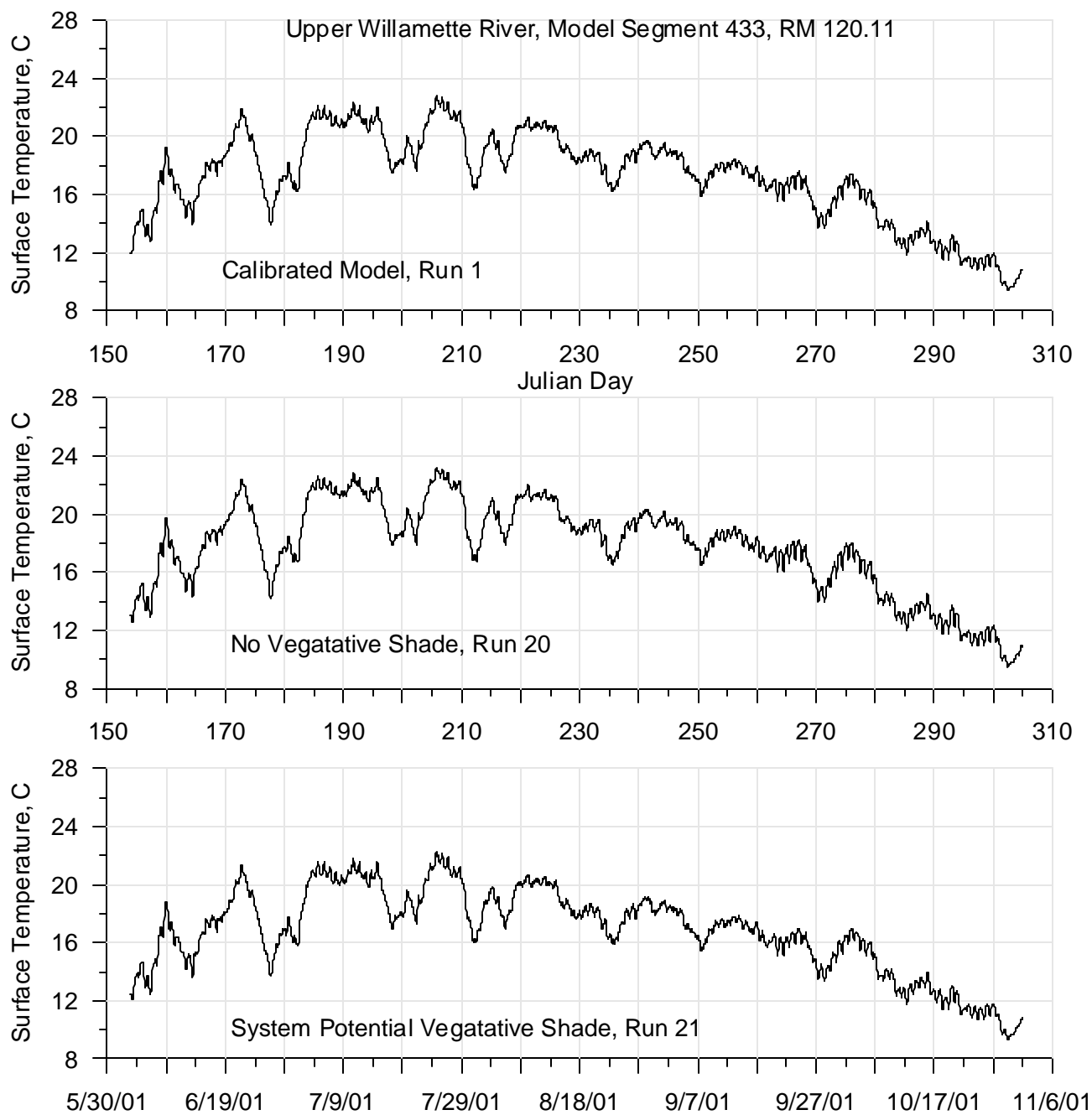
**Figure 640: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 161.98**



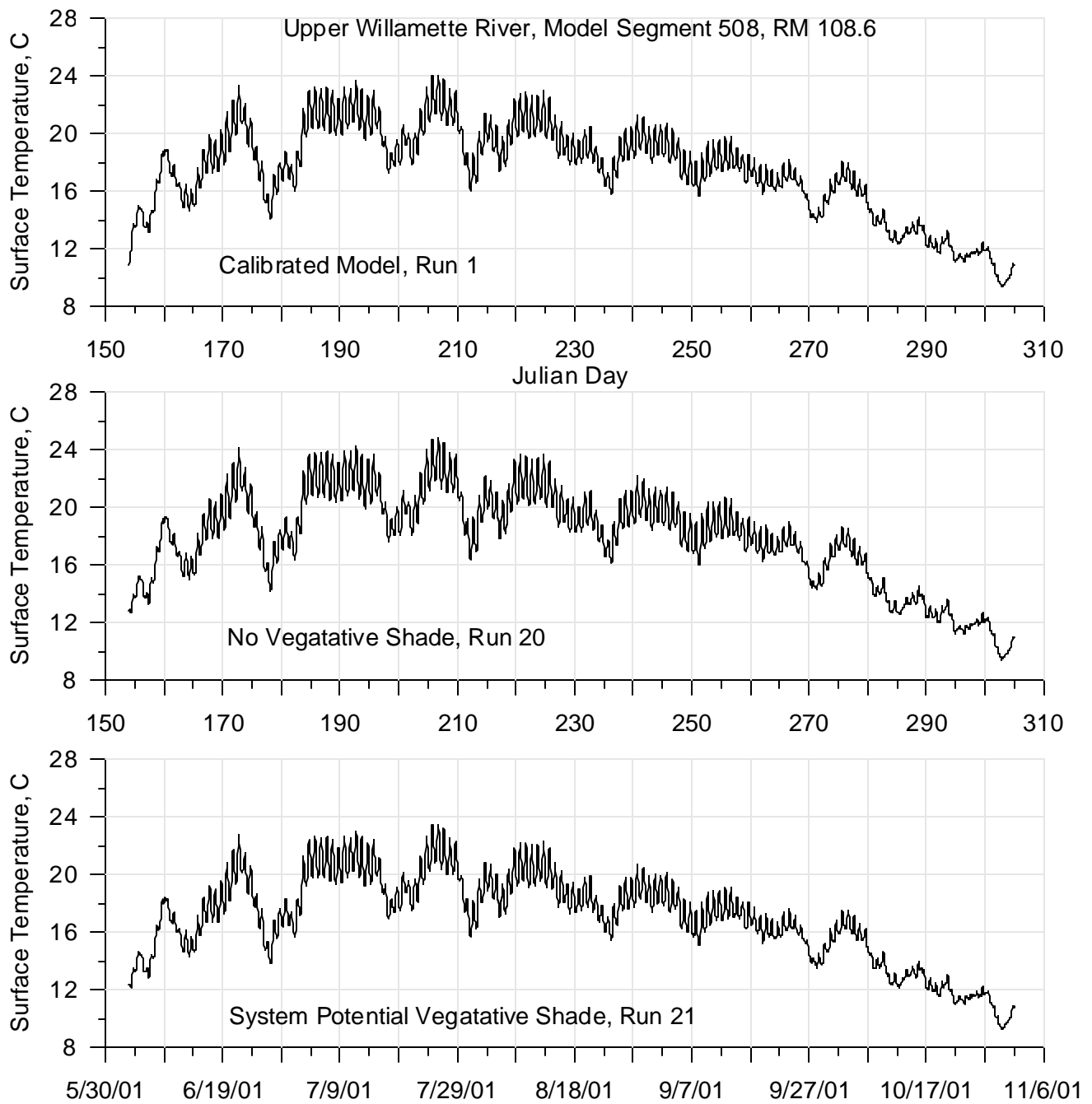
**Figure 641: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 149.4**



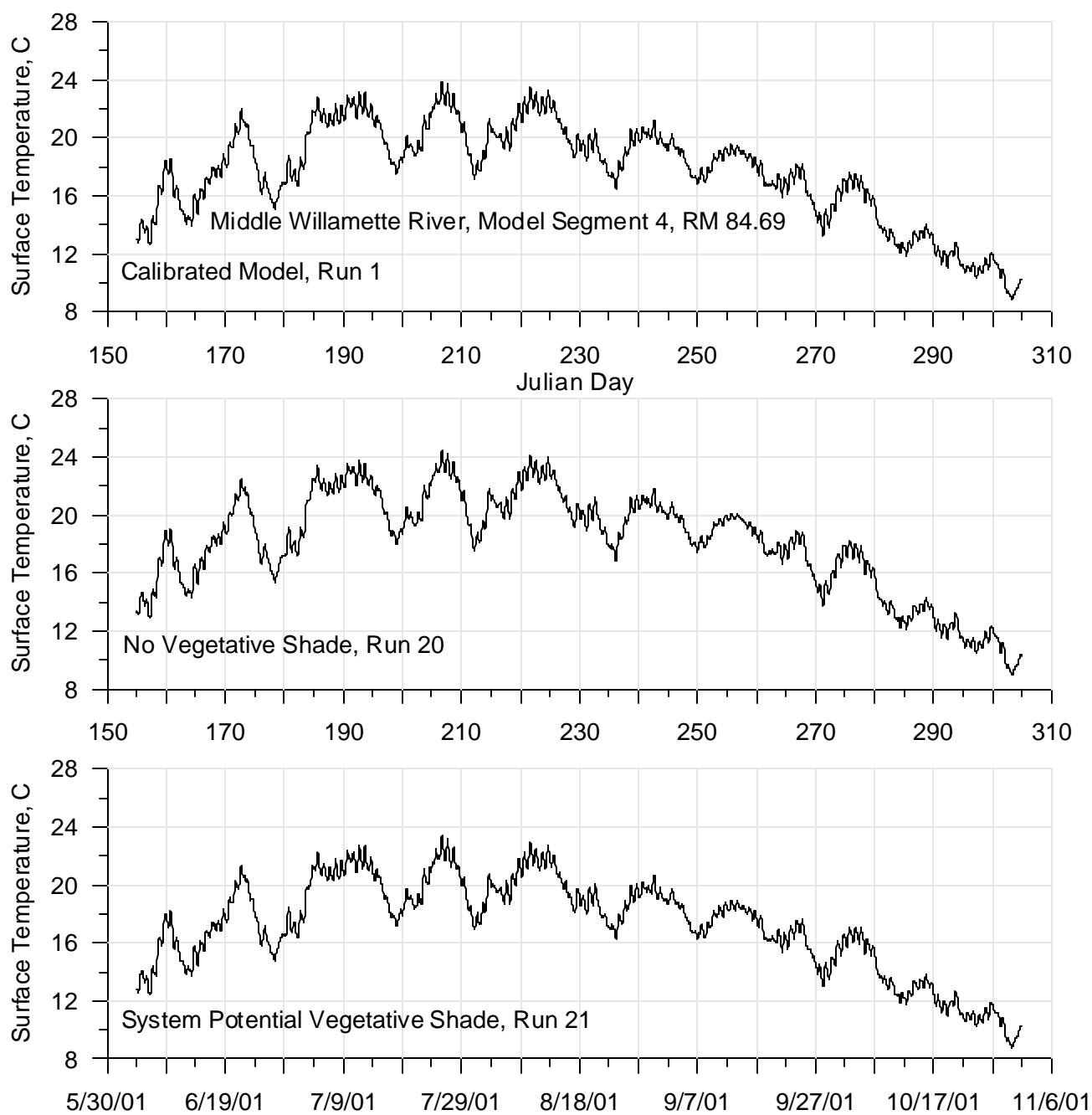
**Figure 642: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 133**



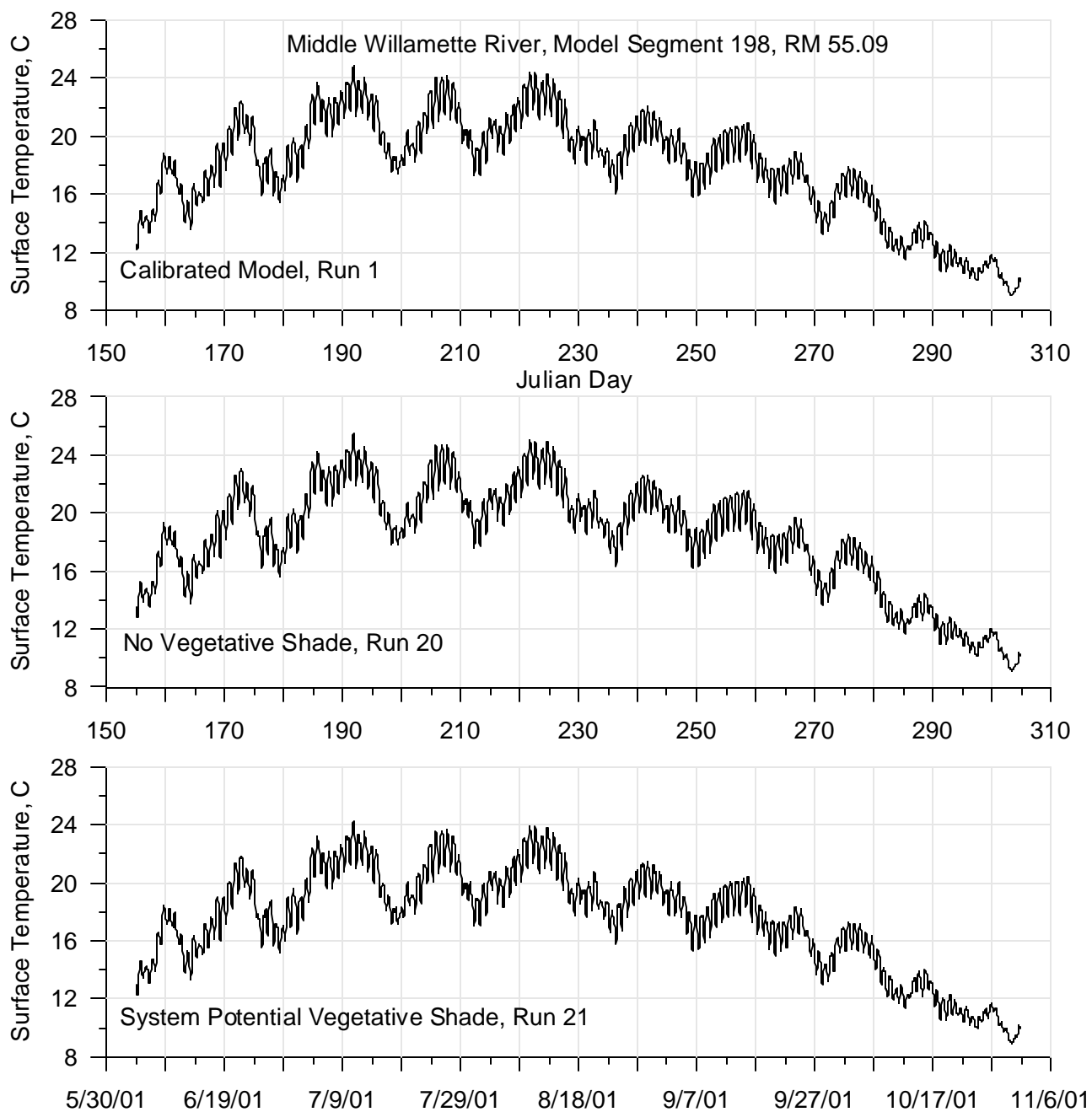
**Figure 643: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 120.11**



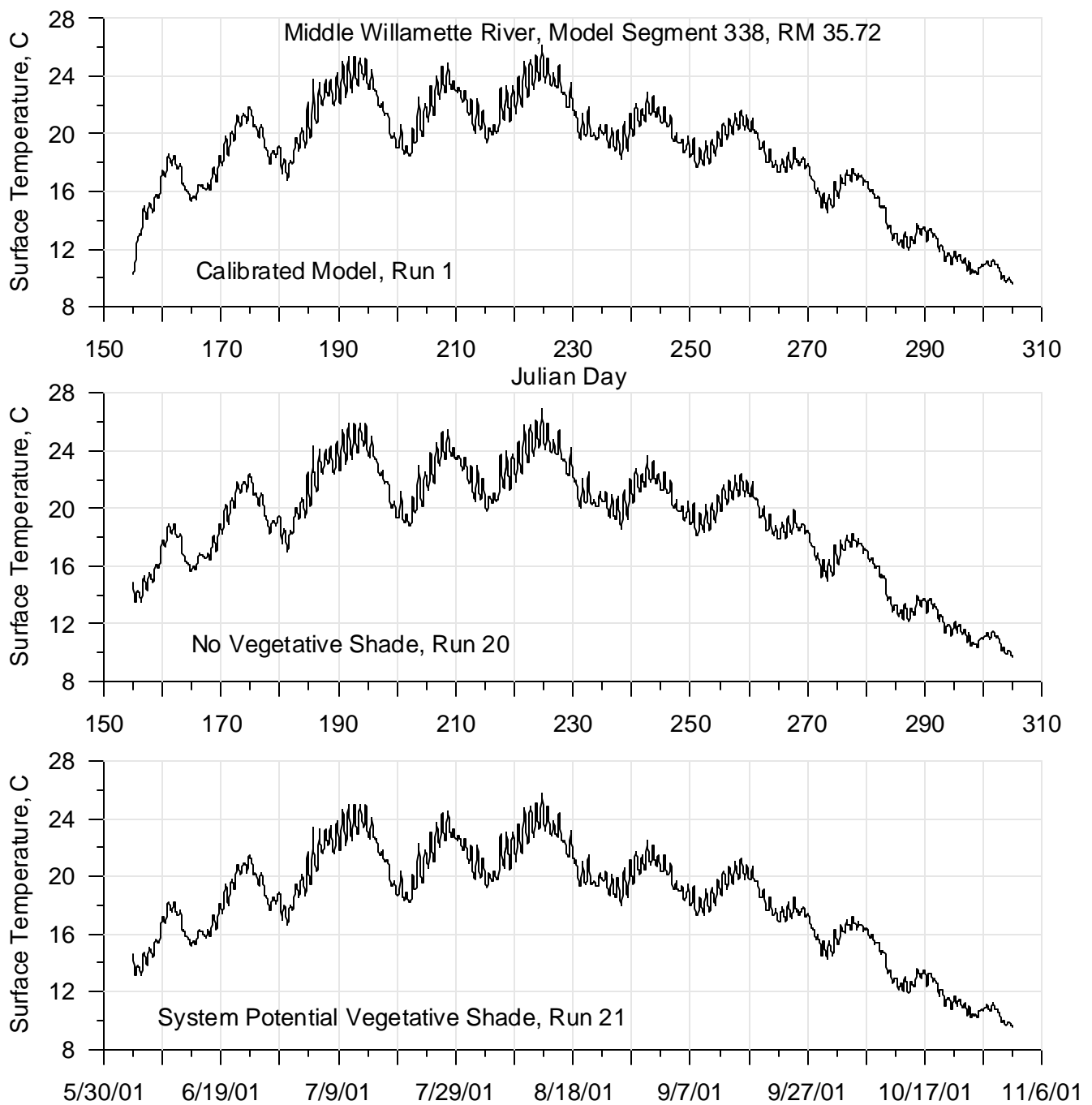
**Figure 644: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 108.6**



**Figure 645: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 84.69**

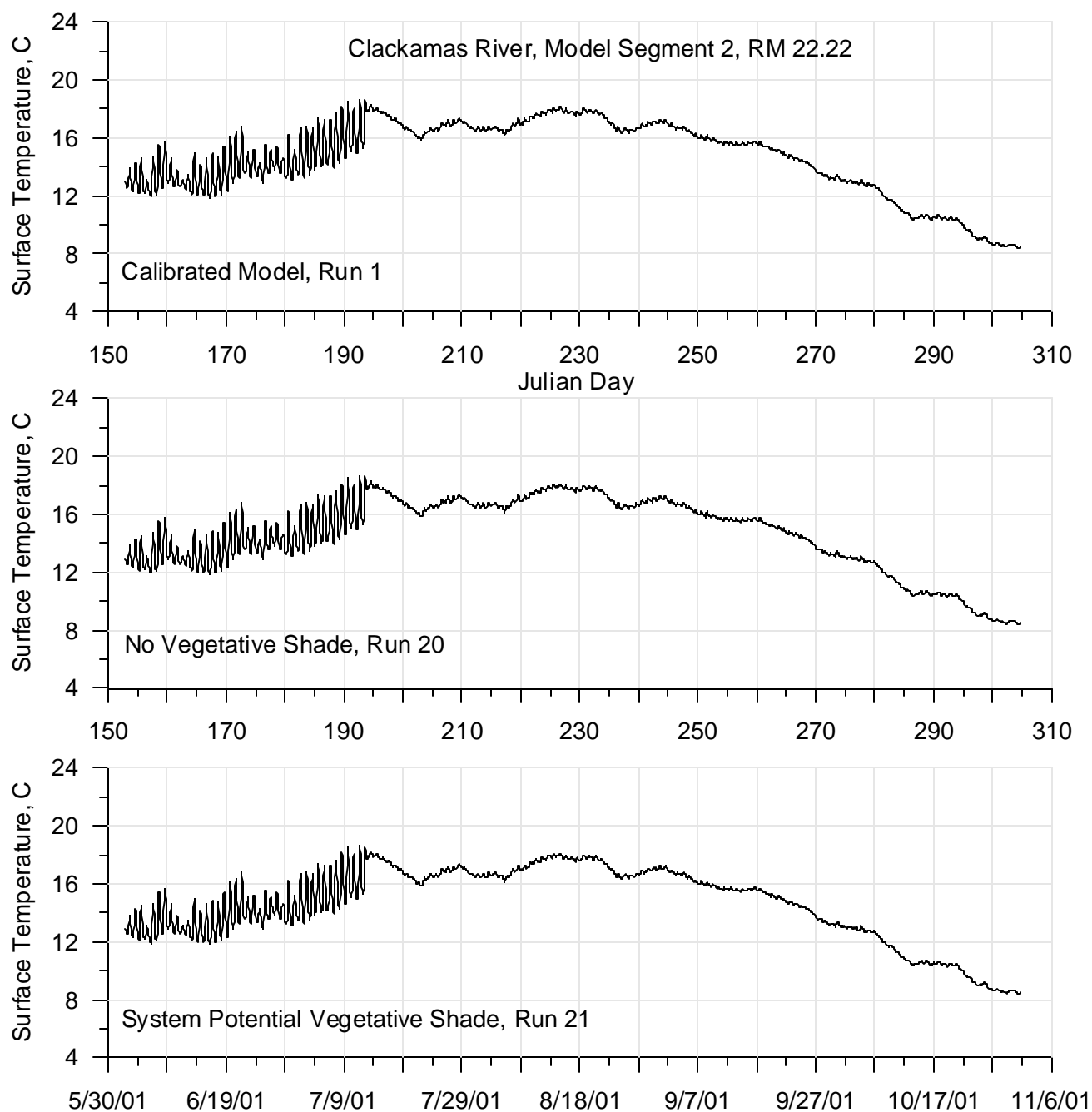


**Figure 646: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 55.09**

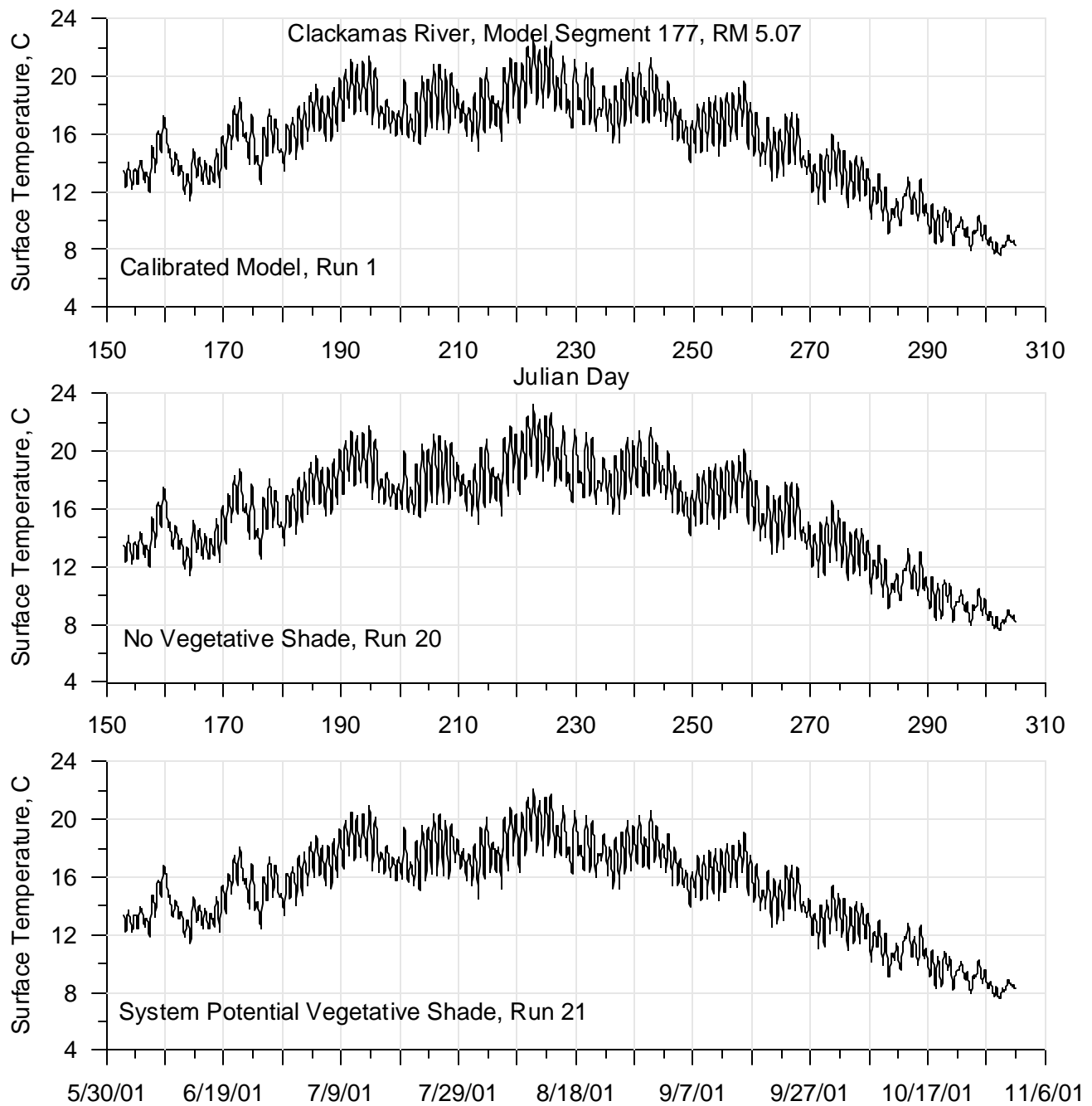


**Figure 647: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 35.72**

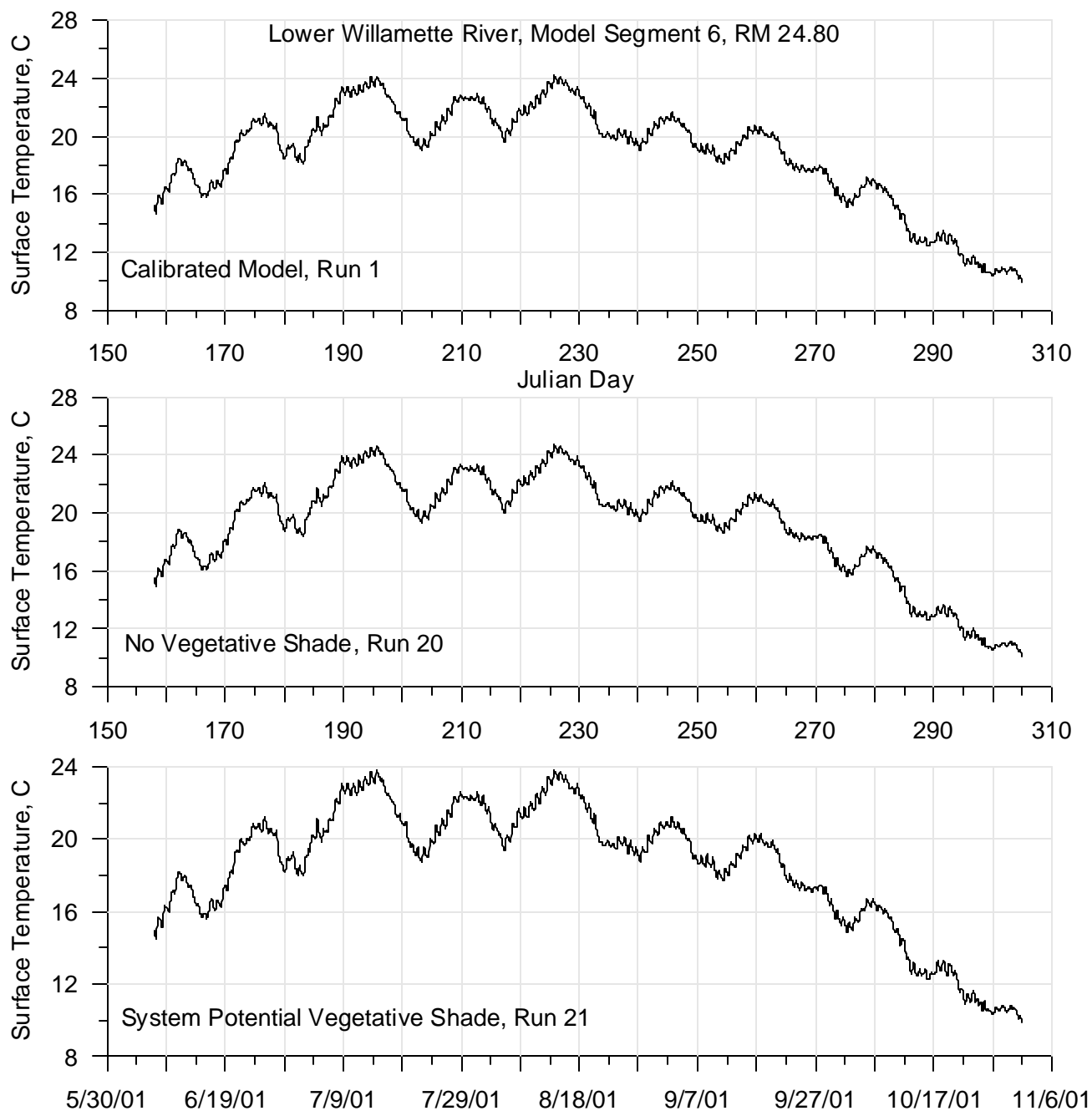




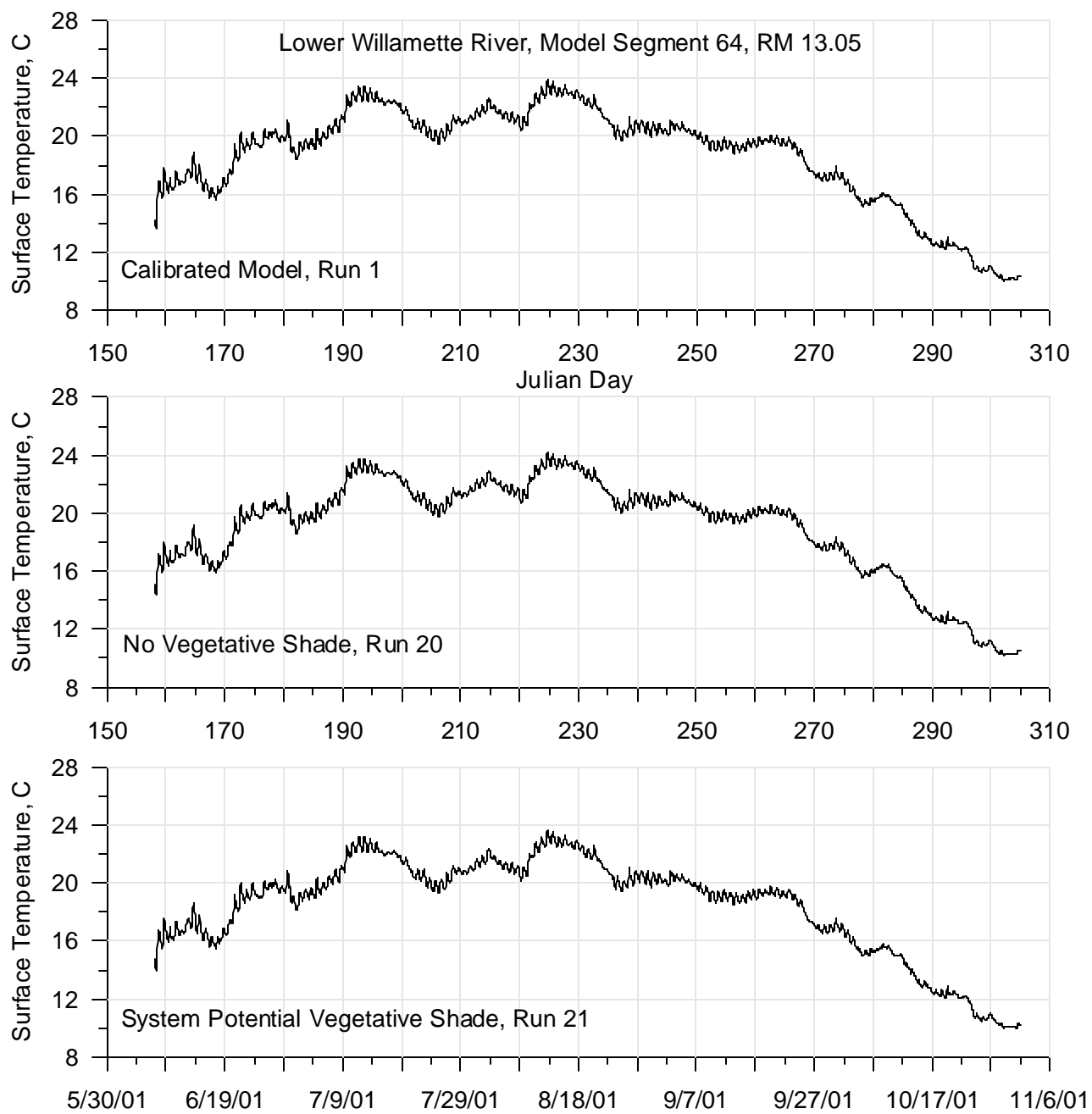
**Figure 648: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Clackamas River at RM 22.22**



**Figure 649: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Clackamas River at RM 5.07**



**Figure 650: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 24.8**



**Figure 651: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 13.05**

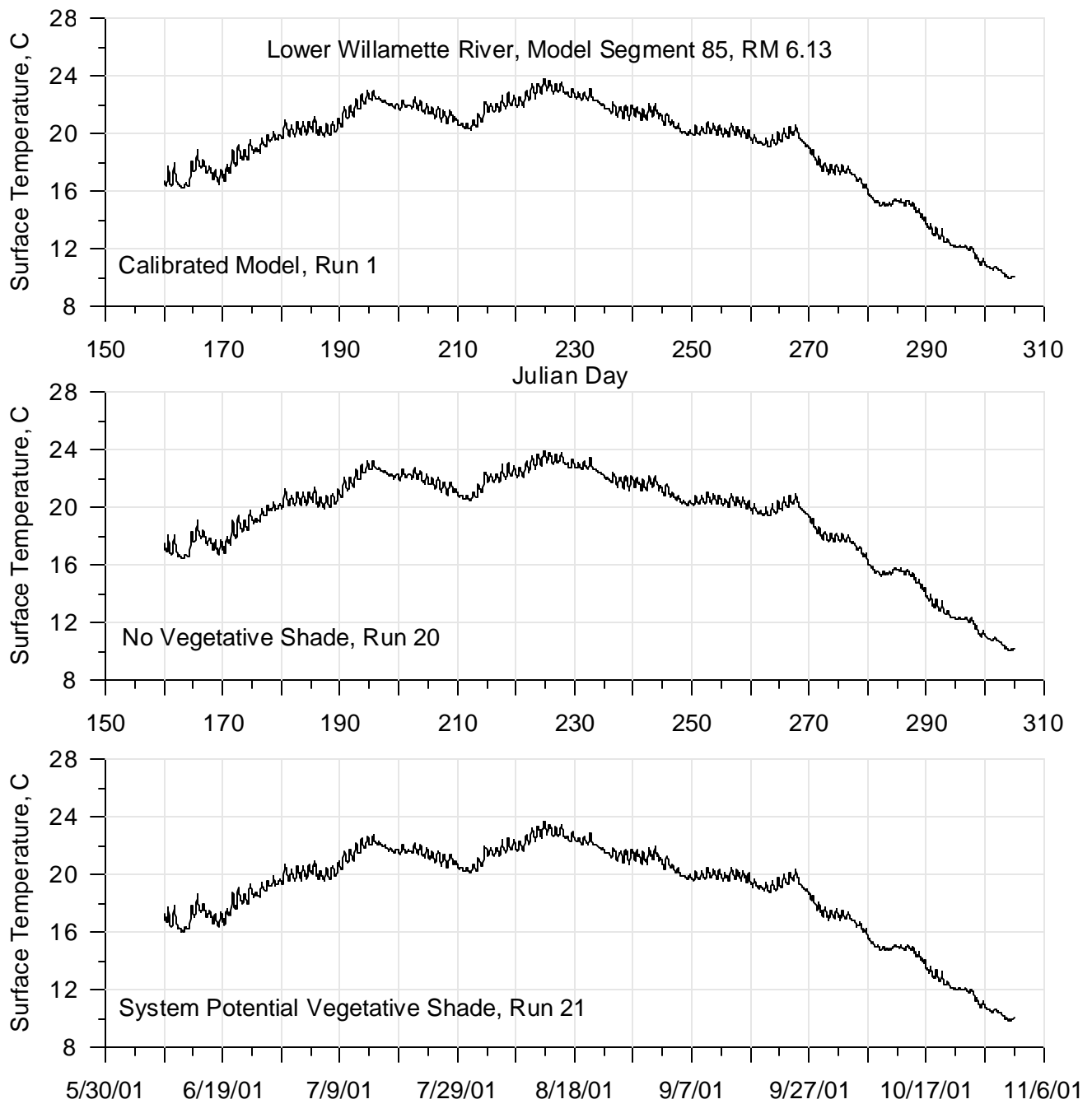
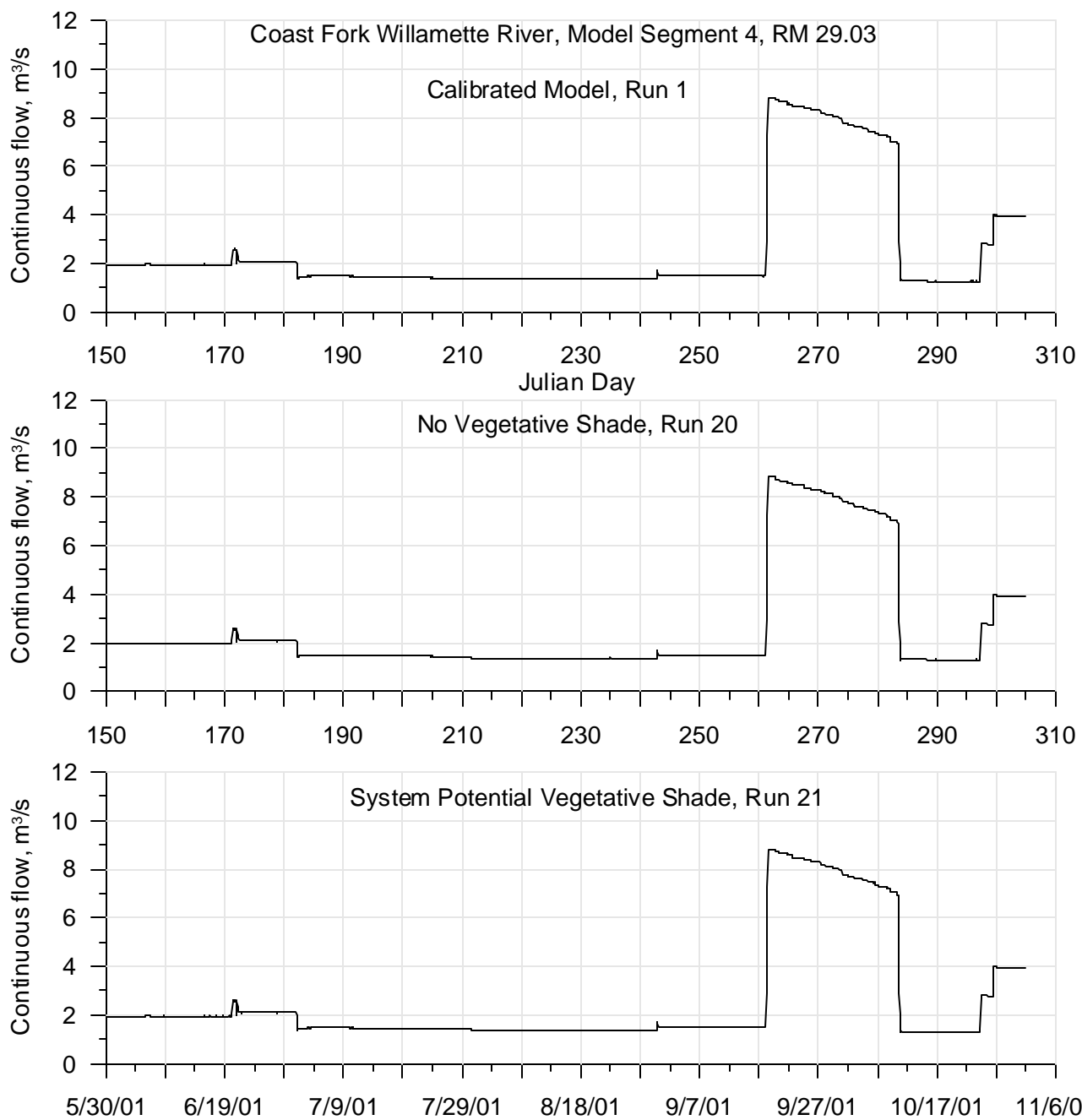
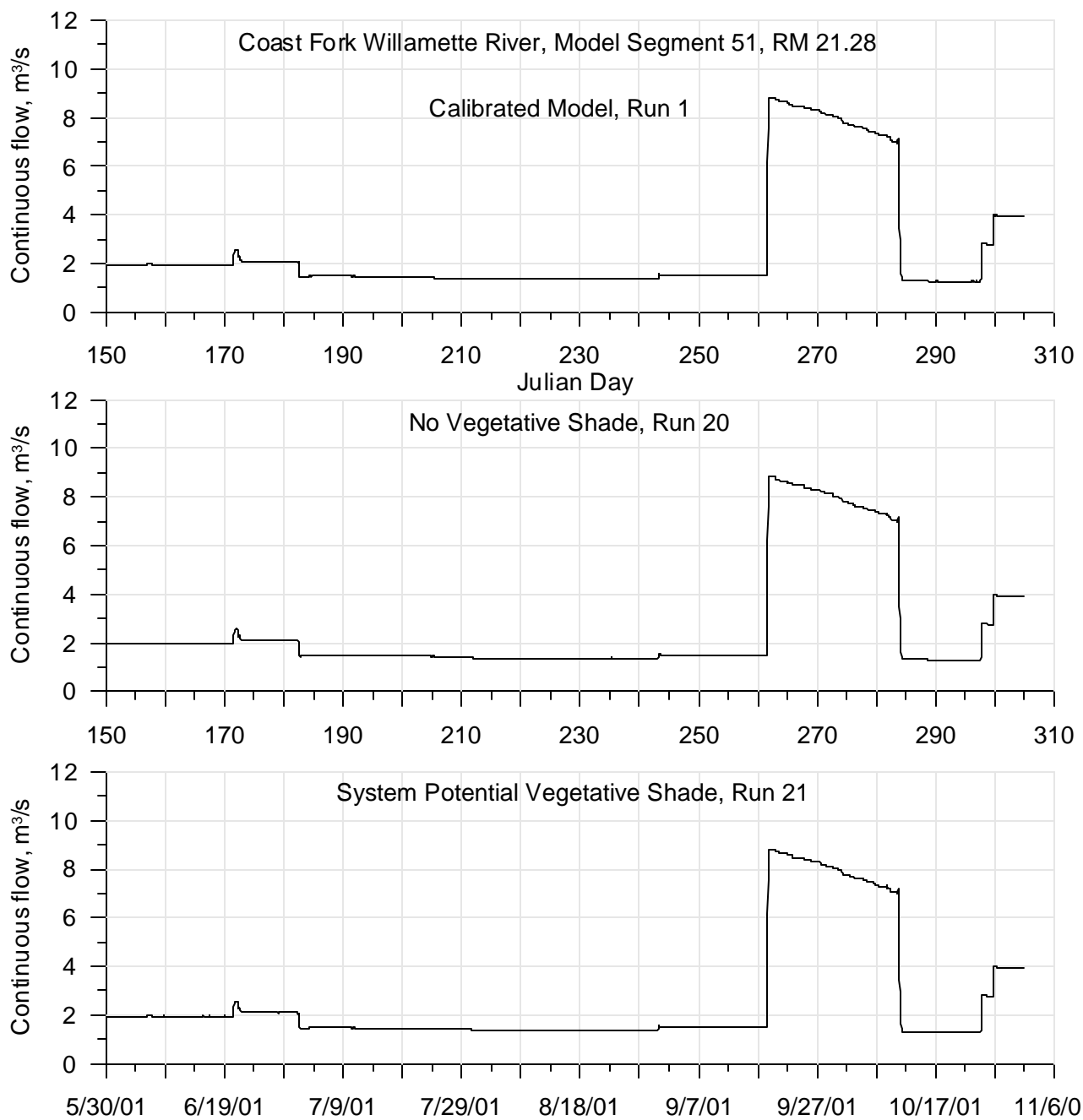


Figure 652: Calibrated model compared with varying vegetative shade, continuous temperature for 2001 for the Willamette River at RM 6.13

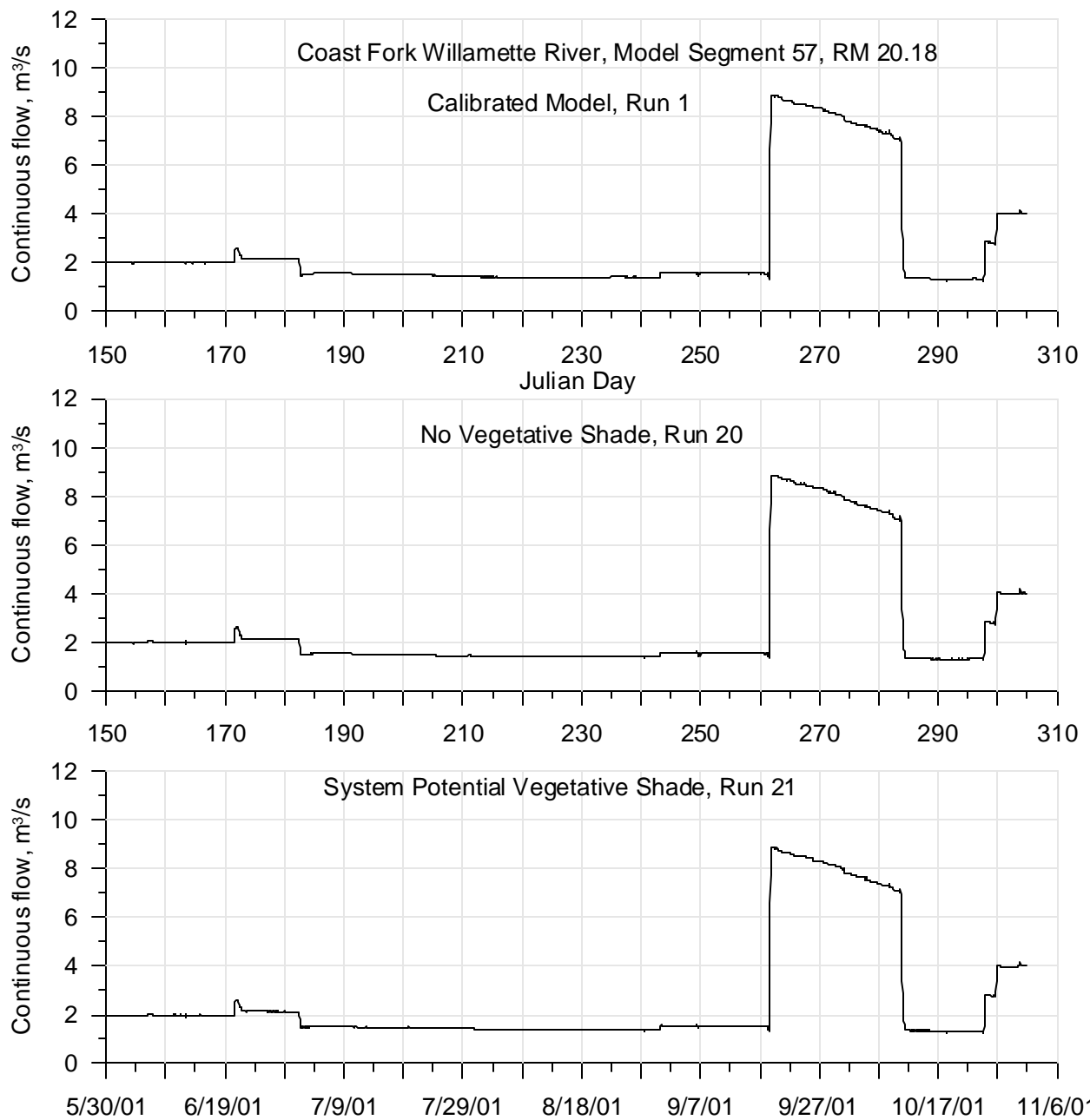
## Continuous Flow



**Figure 653: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Coast Fork Willamette River at RM 29.03**

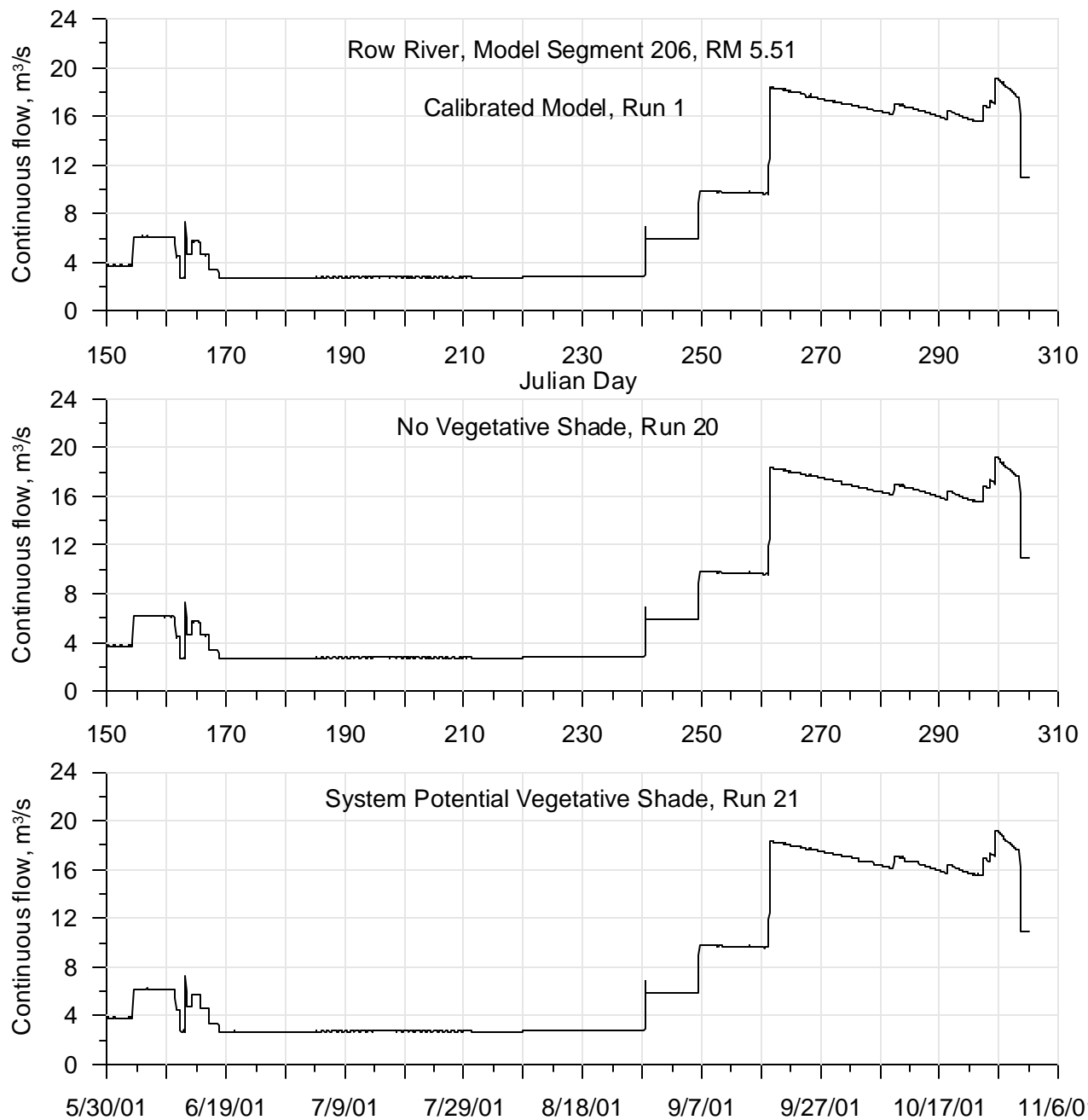


**Figure 654: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Coast Fork Willamette River at RM 21.28**

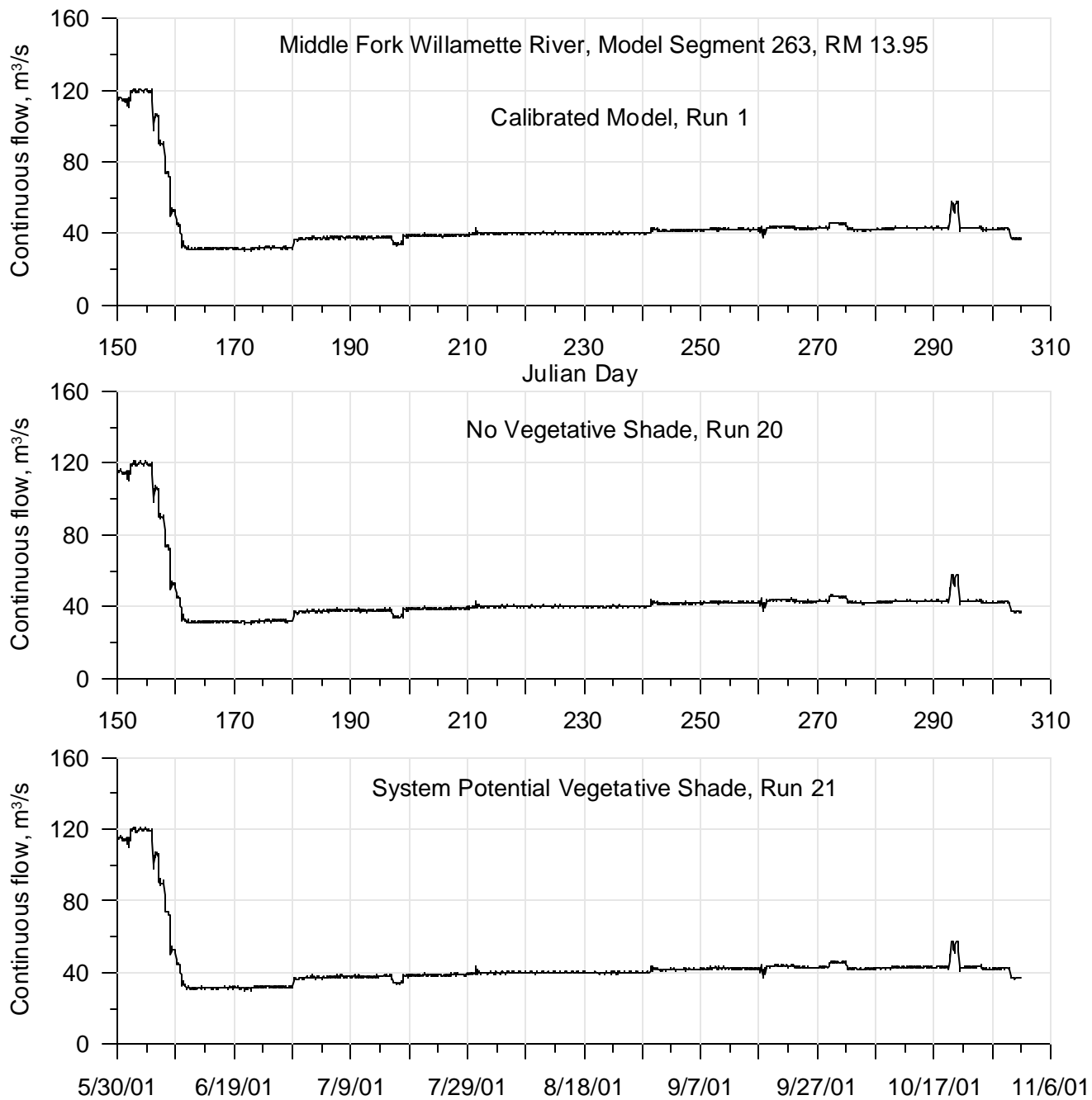


**Figure 655: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Coast Fork Willamette River at RM 20.13**

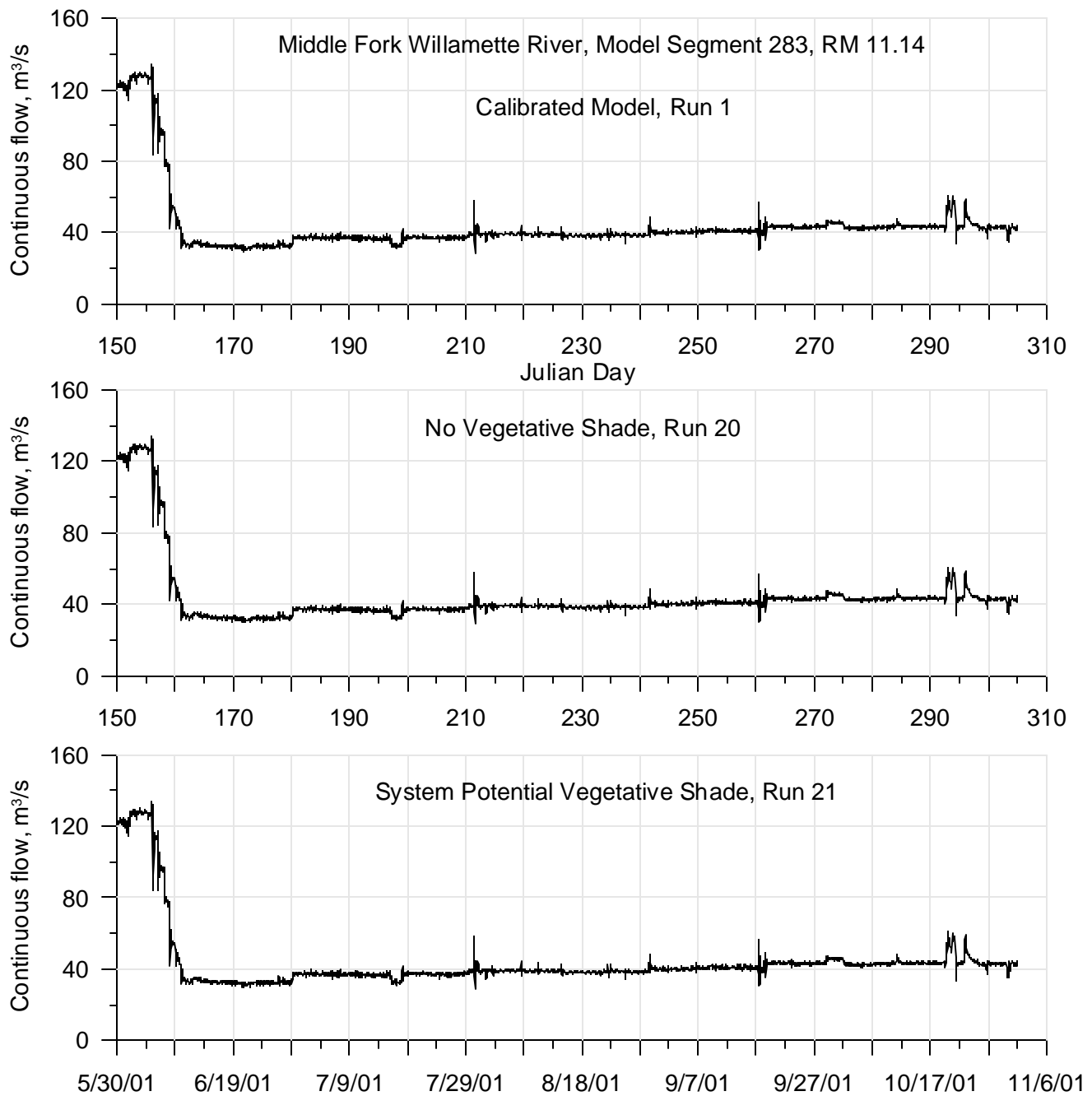




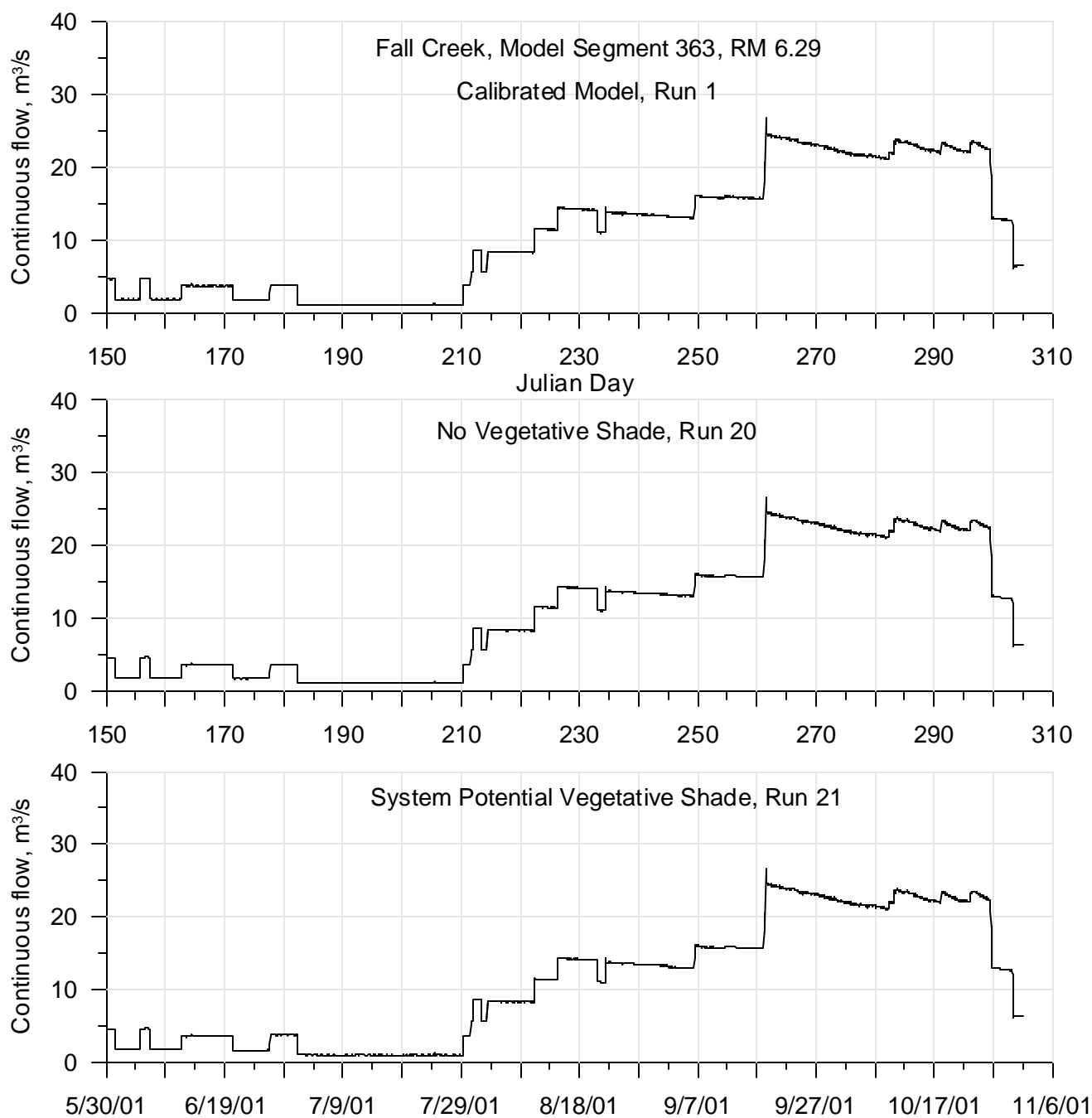
**Figure 656: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Row River at RM 5.51**



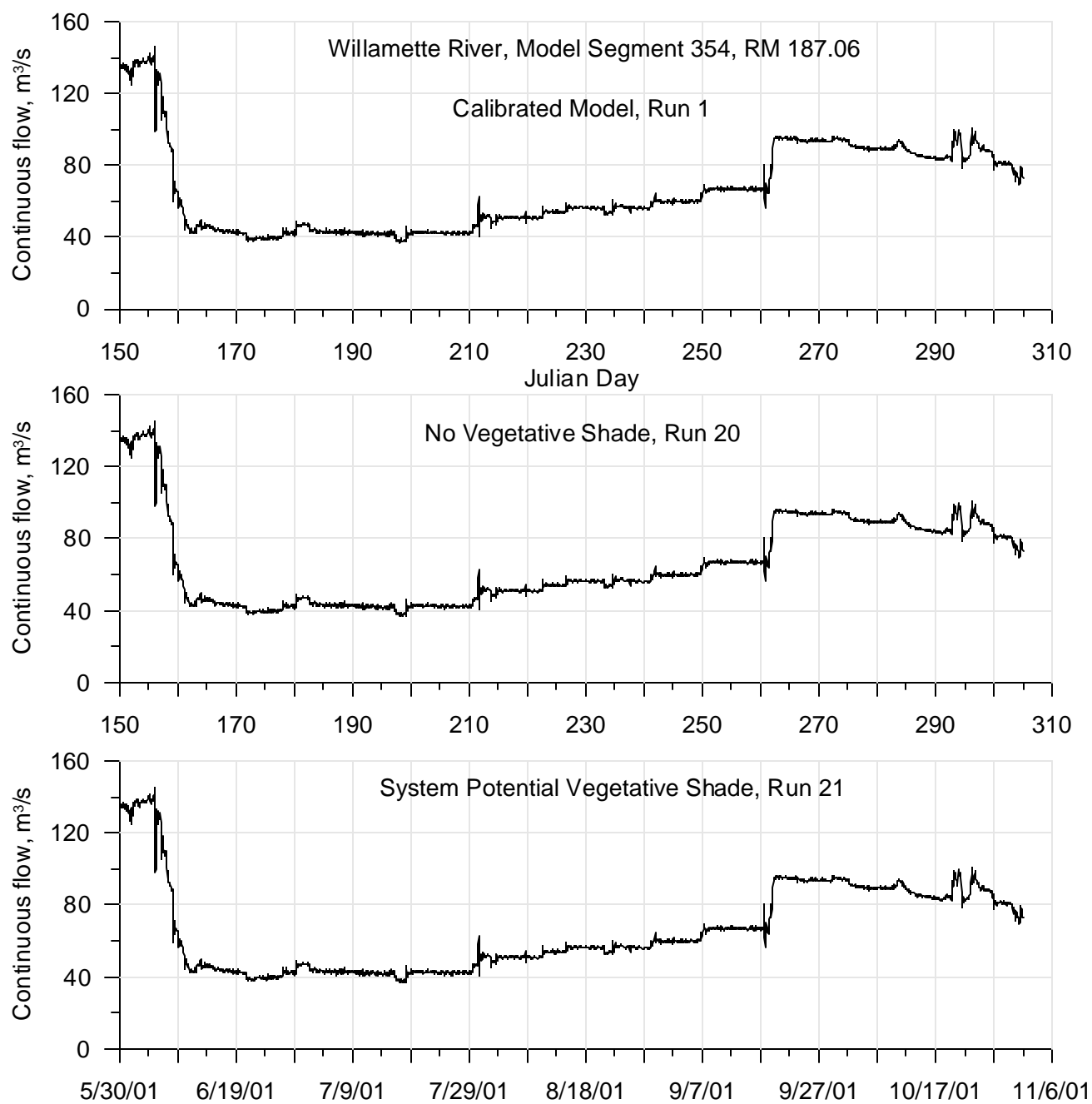
**Figure 657: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Middle Fork Willamette River at RM 13.95**



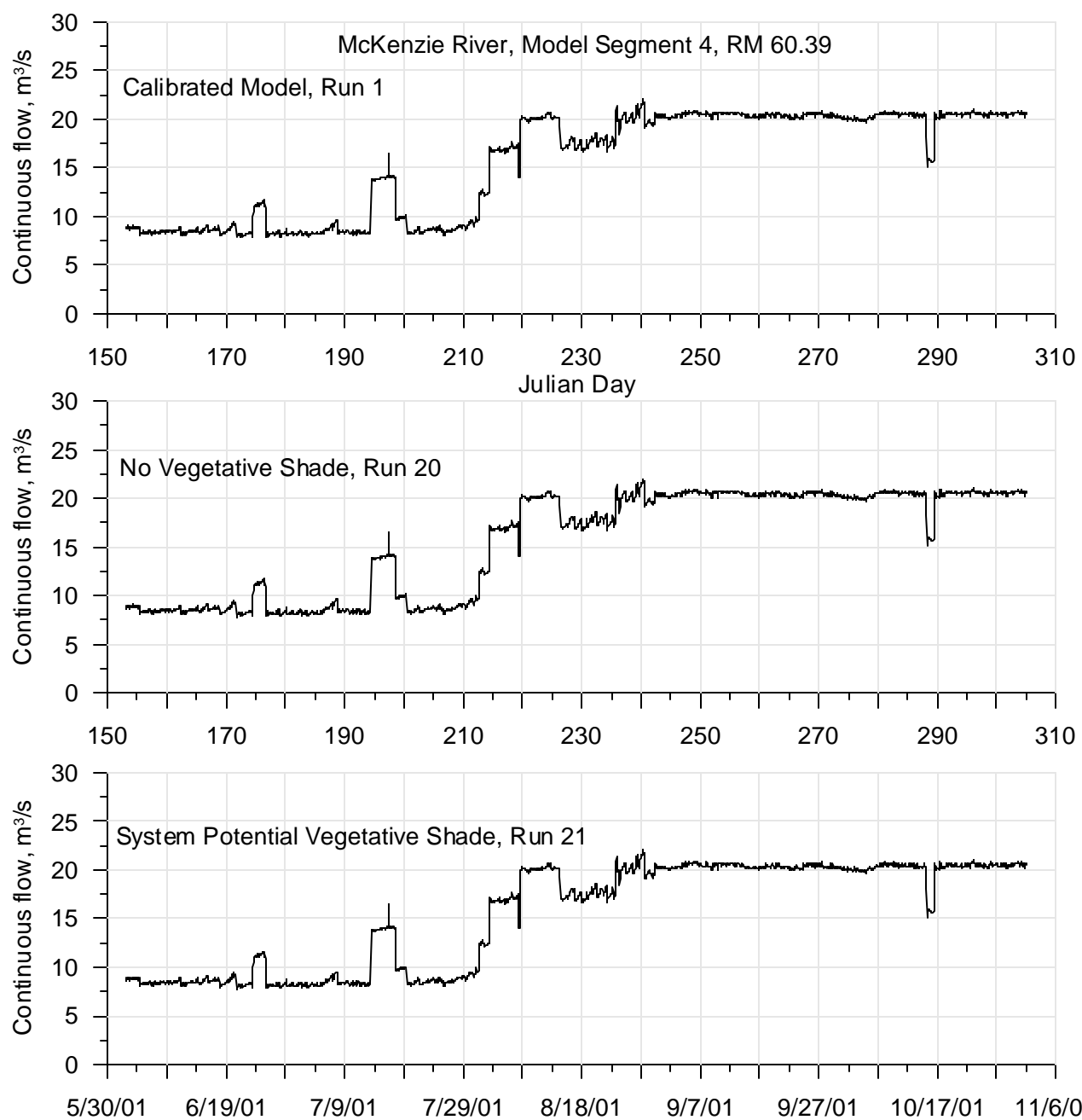
**Figure 658: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Middle Fork Willamette River at RM 11.14**



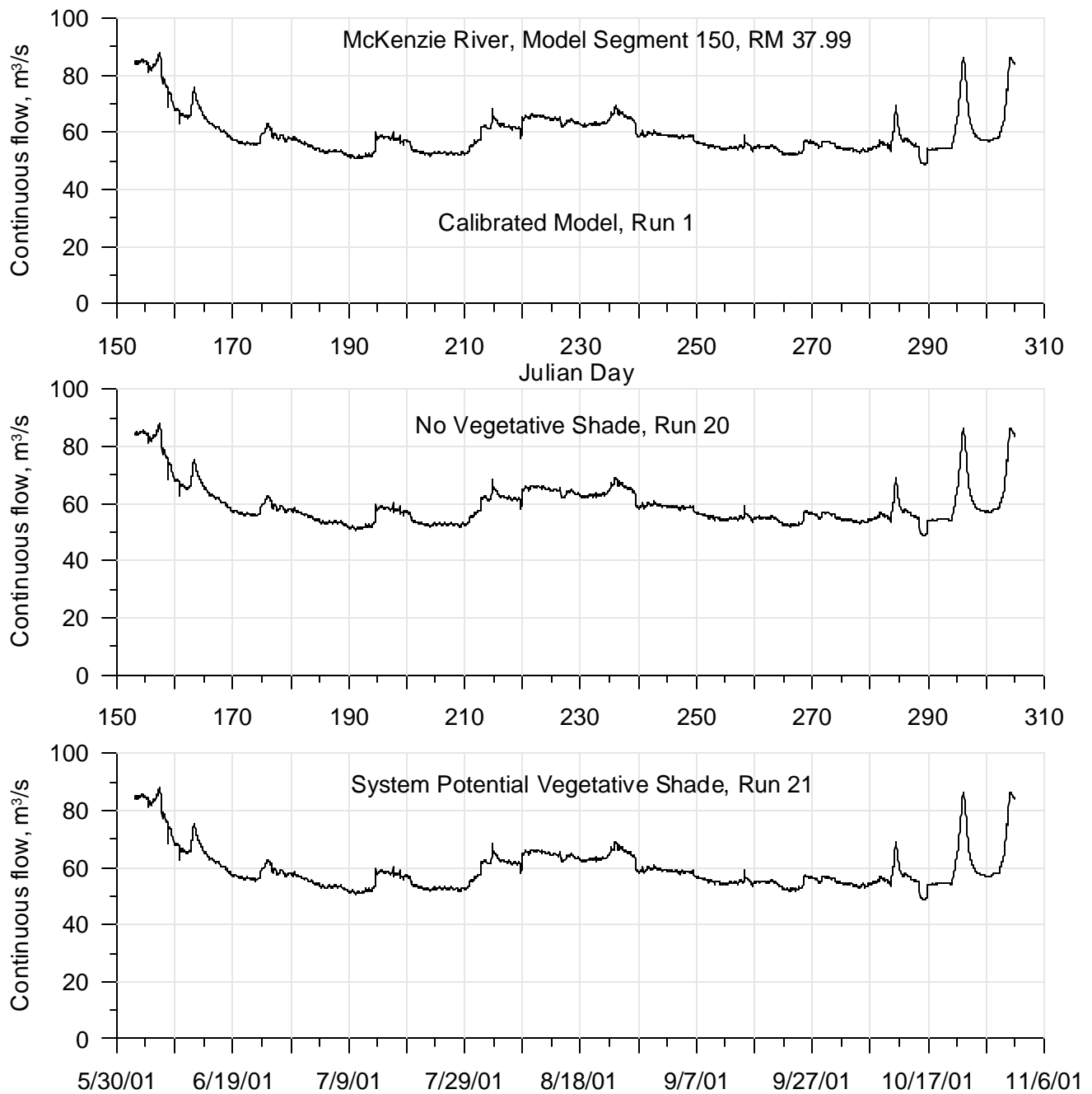
**Figure 659: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for Fall Creek at RM 6.29**



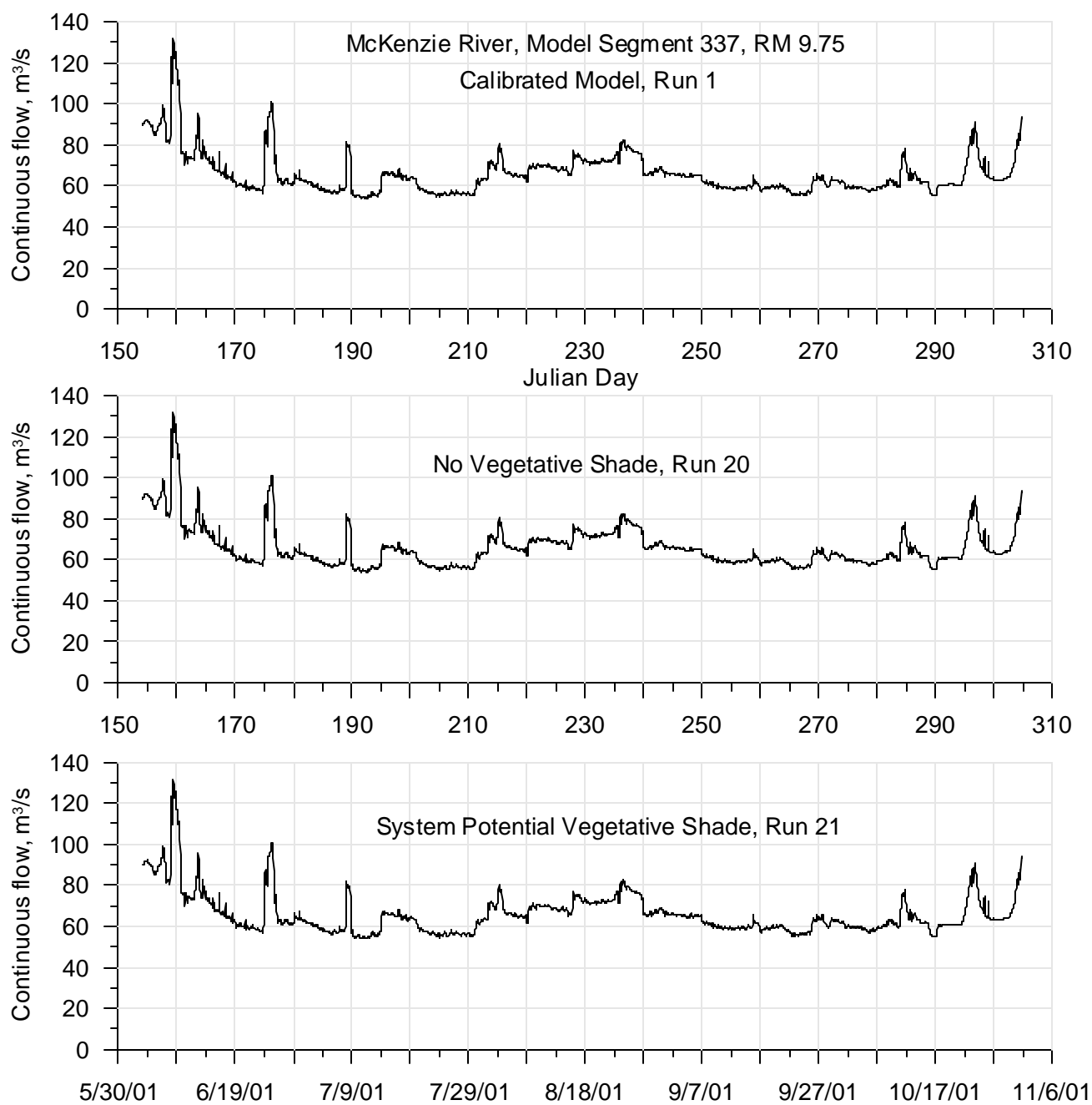
**Figure 660: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 187.06**



**Figure 661: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the McKenzie River at RM 60.39**

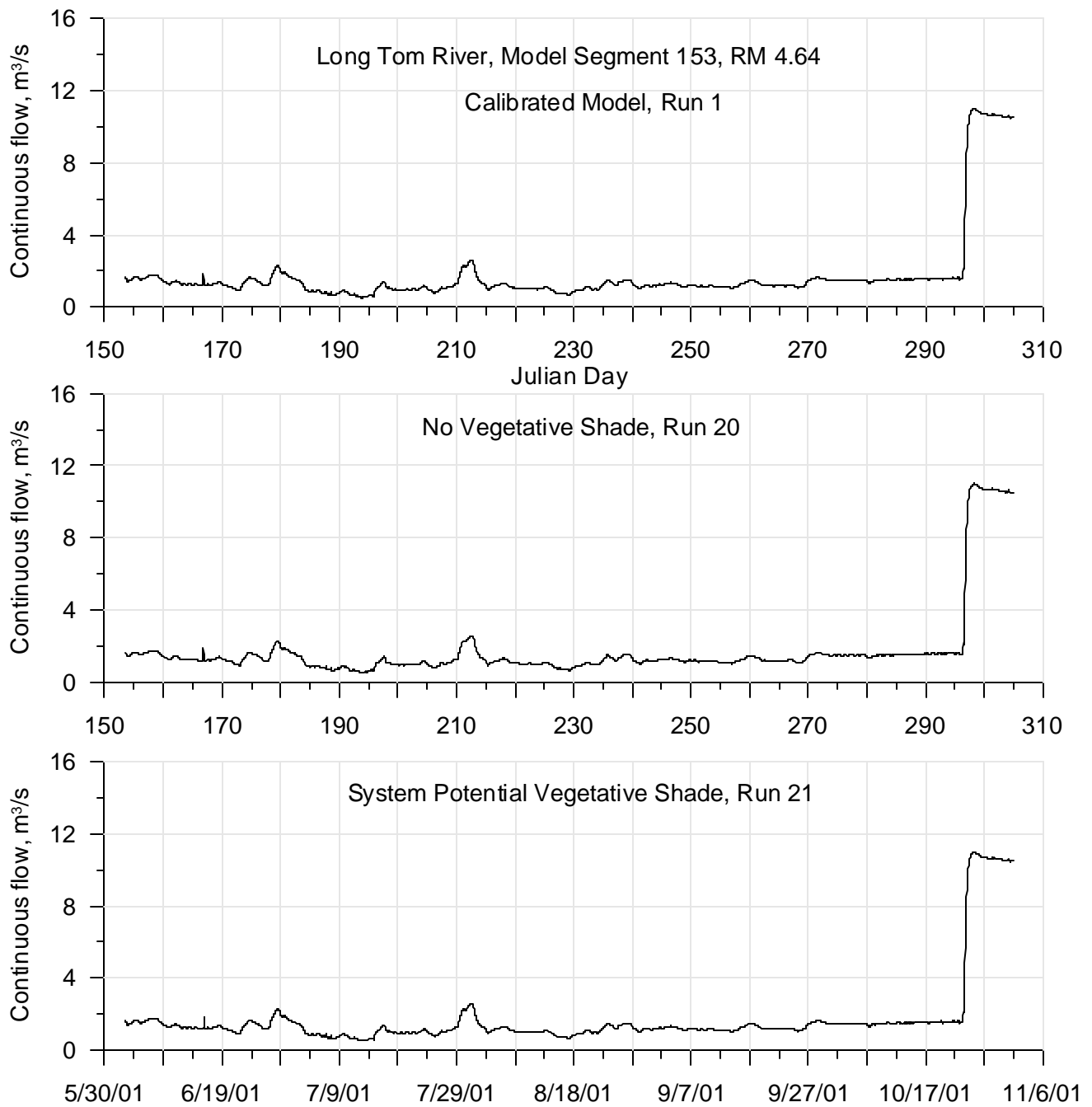


**Figure 662: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the McKenzie River at RM 37.99**

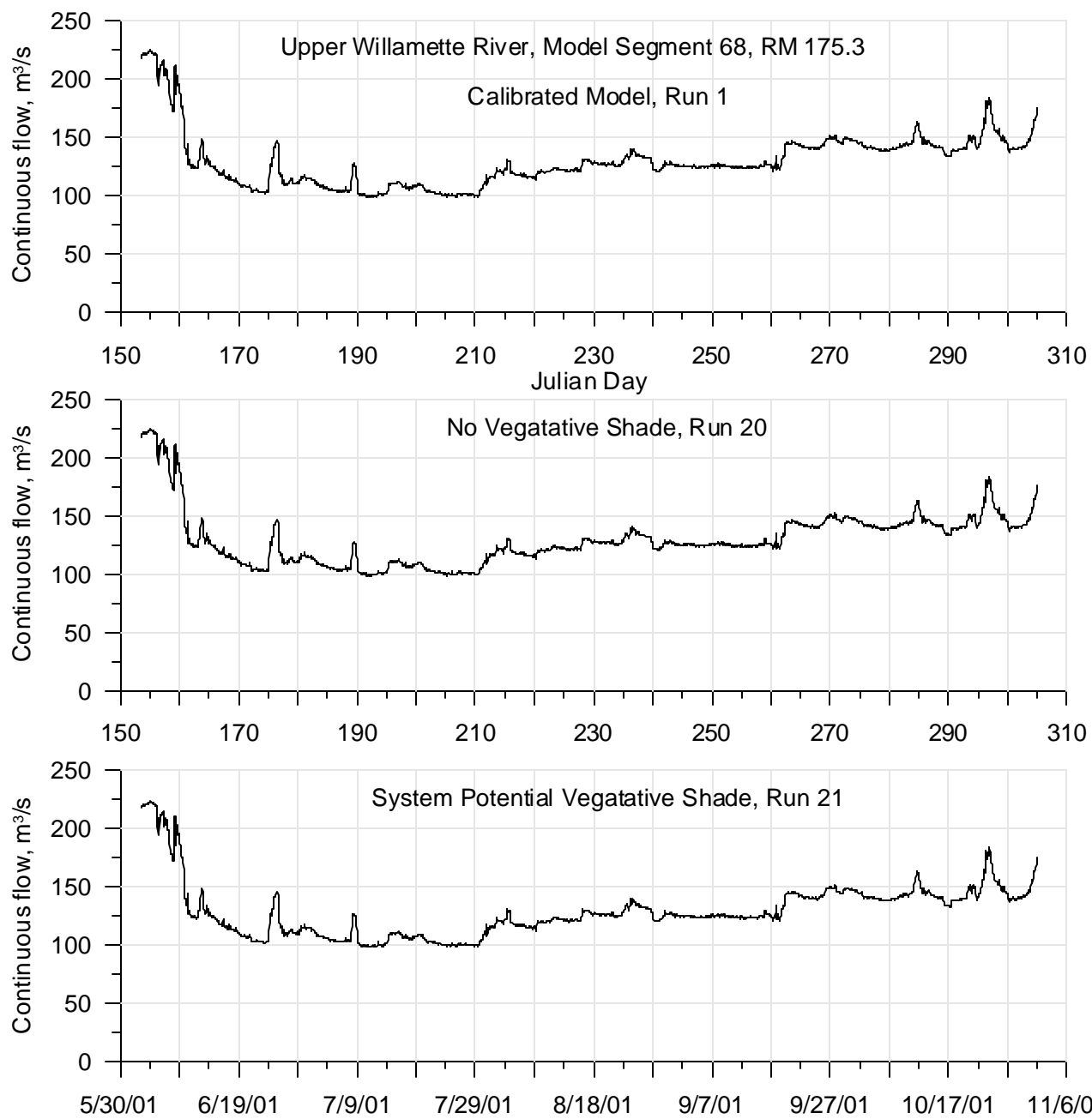


**Figure 663: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the McKenzie River at RM 9.75**

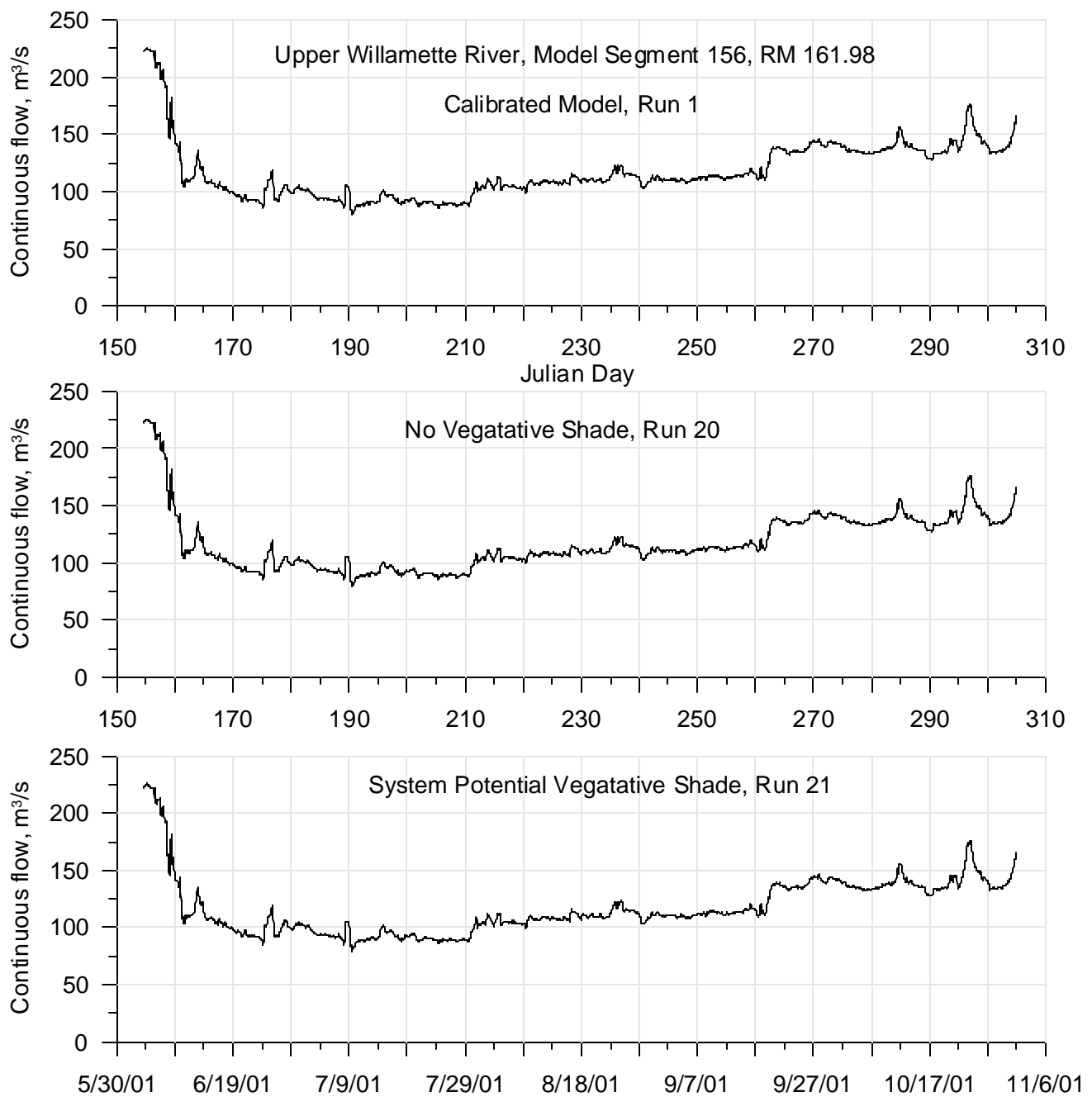




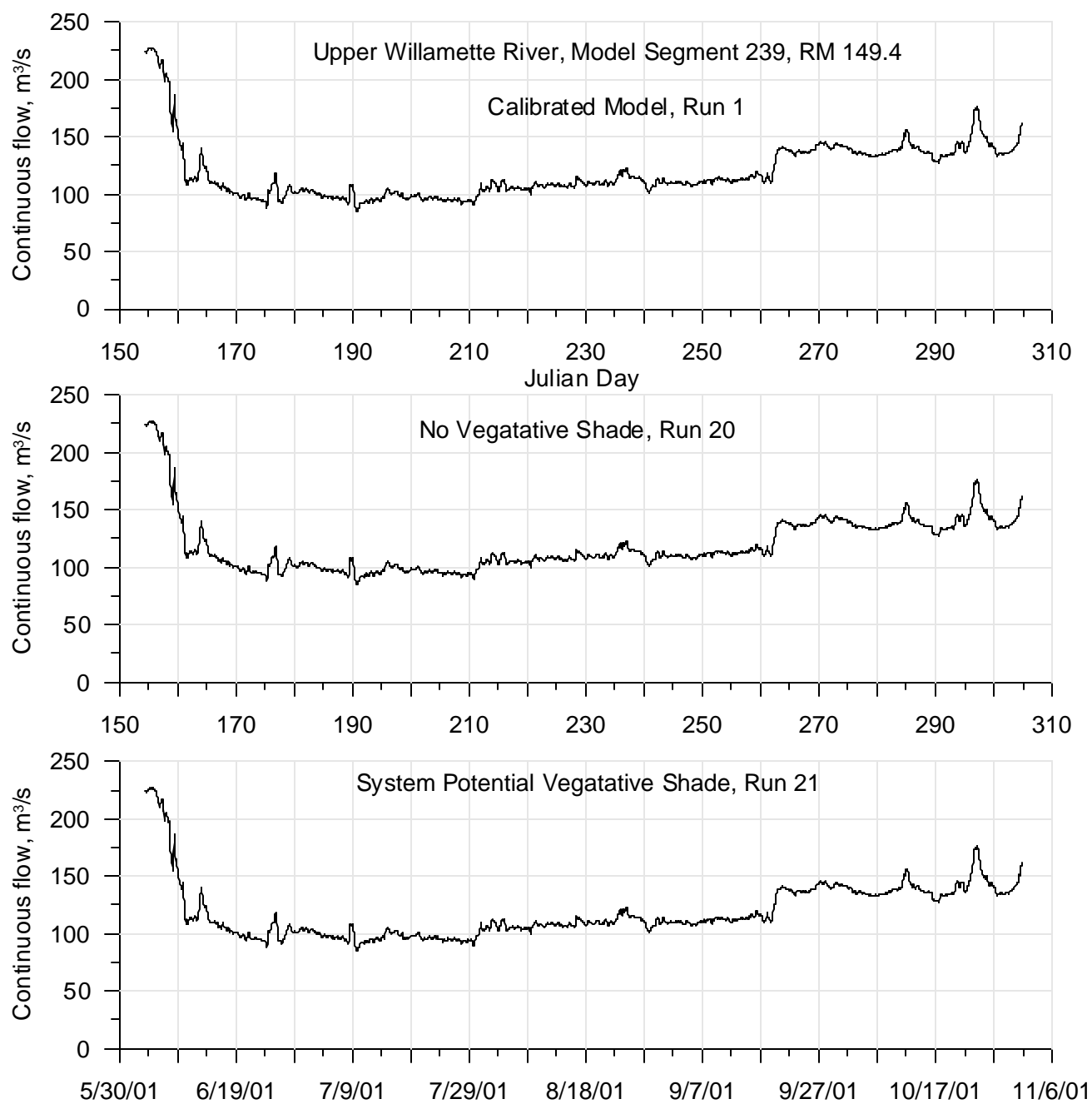
**Figure 664: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Long Tom River at RM 4.64**



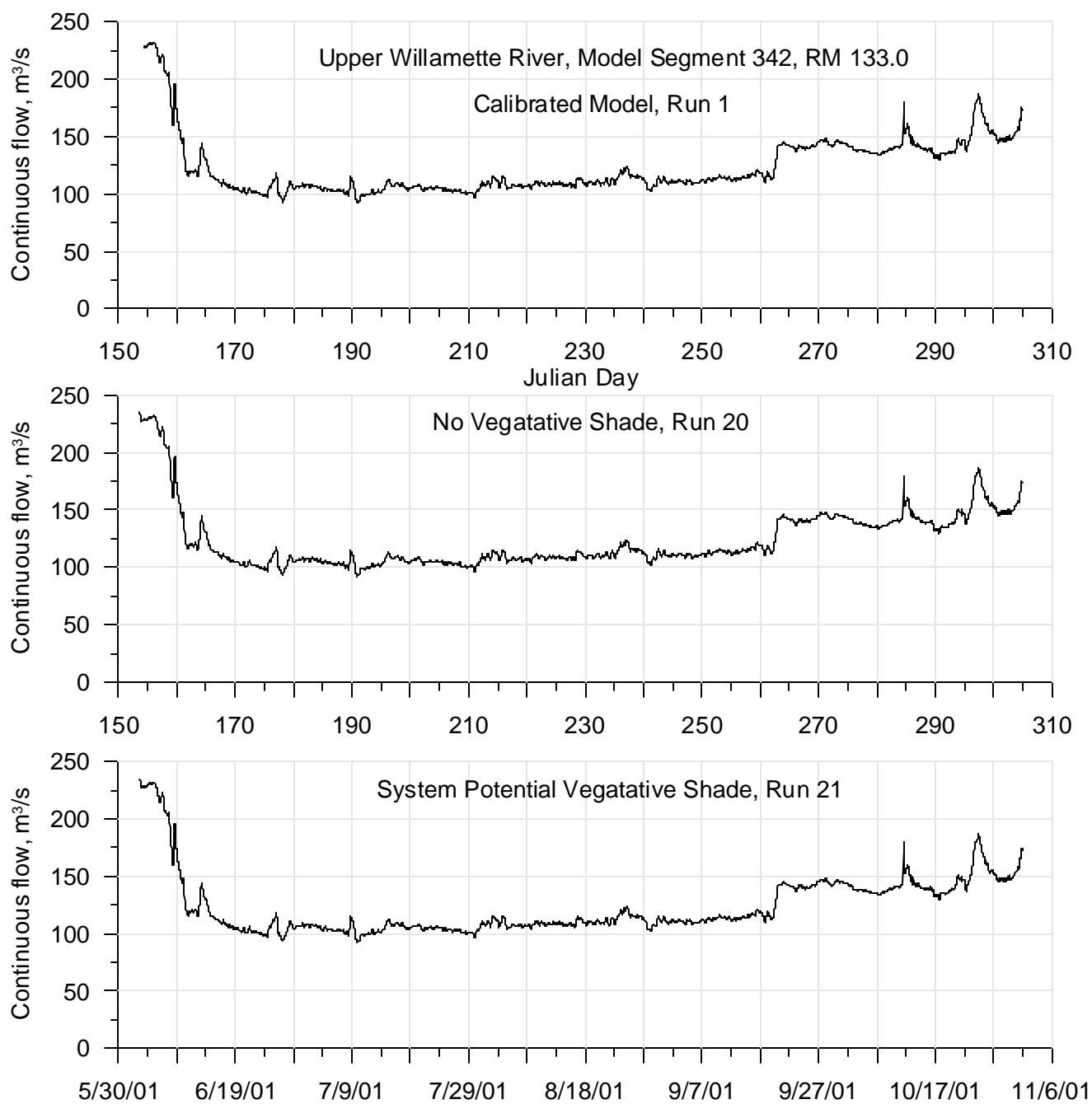
**Figure 665: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 175.3**



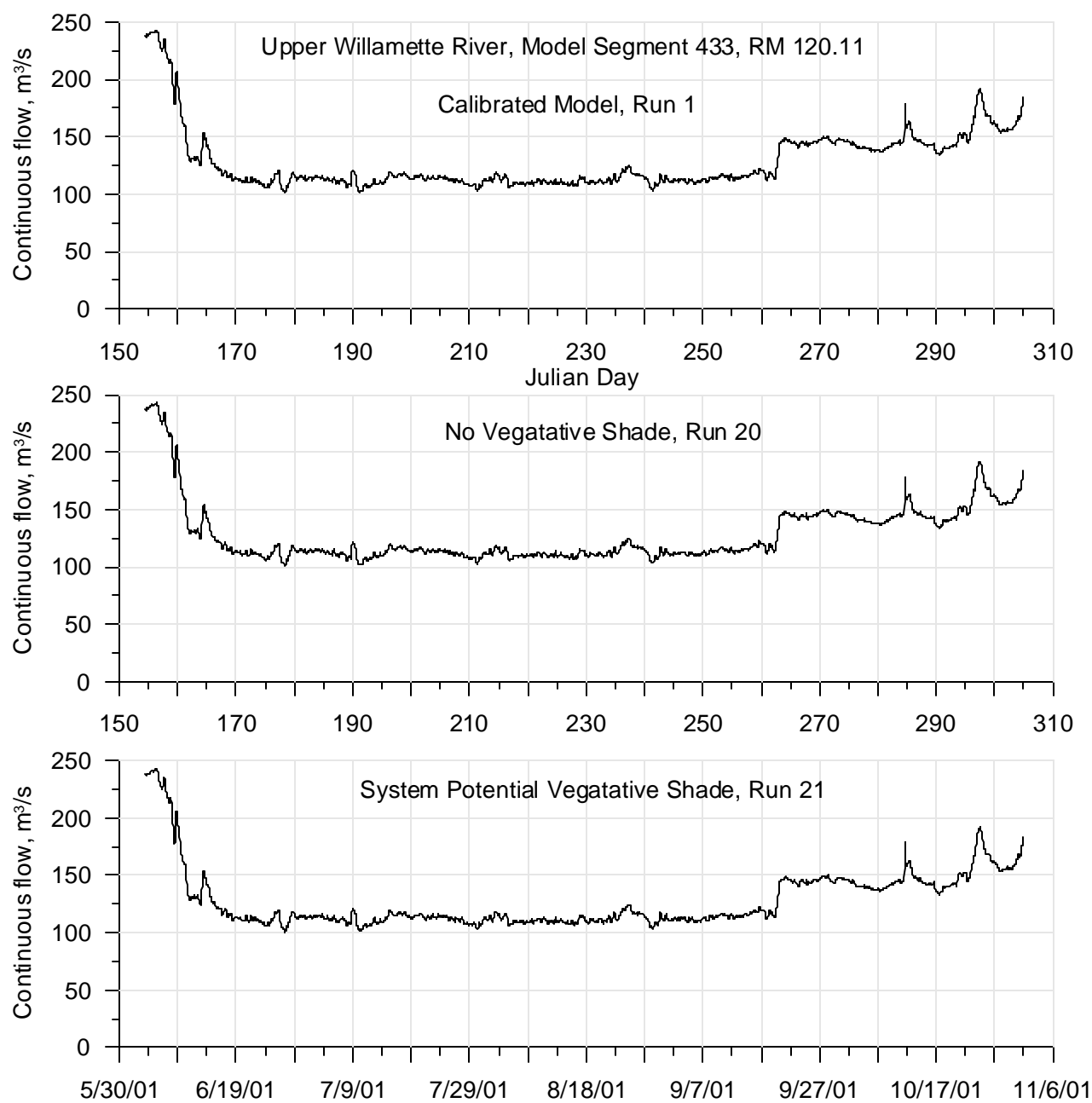
**Figure 666: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 161.98**



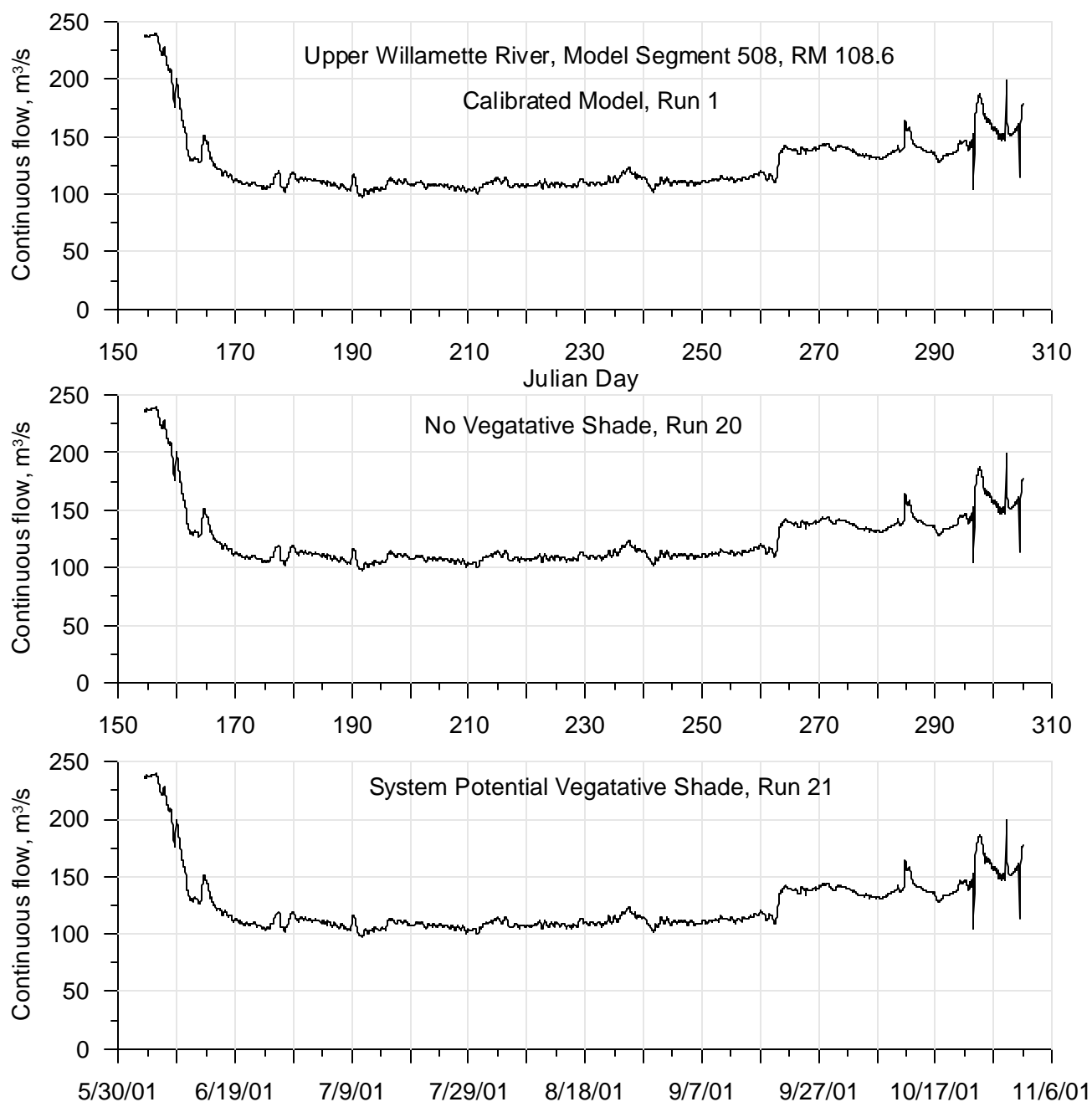
**Figure 667: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 149.4**



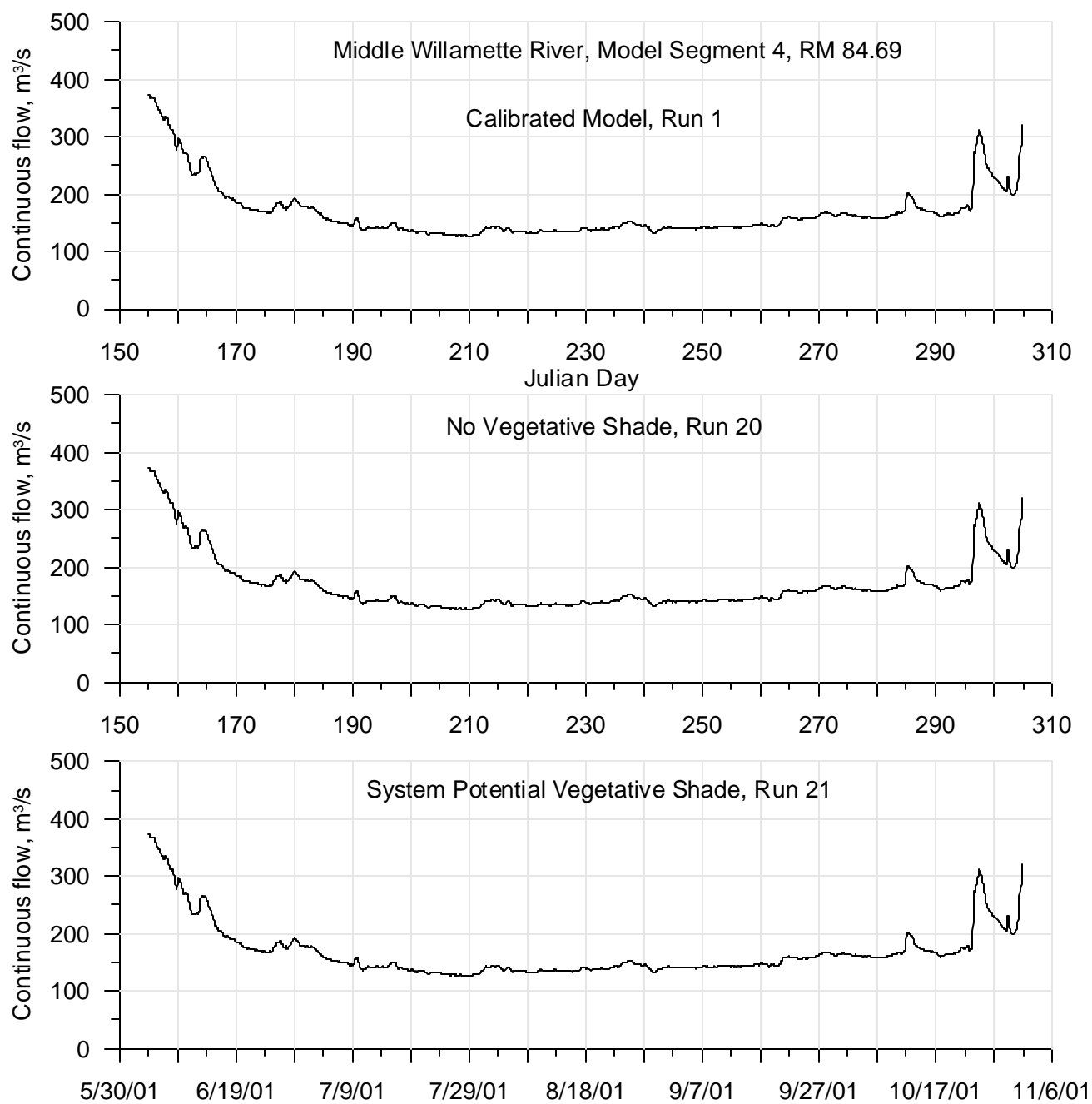
**Figure 668: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 133**



**Figure 669: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 120.11**

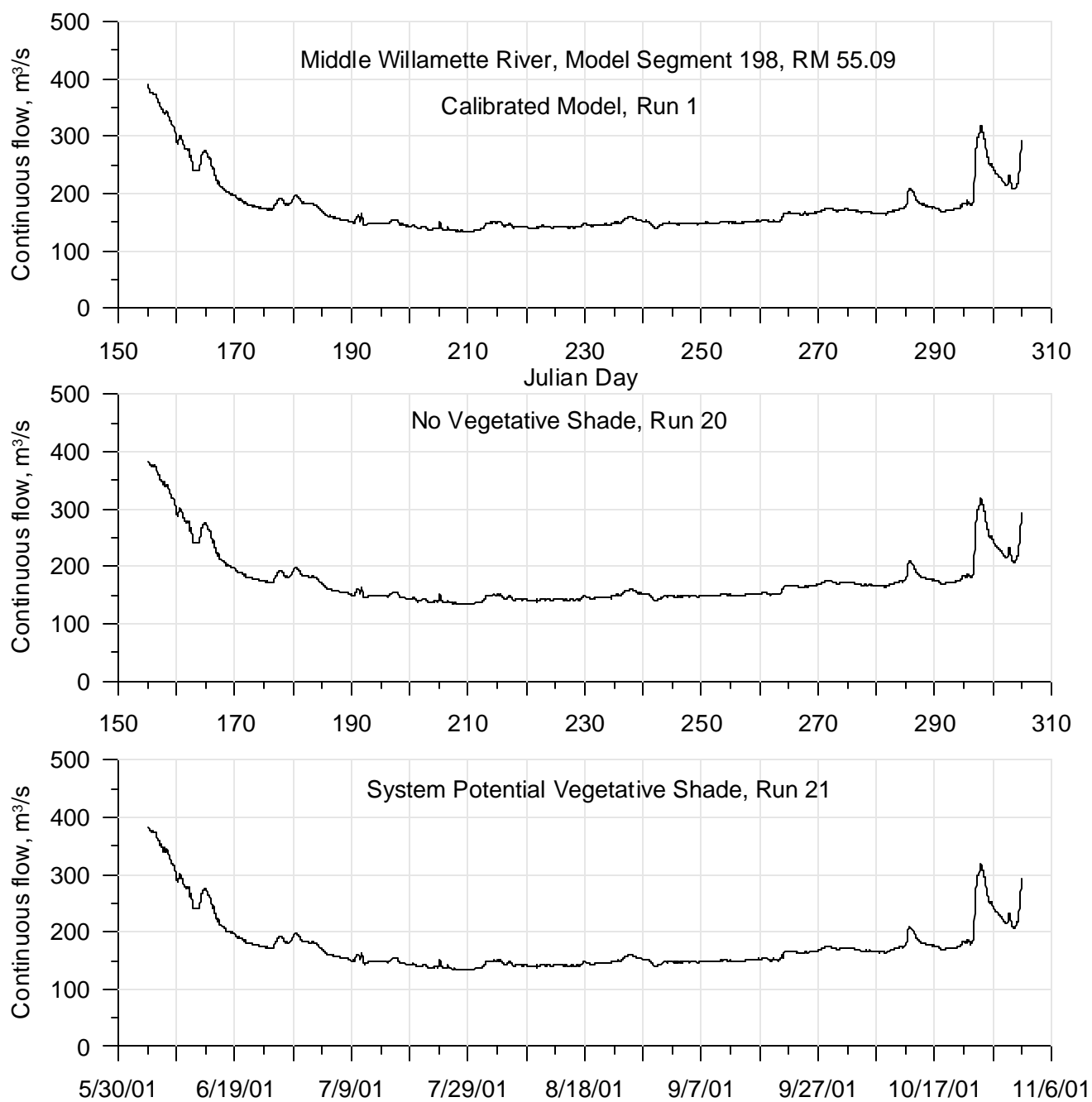


**Figure 670: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 108.6**

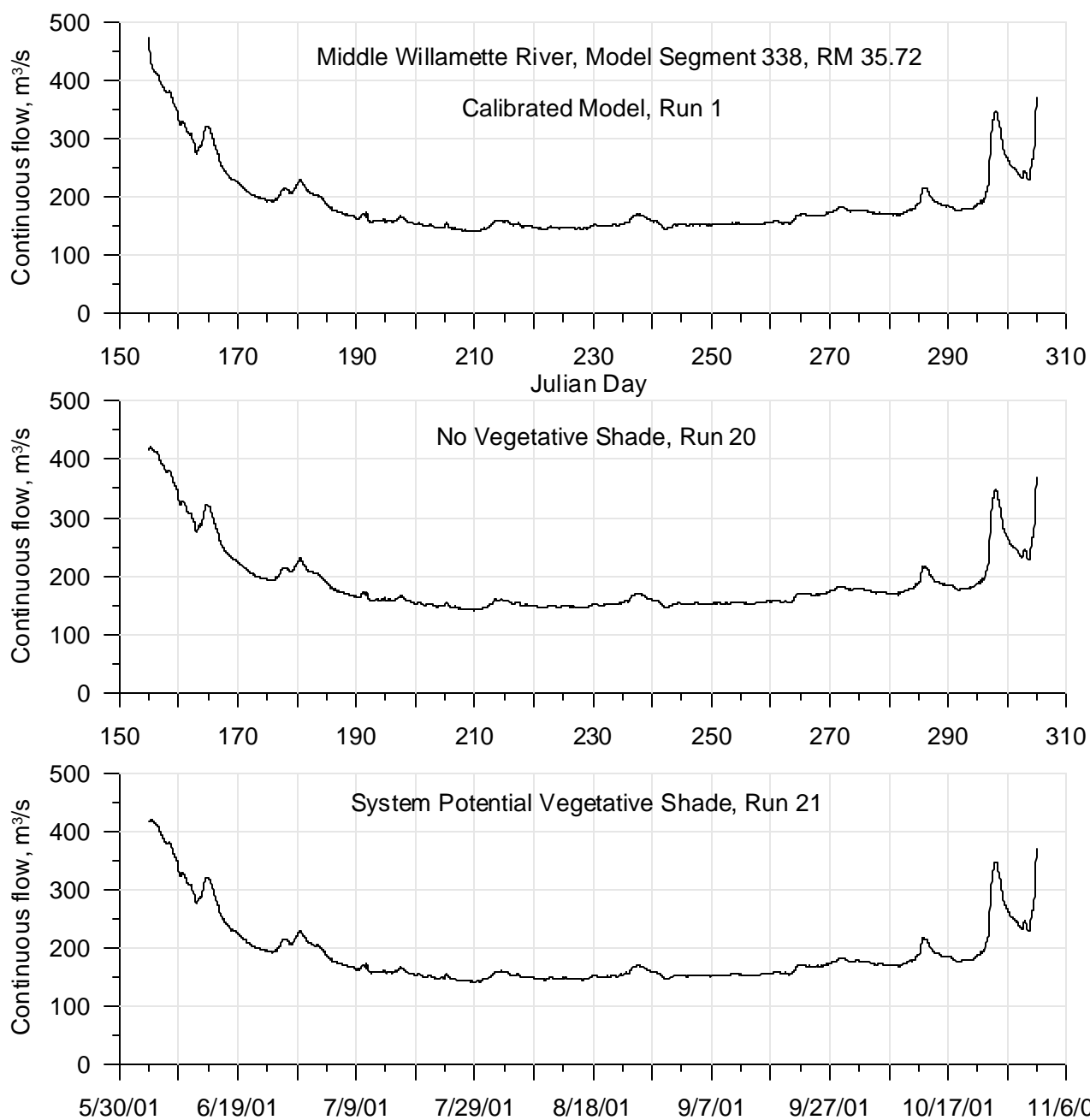


**Figure 671: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 84.69**

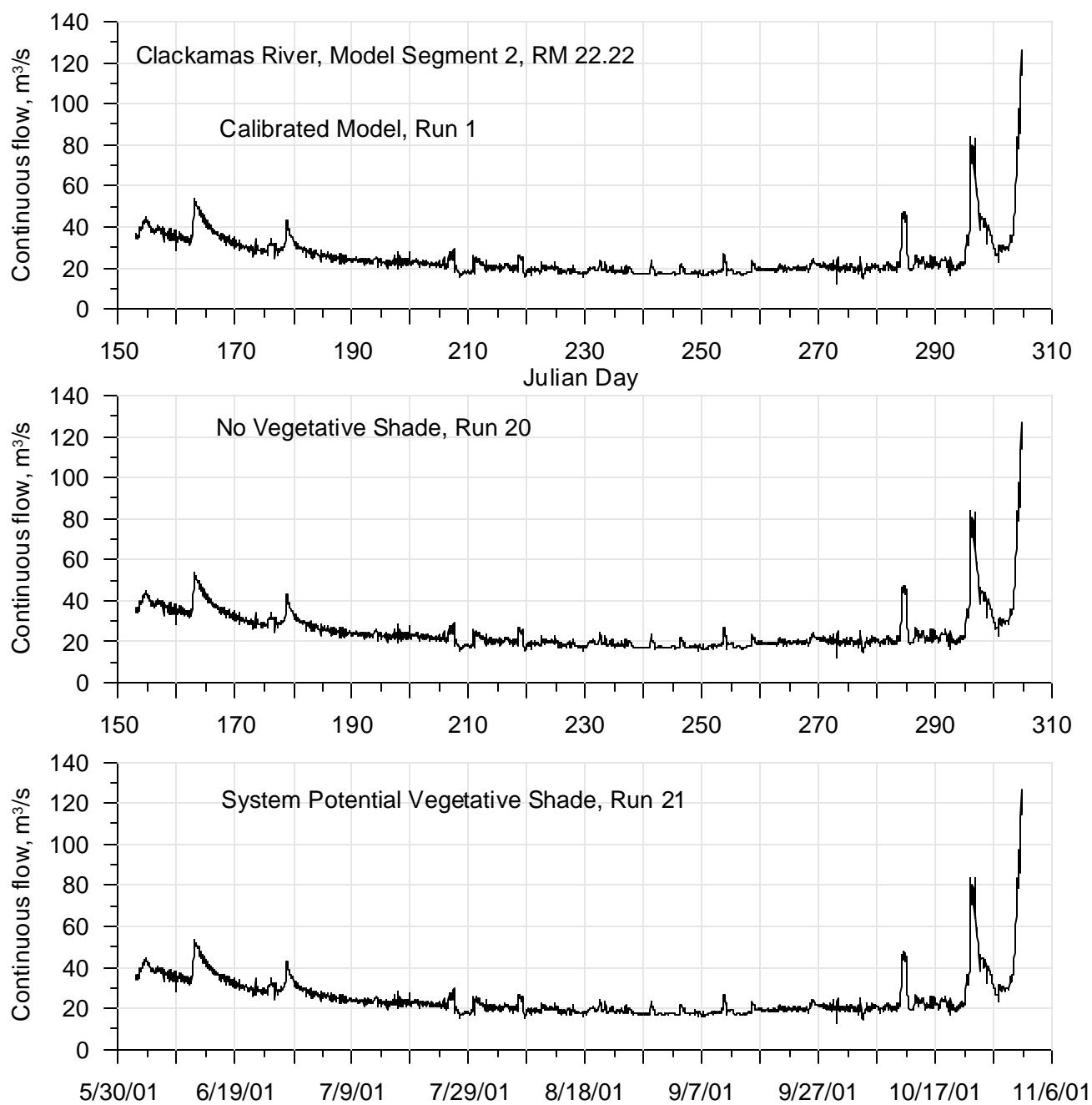




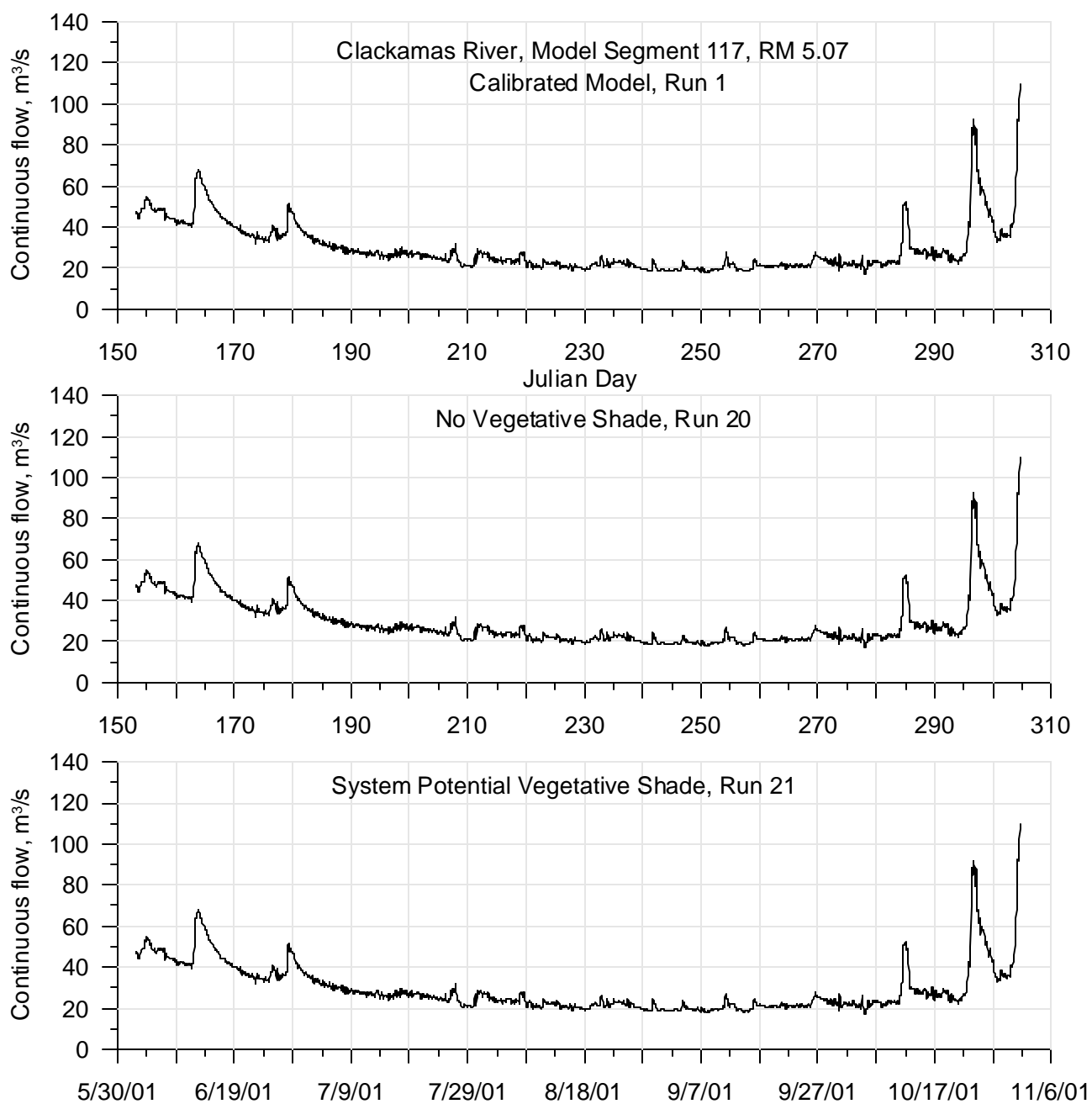
**Figure 672: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 55.09**



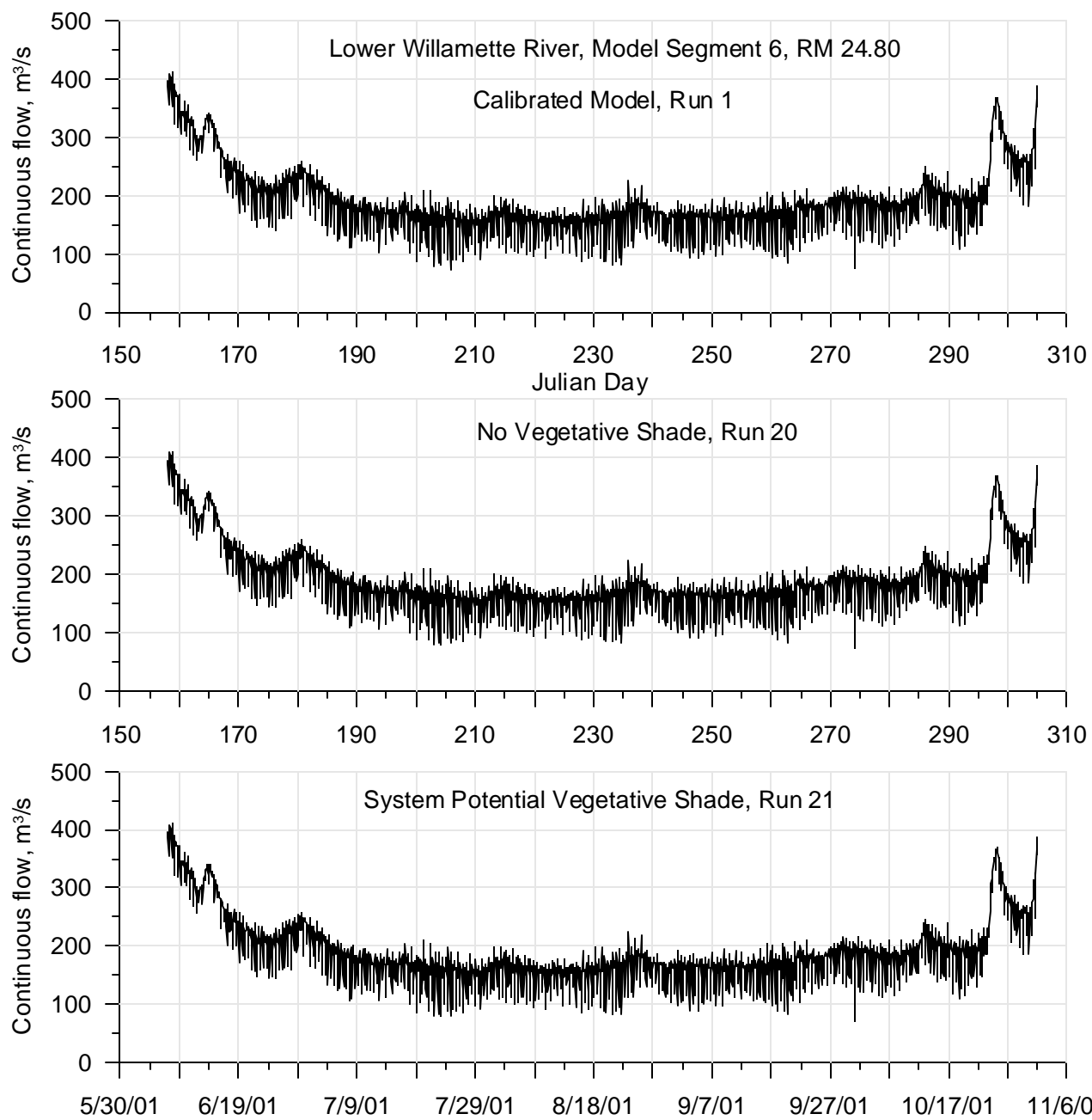
**Figure 673: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 35.72**



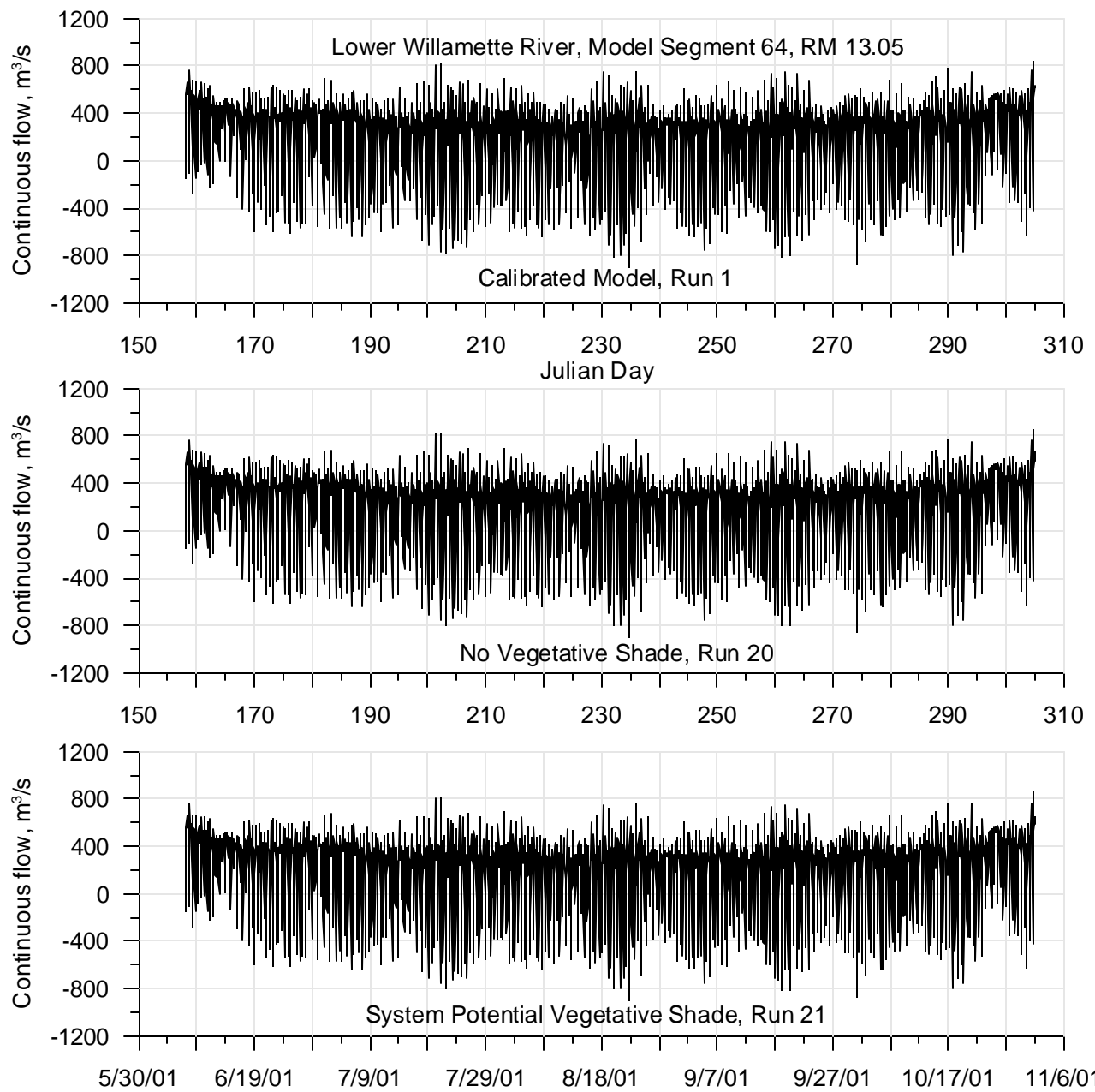
**Figure 674: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Clackamas River at RM 22.22**



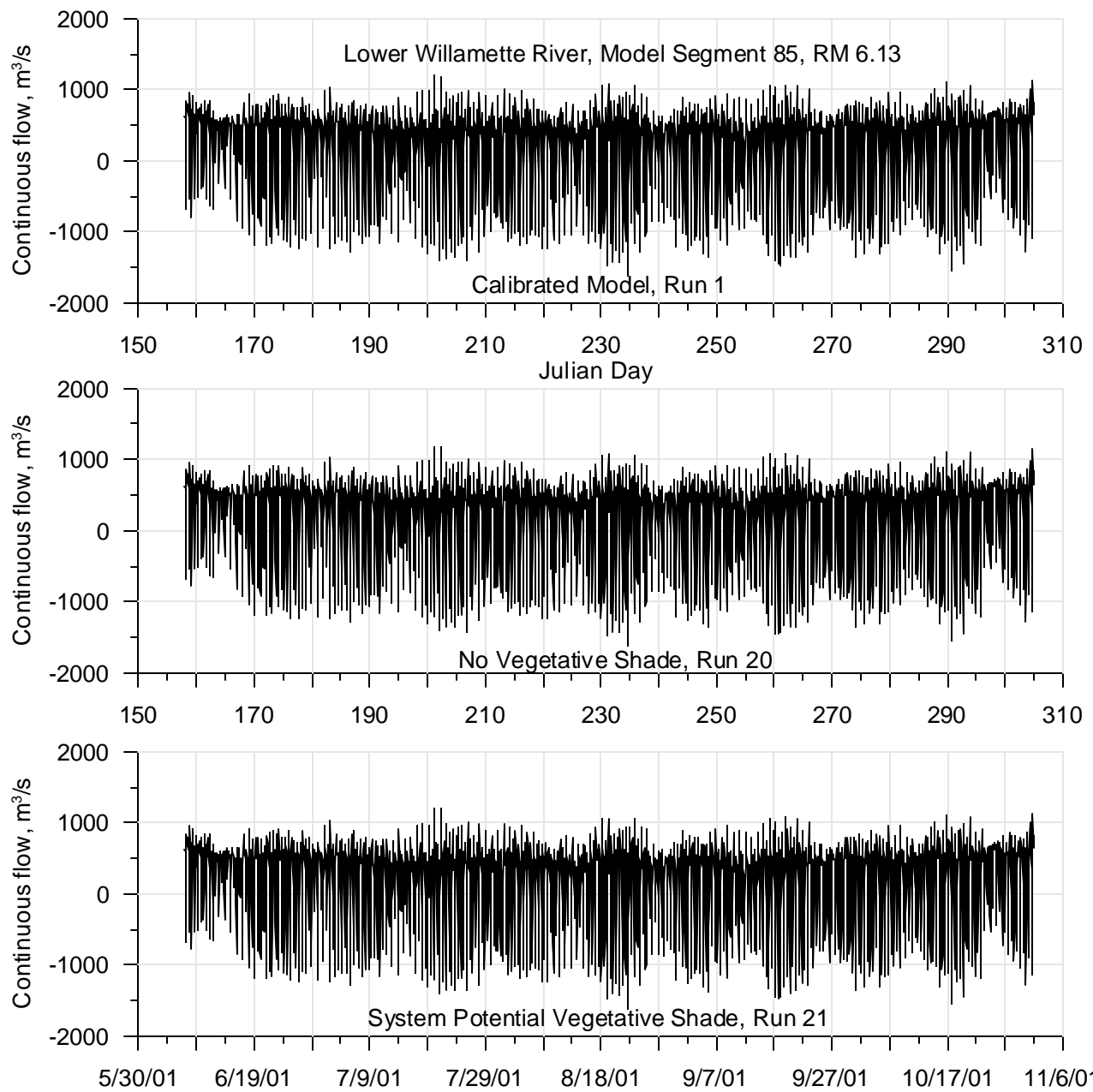
**Figure 675: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Clackamas River at RM 5.07**



**Figure 676: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 24.8**



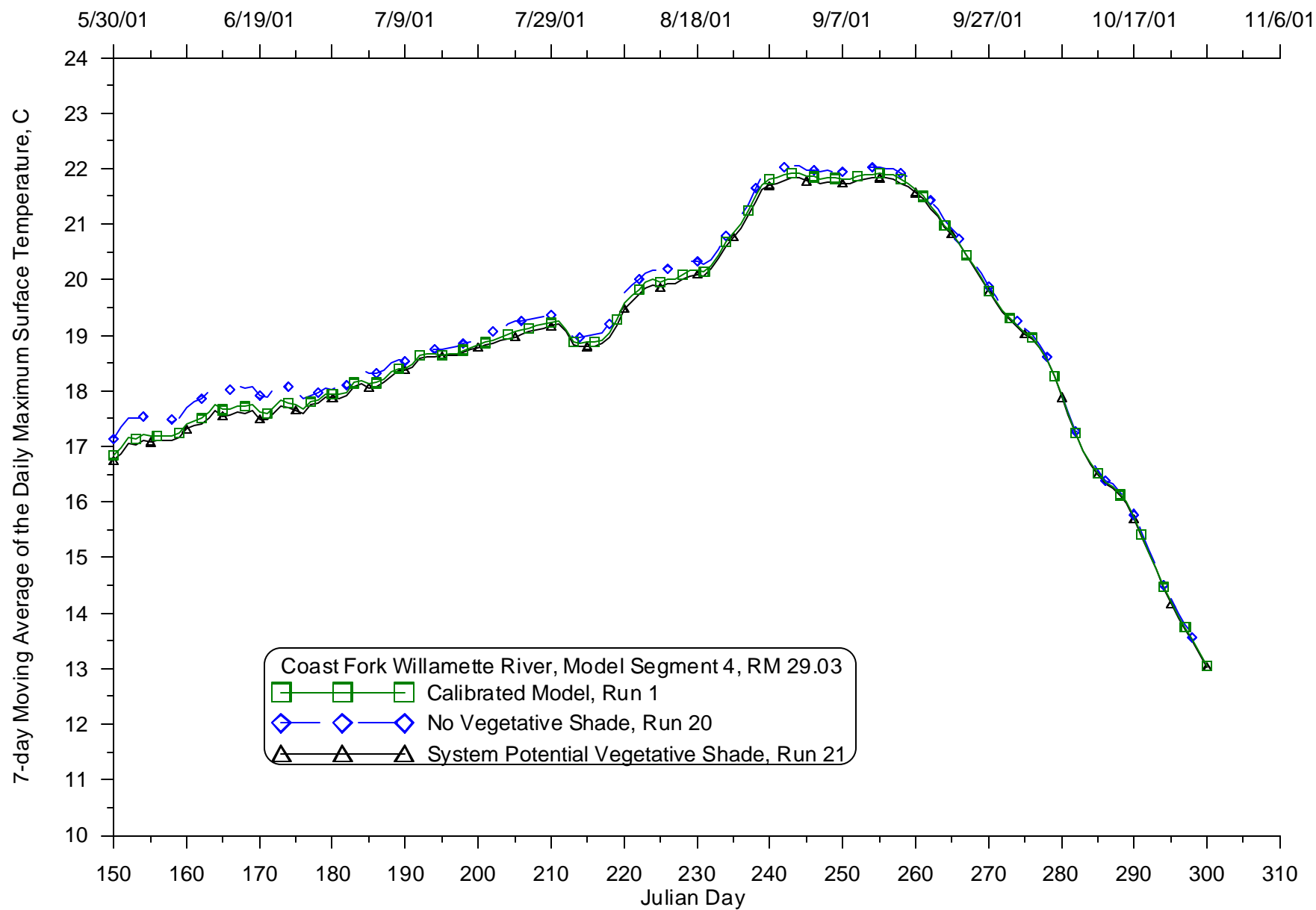
**Figure 677: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 13.05**



**Figure 678: Calibrated model compared with varying vegetative shade, continuous flow for 2001 for the Willamette River at RM 6.13**

**Daily seven day moving average of daily maximum temperature**





**Figure 679: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 29.03**

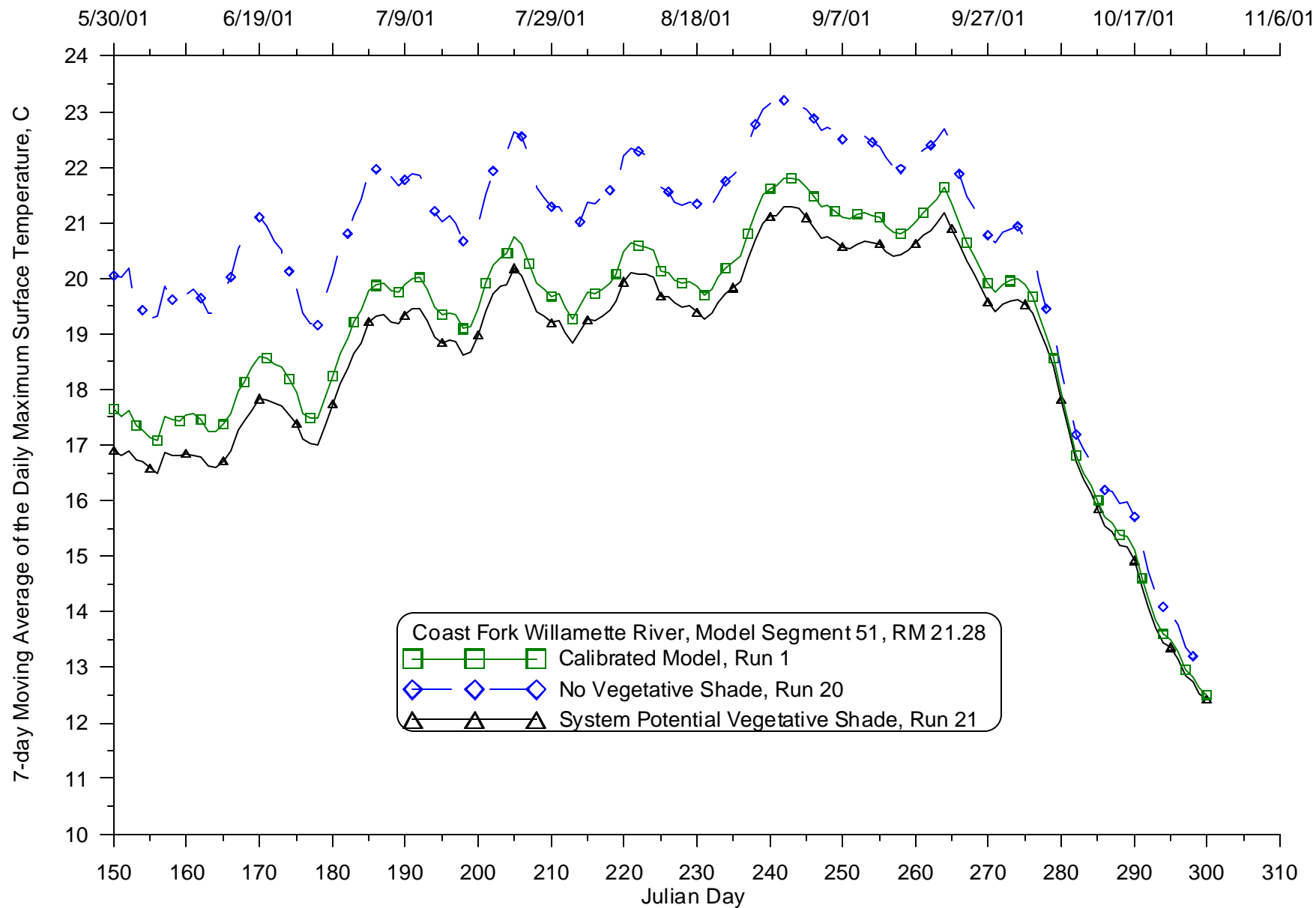
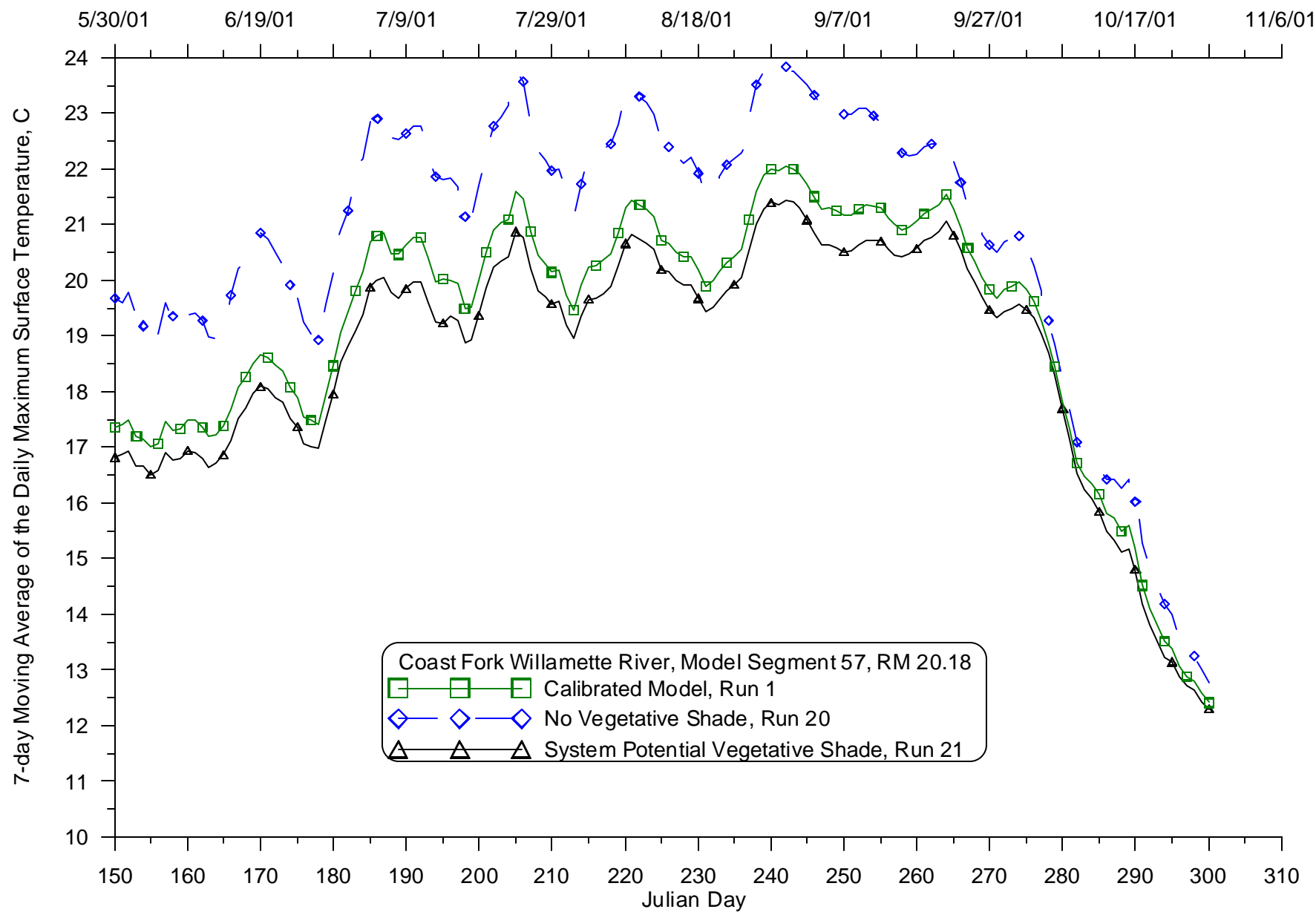


Figure 680: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 21.28



**Figure 681: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 20.18**

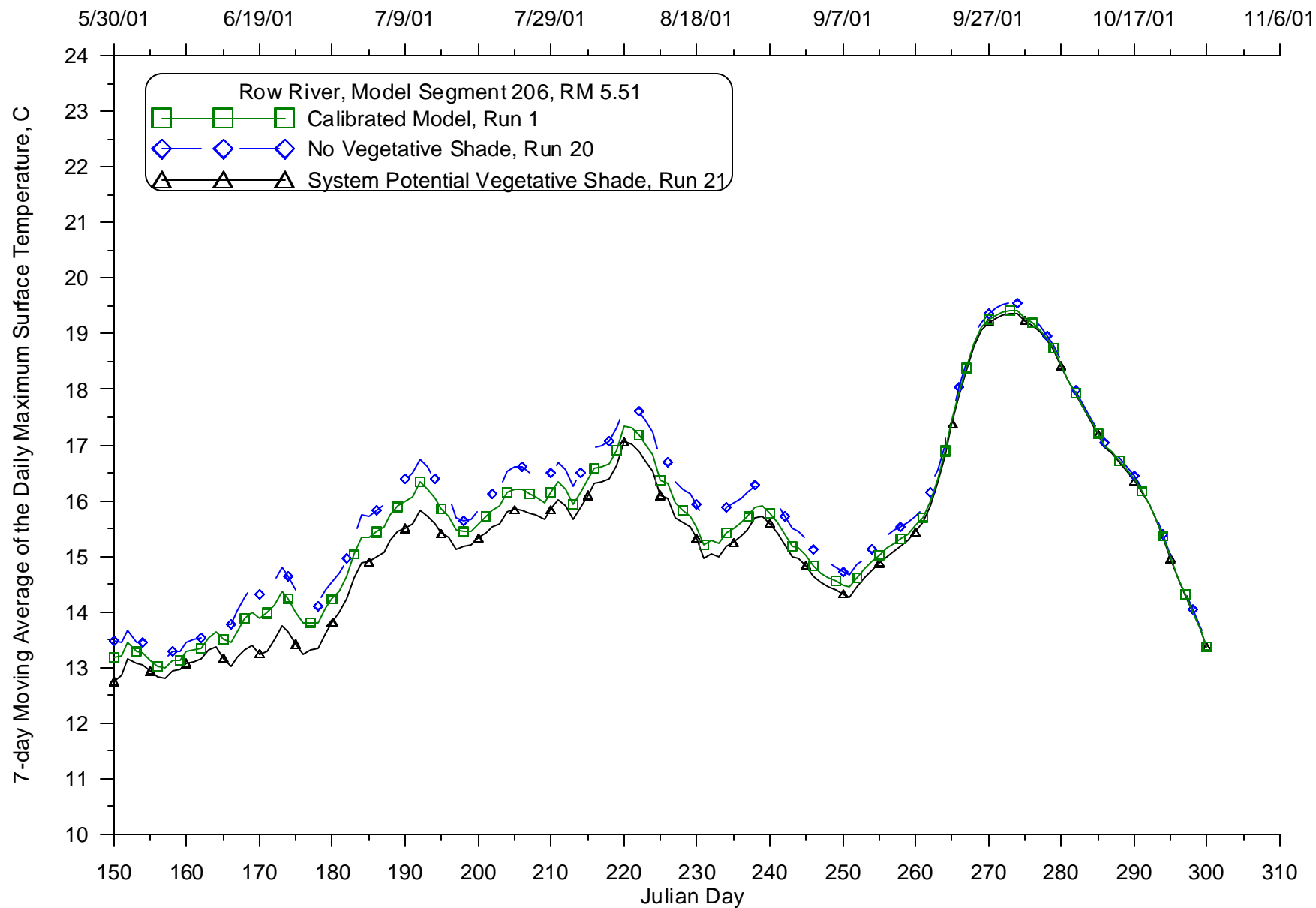
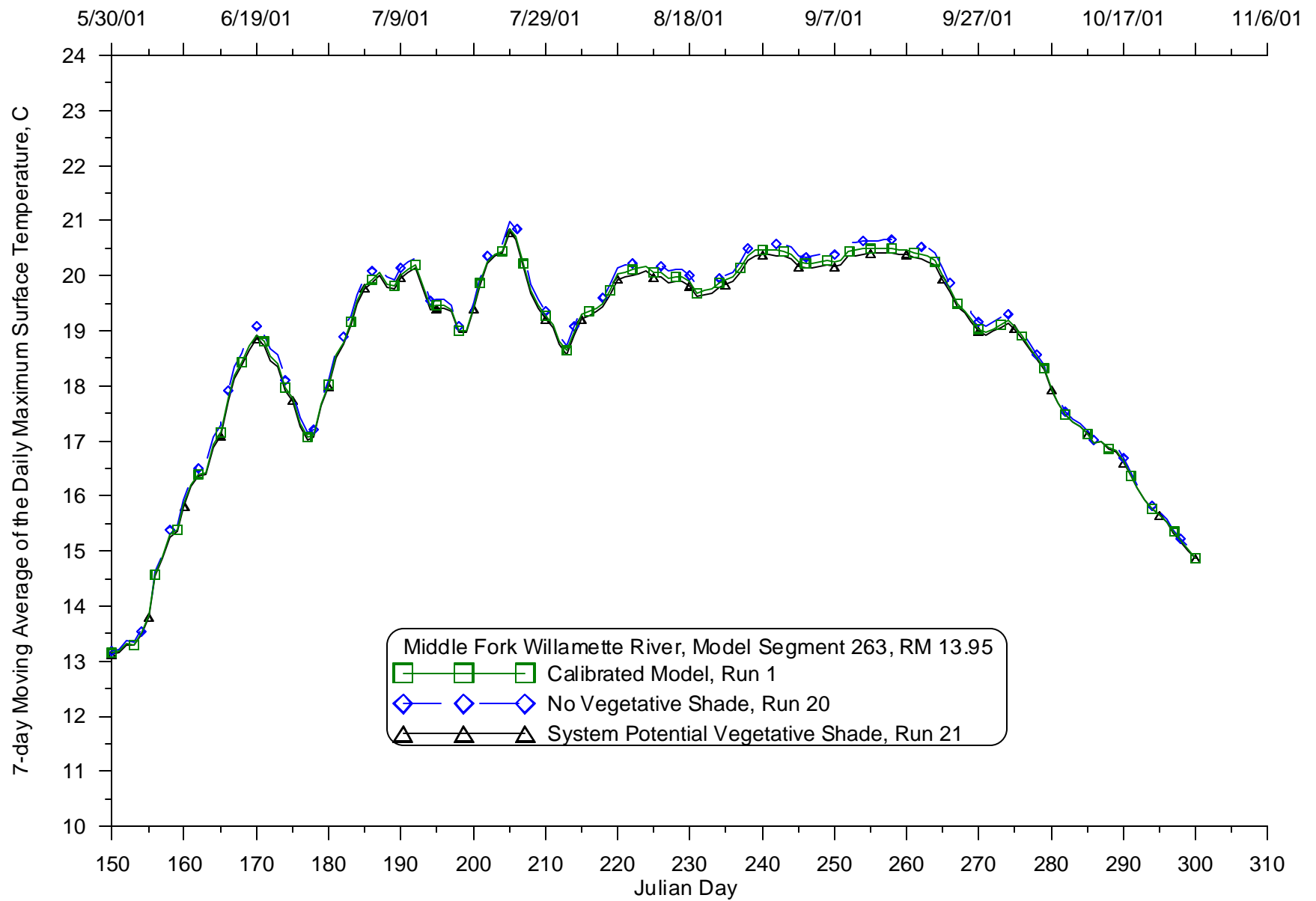
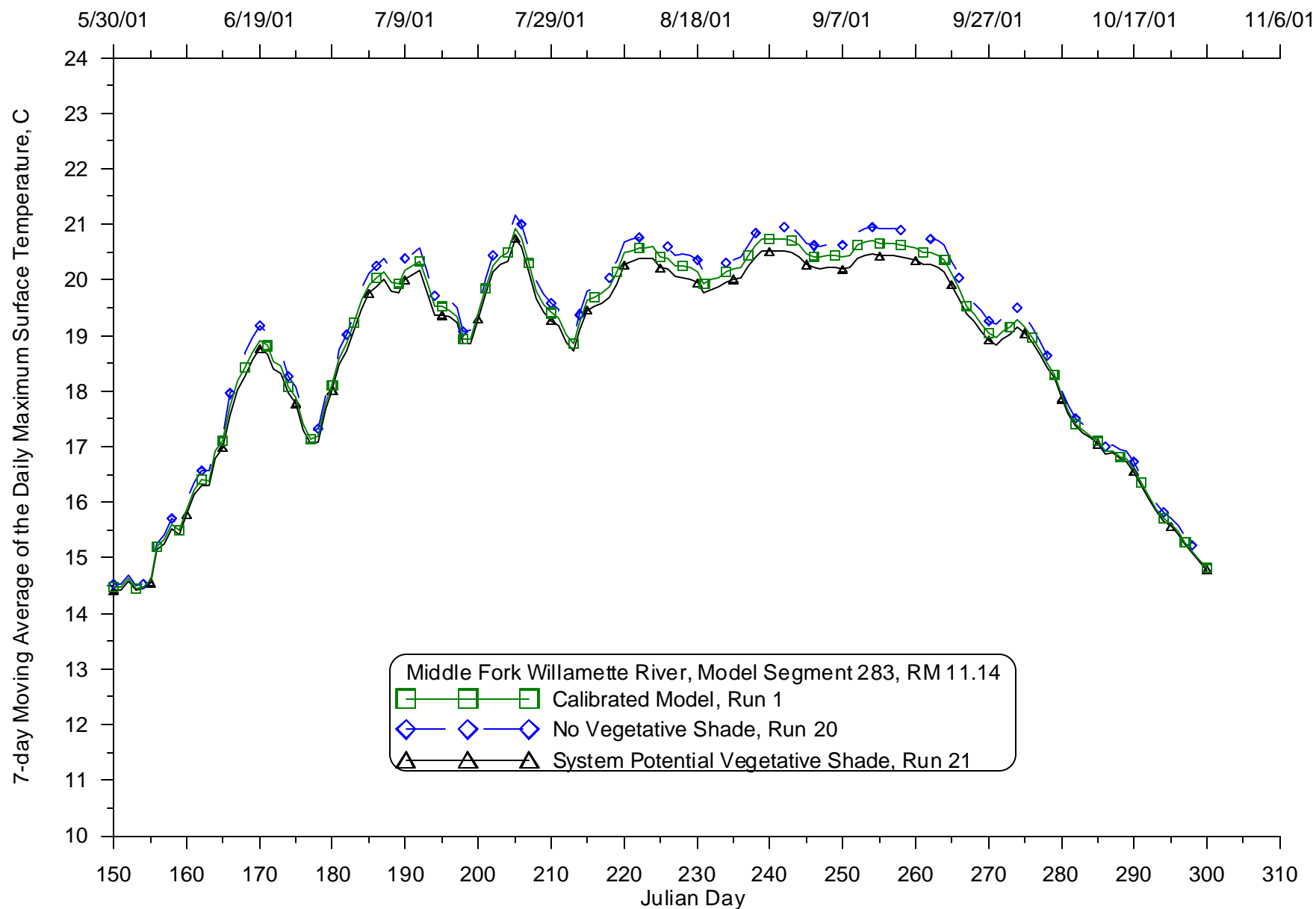


Figure 682: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Row River at RM 5.51



**Figure 683: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 684: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Middle Fork Willamette River at RM 11.14**

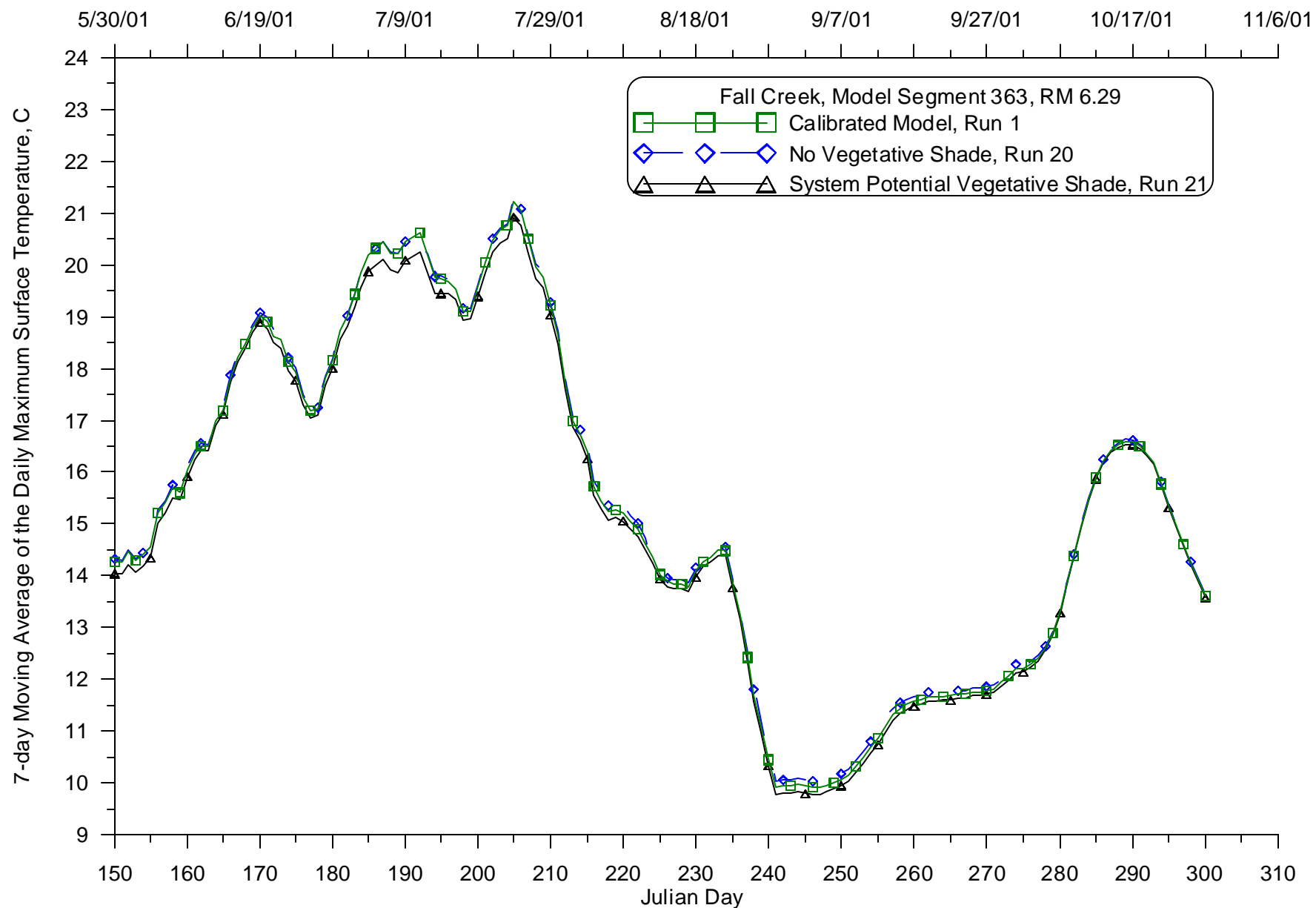
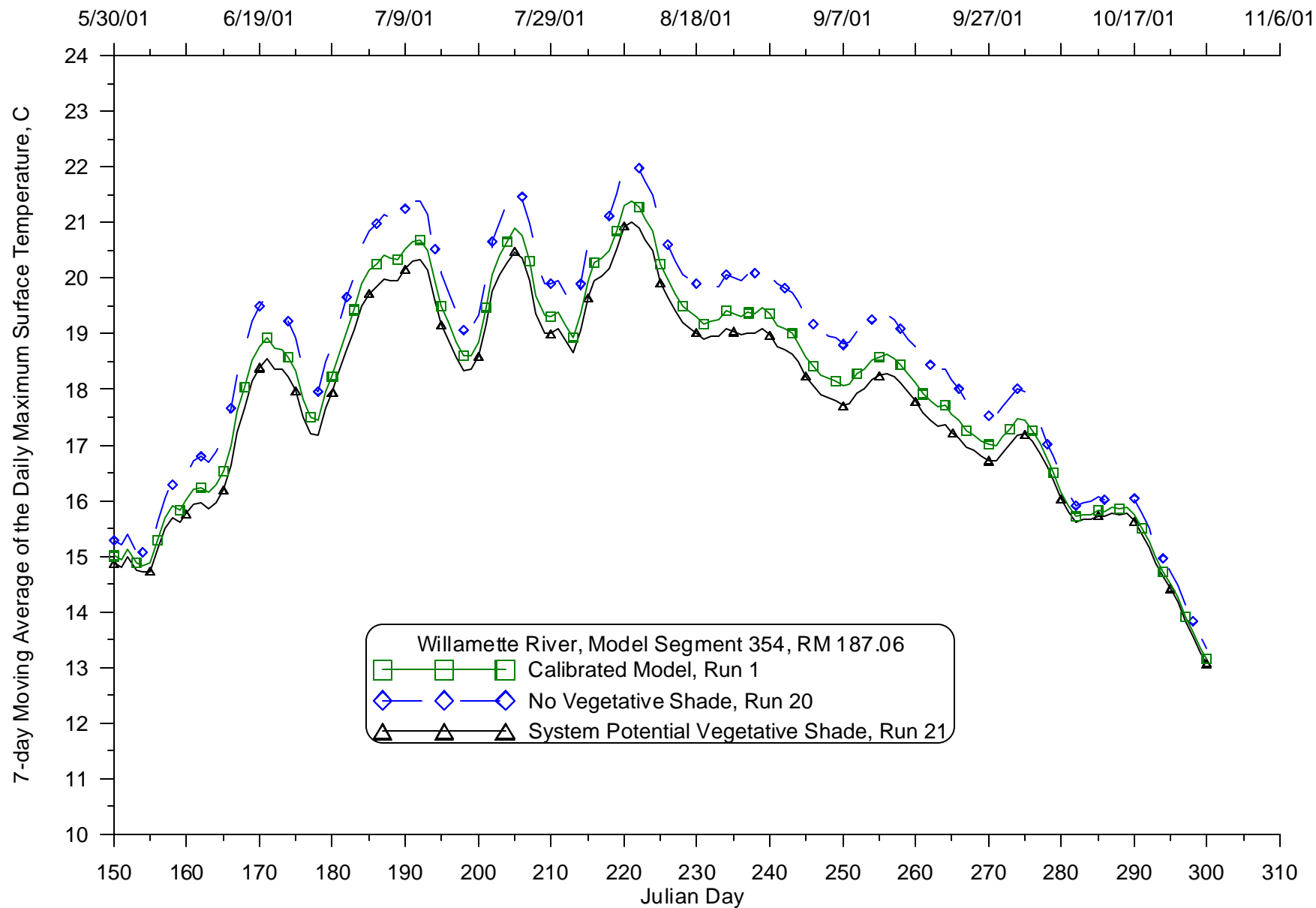


Figure 685: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for Fall Creek at RM 6.29



**Figure 686: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 187.06**



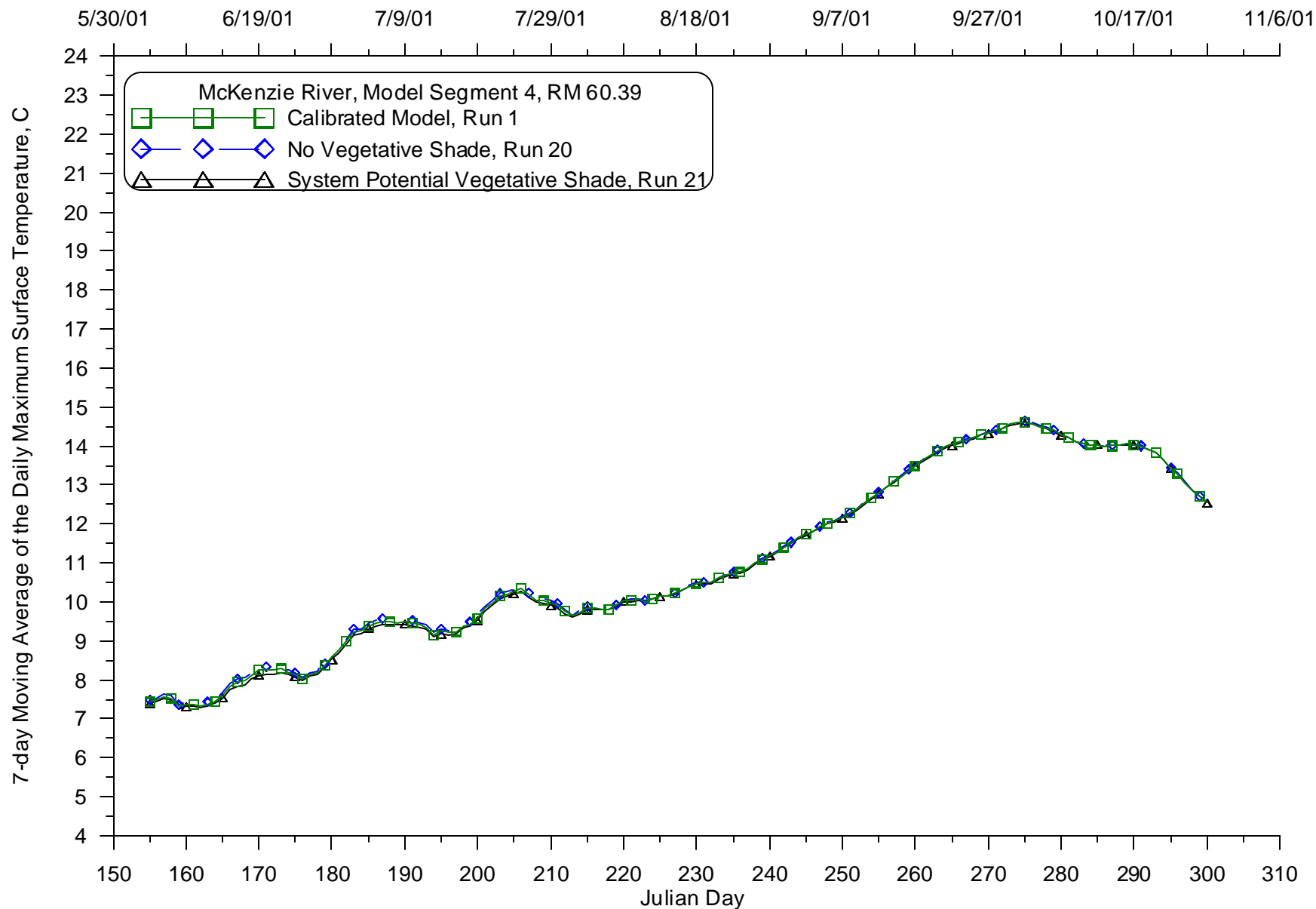
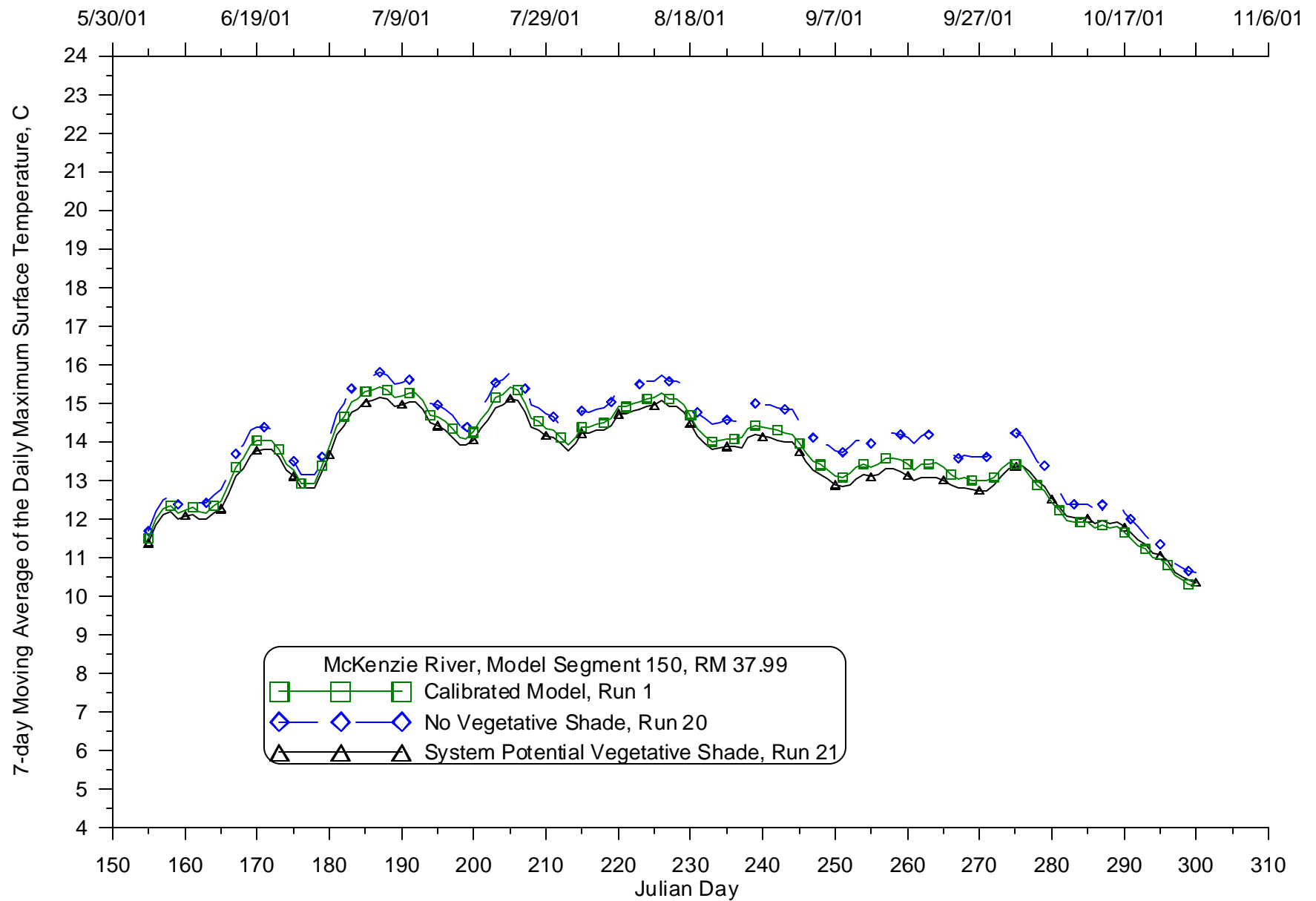


Figure 687: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 60.39



**Figure 688: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 37.99**

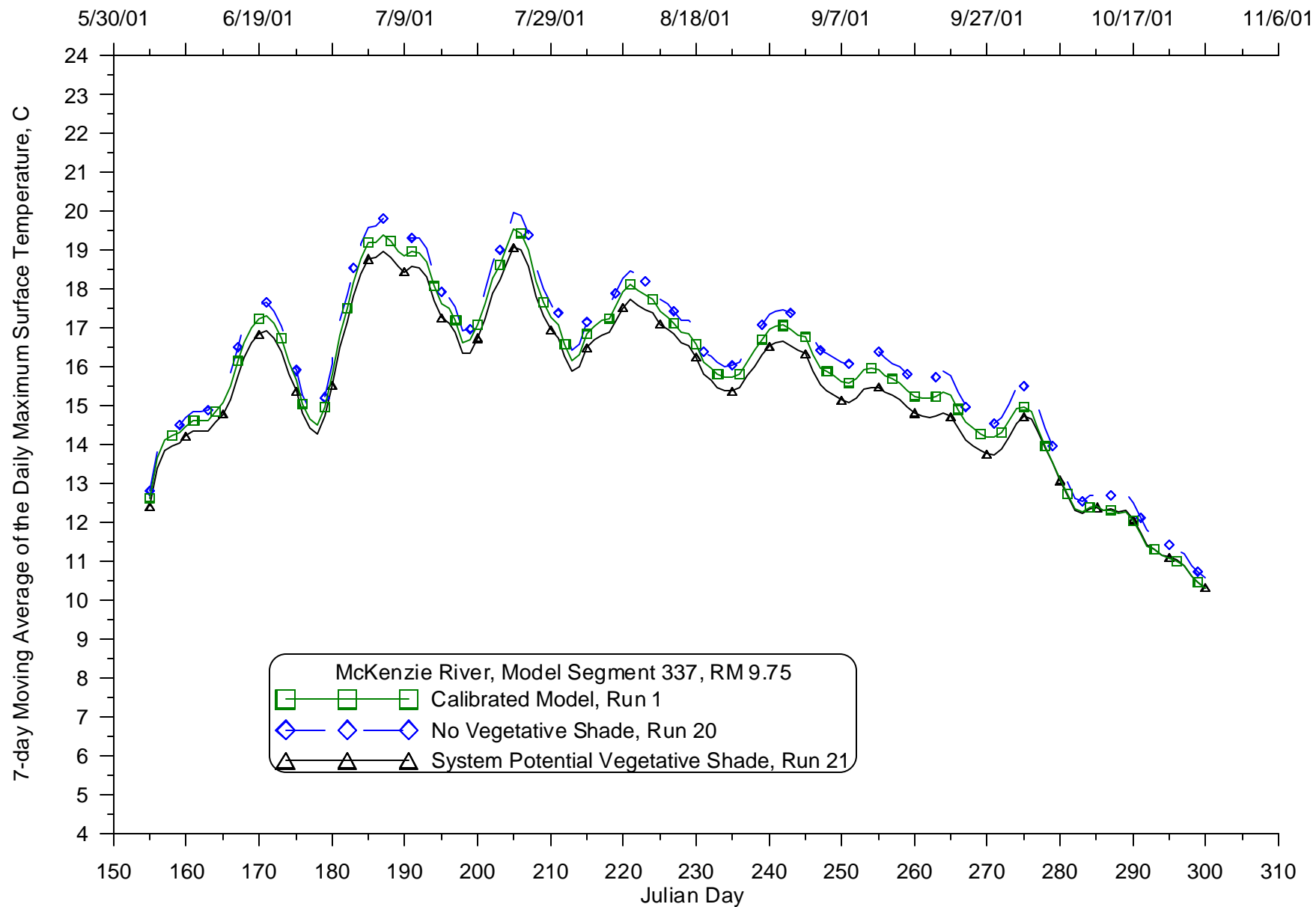
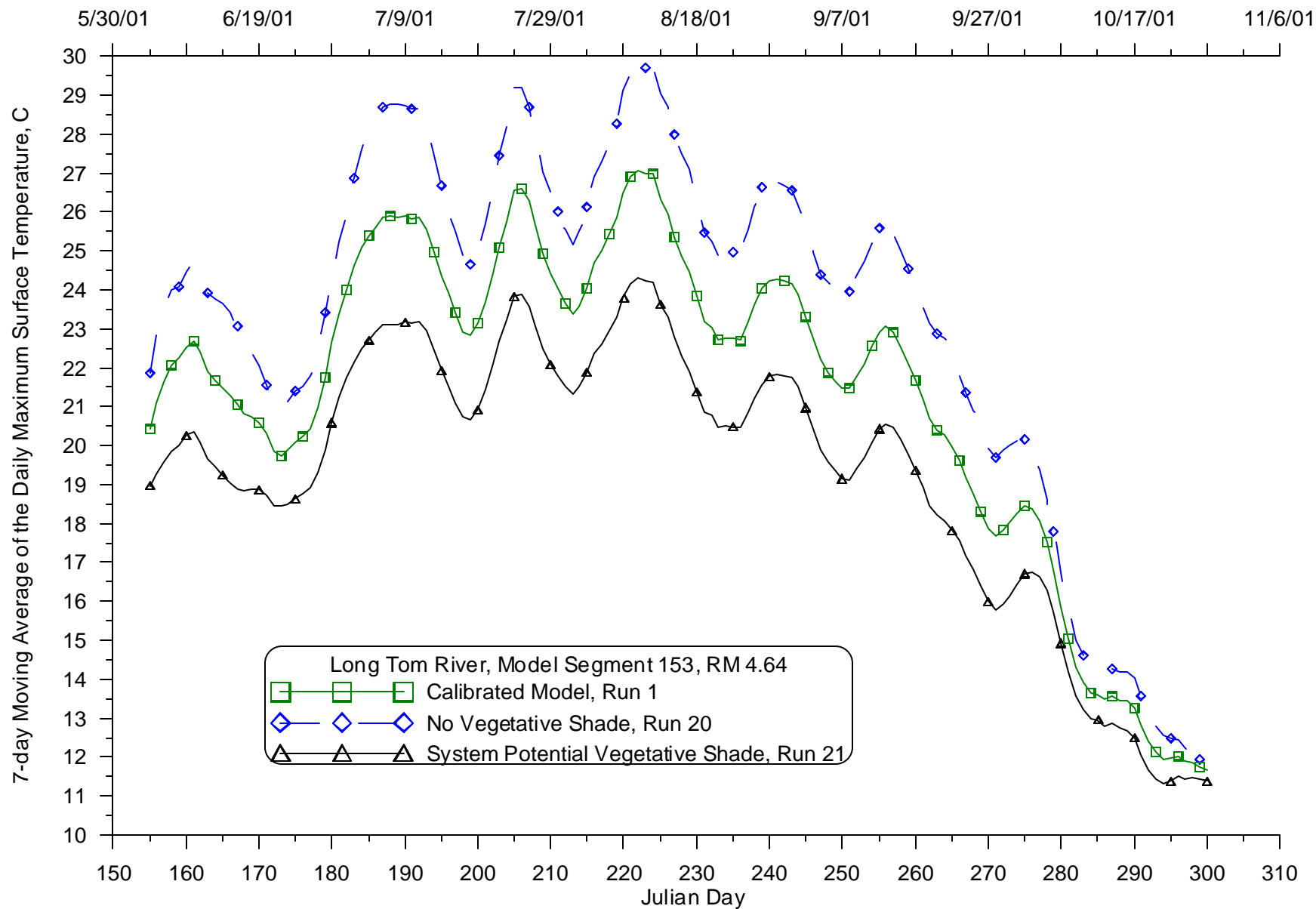


Figure 689: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 9.75



**Figure 690: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Long Tom River at RM 4.64**

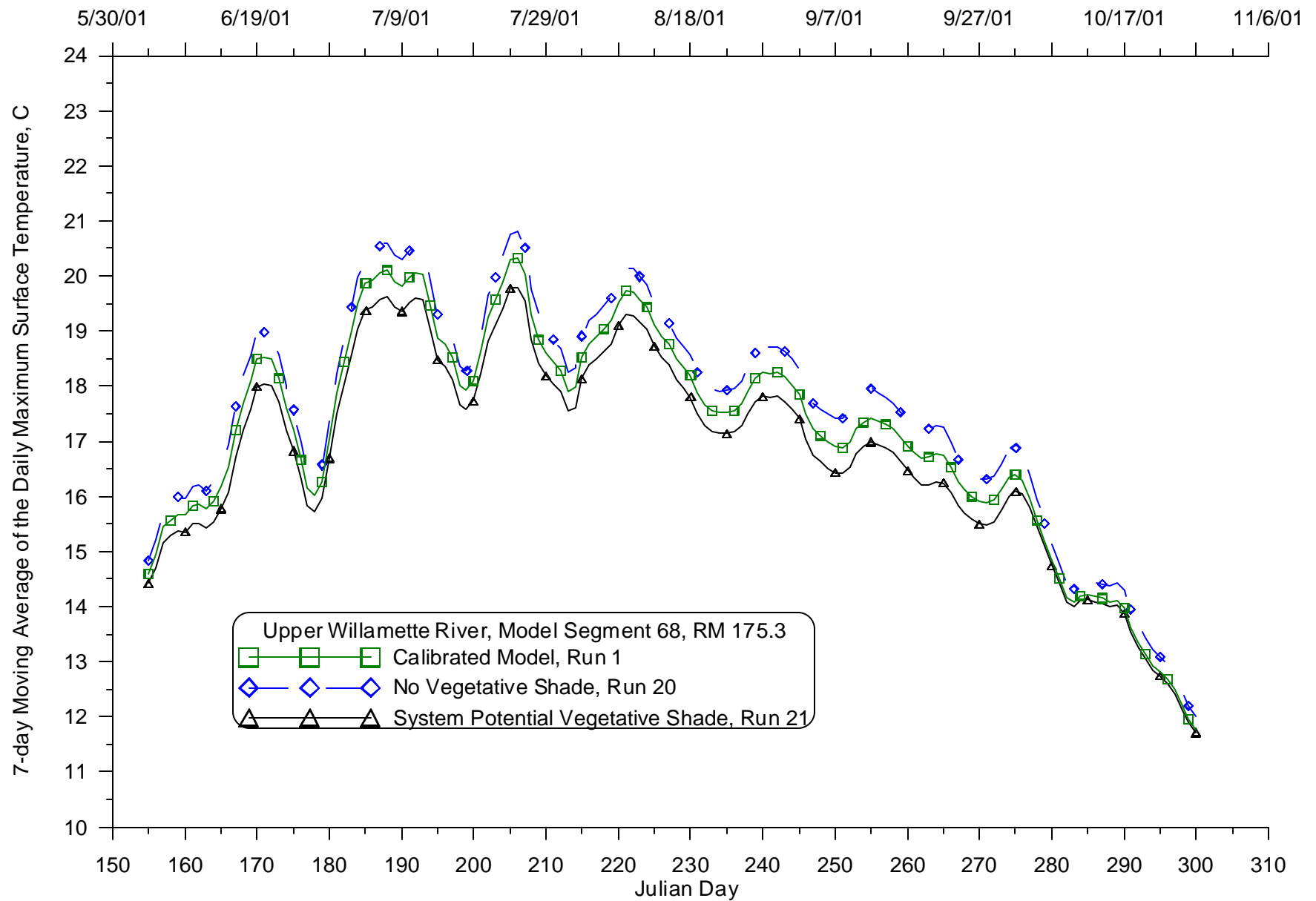


Figure 691: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 175.3

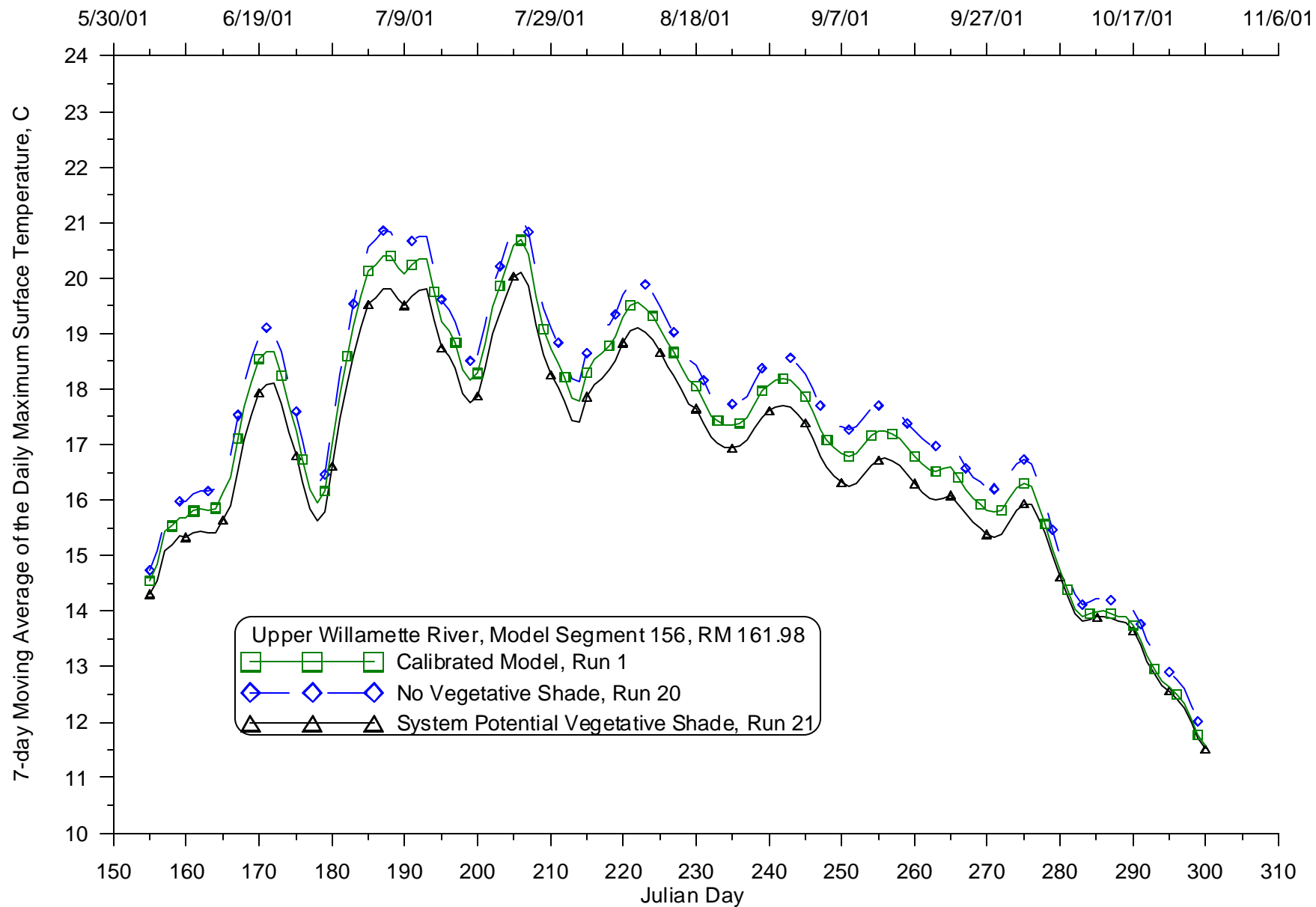


Figure 692: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 161.98

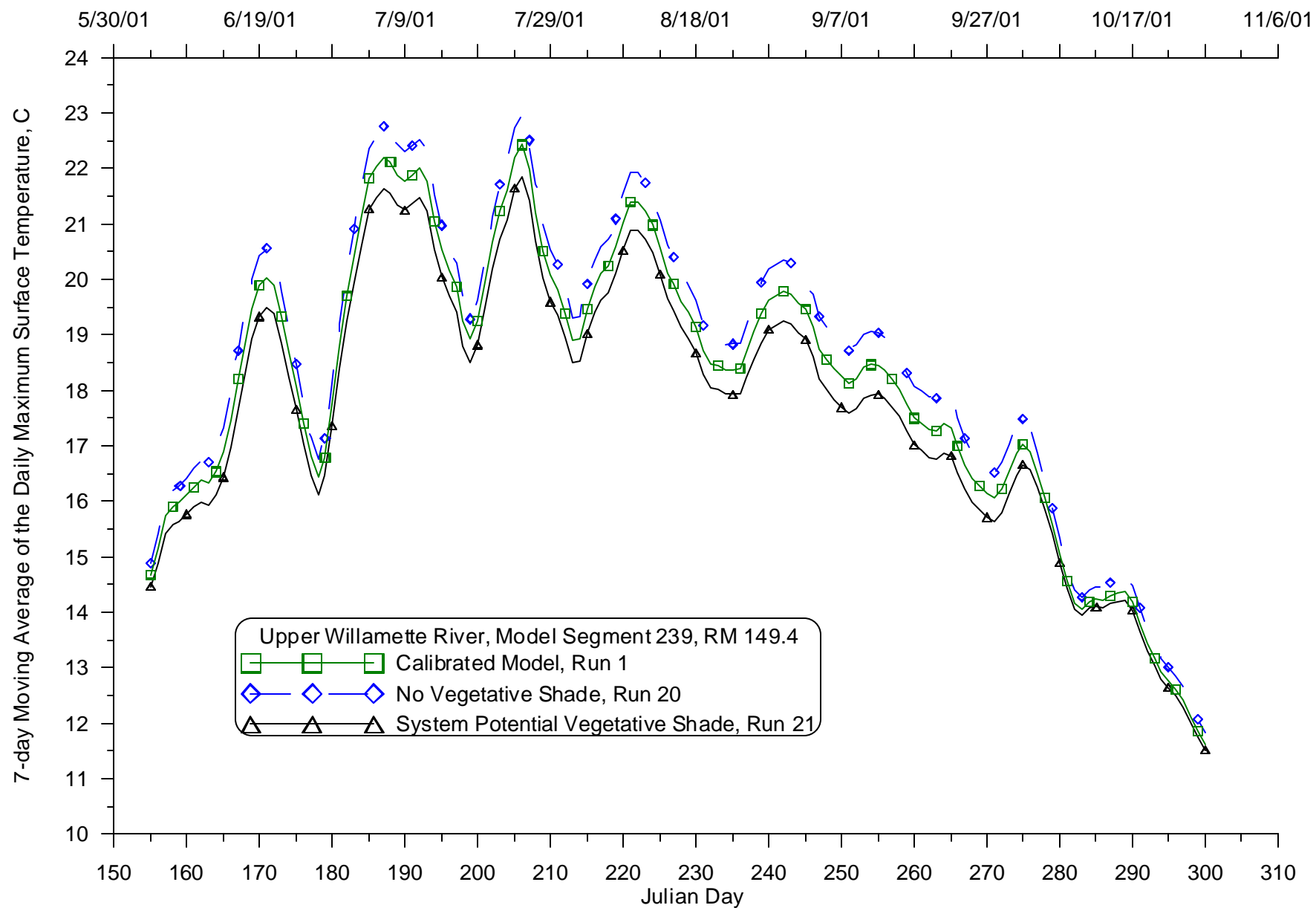


Figure 693: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 149.4

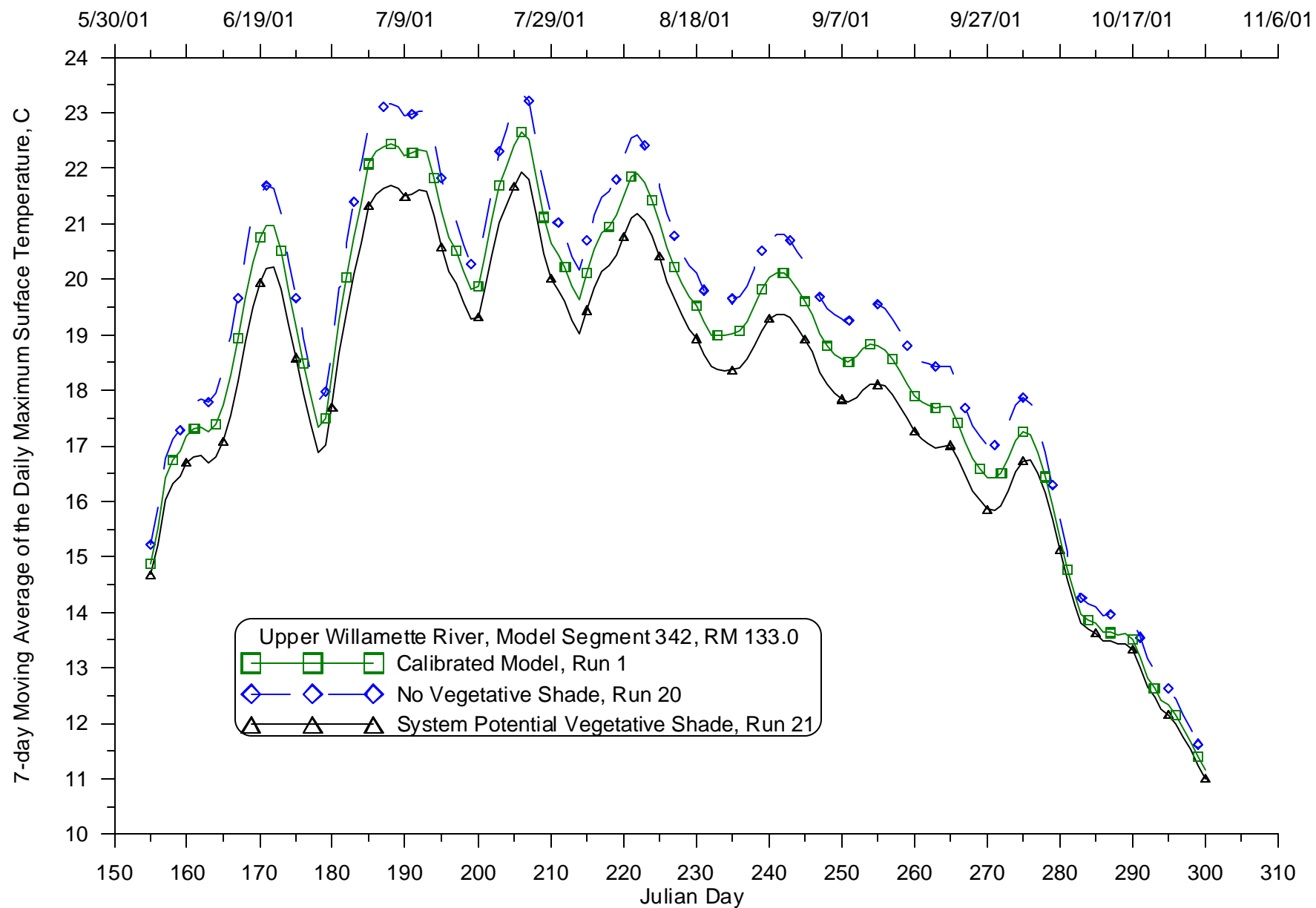
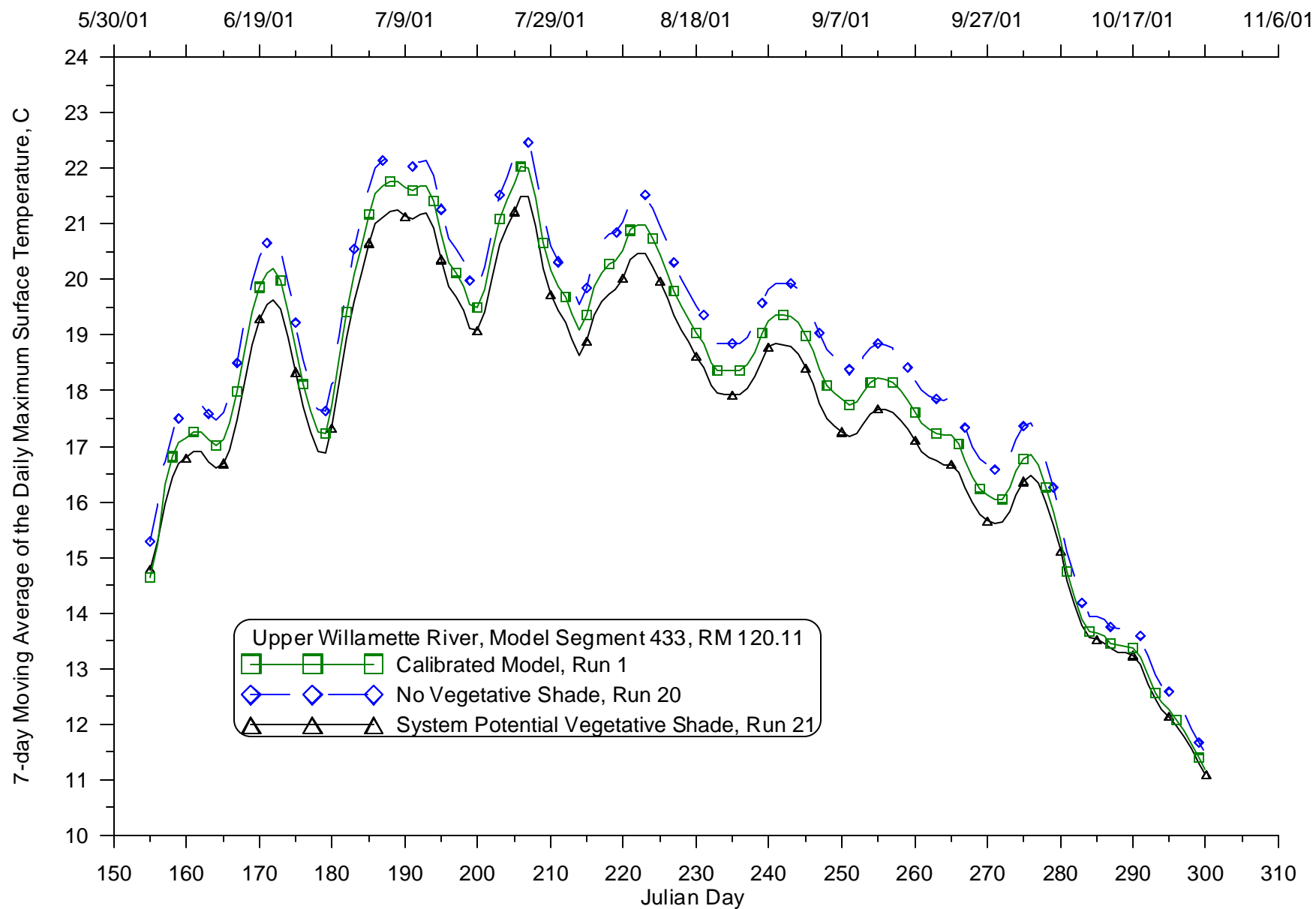


Figure 694: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 133





**Figure 695: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 120.11**

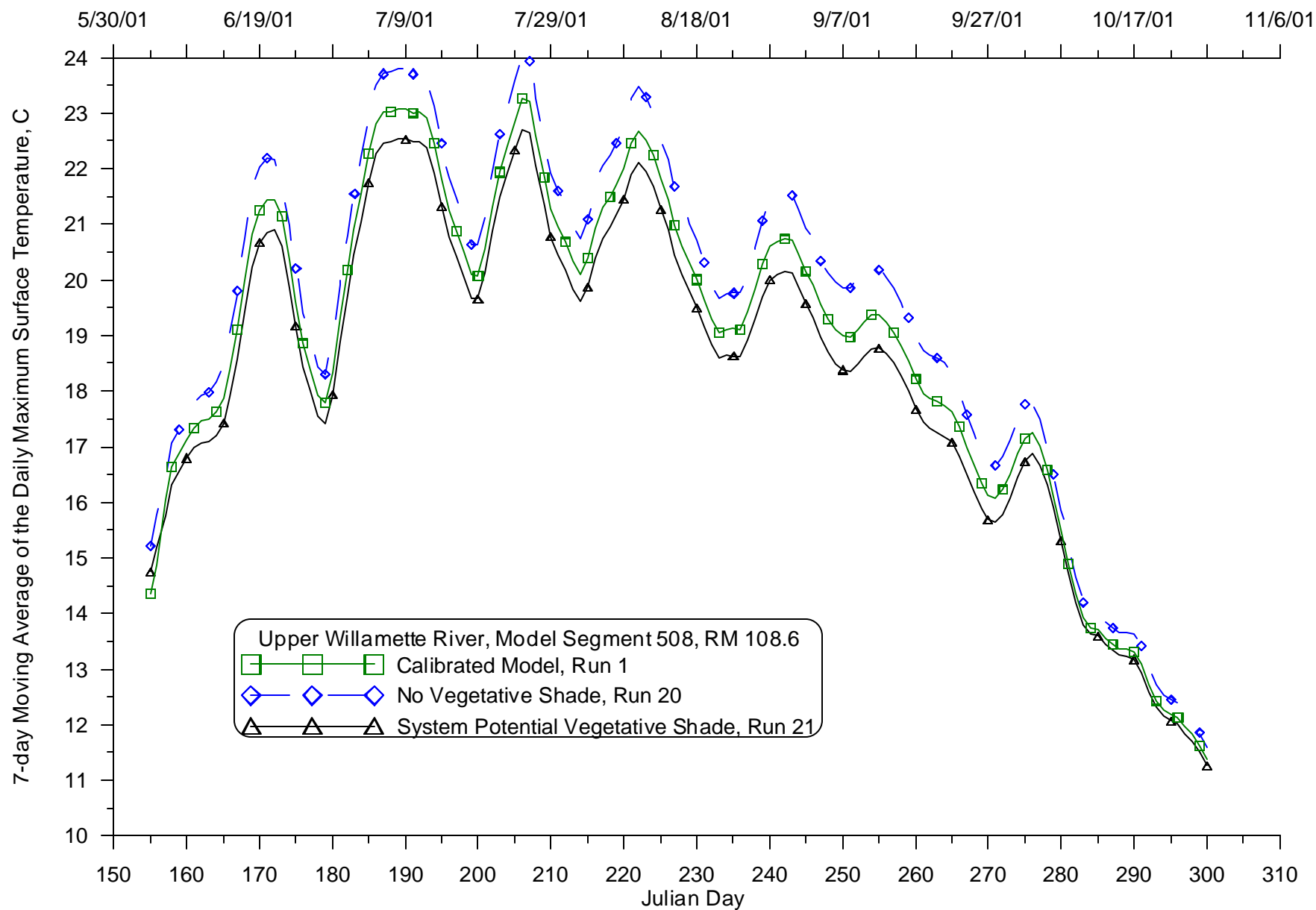
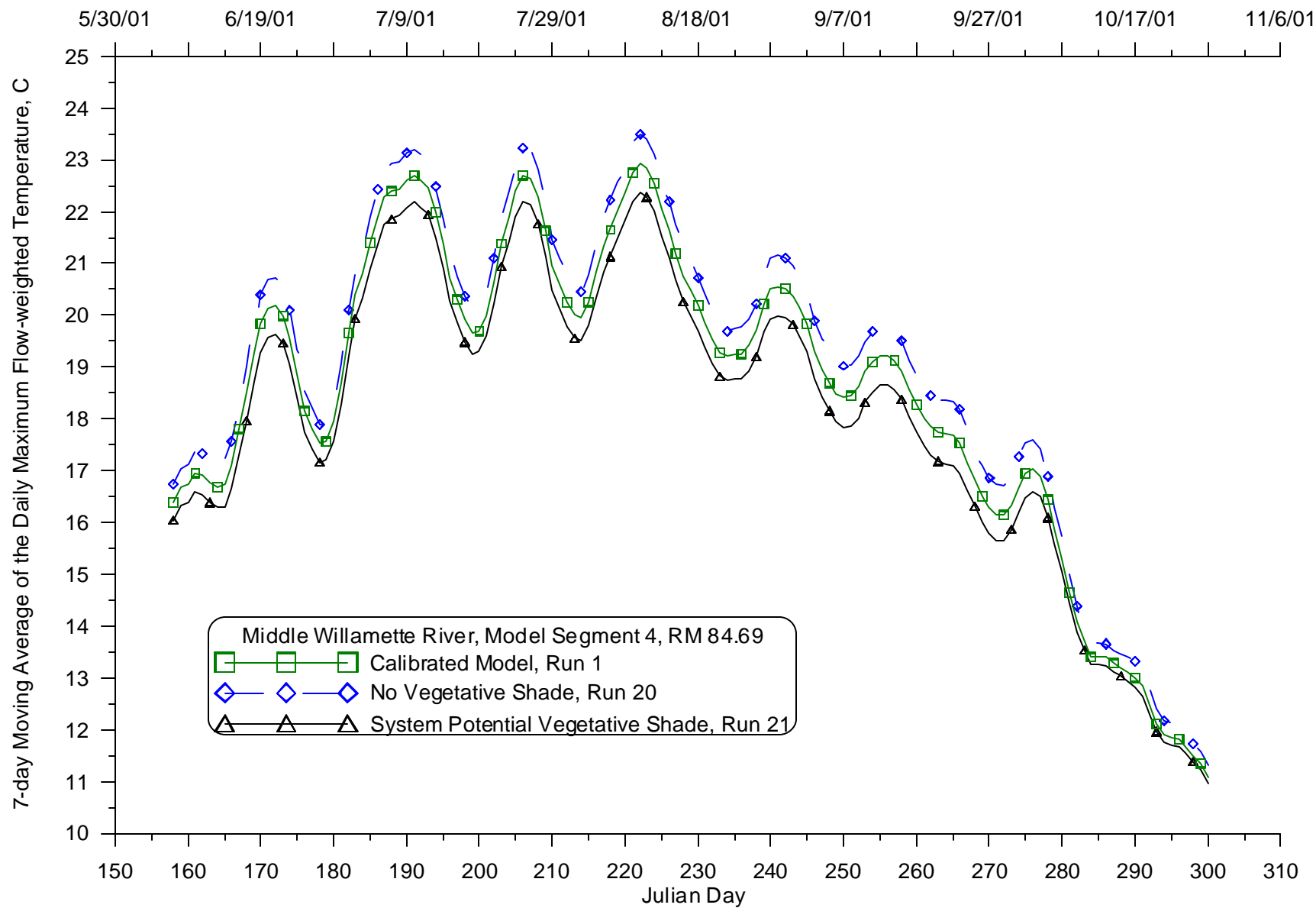


Figure 696: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 108.6



**Figure 697: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 84.69**

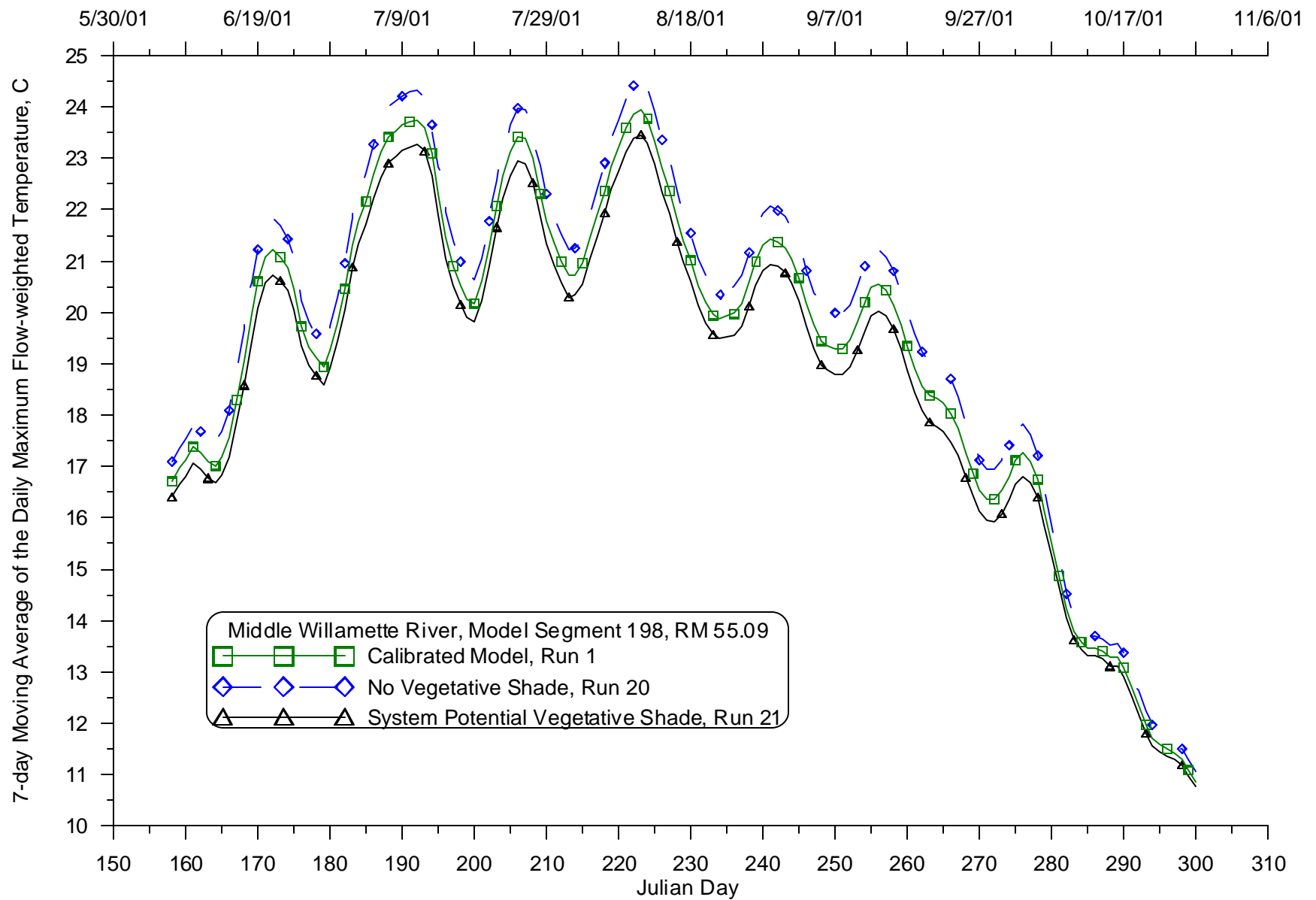


Figure 698: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 55.09

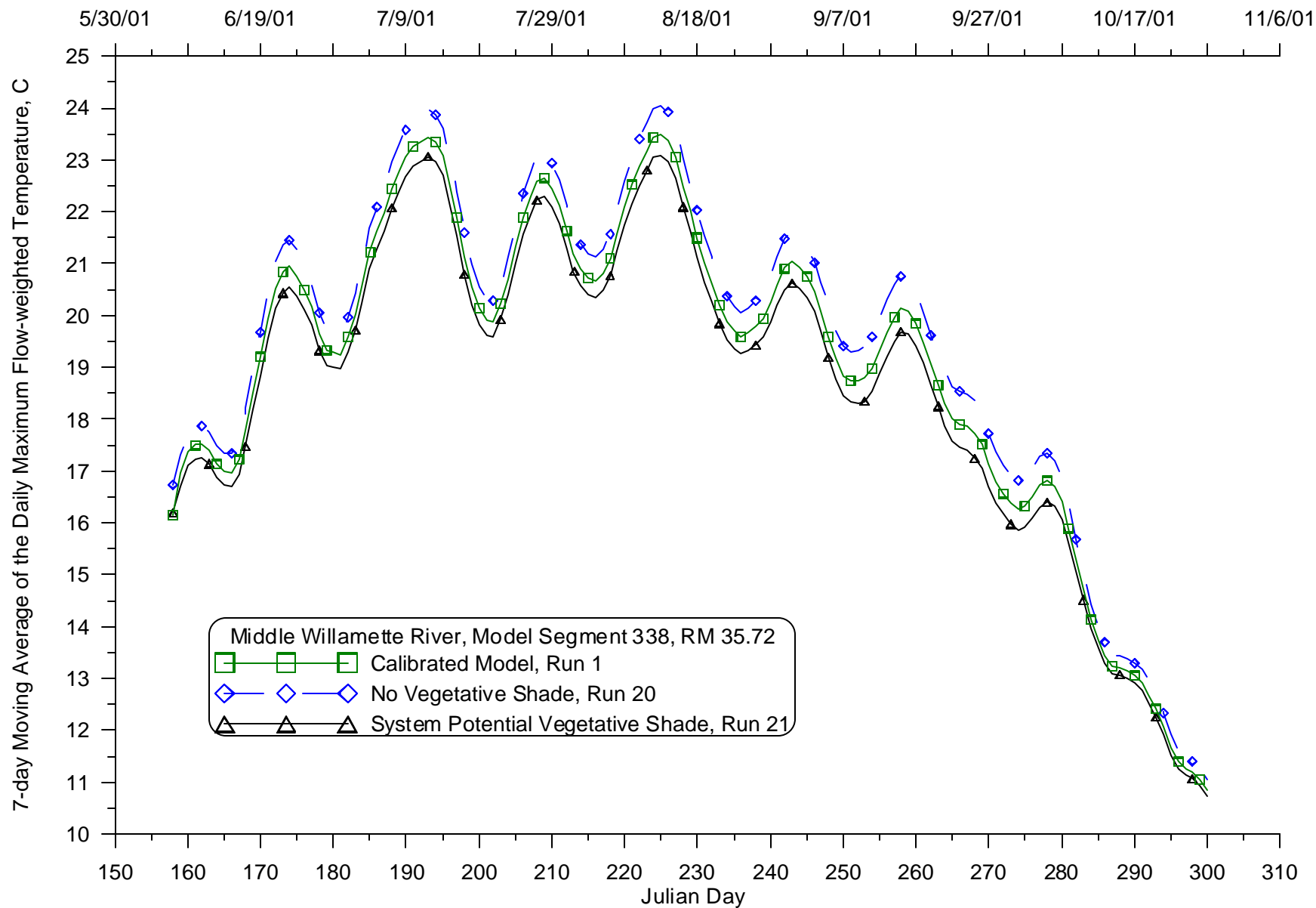


Figure 699: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 35.72

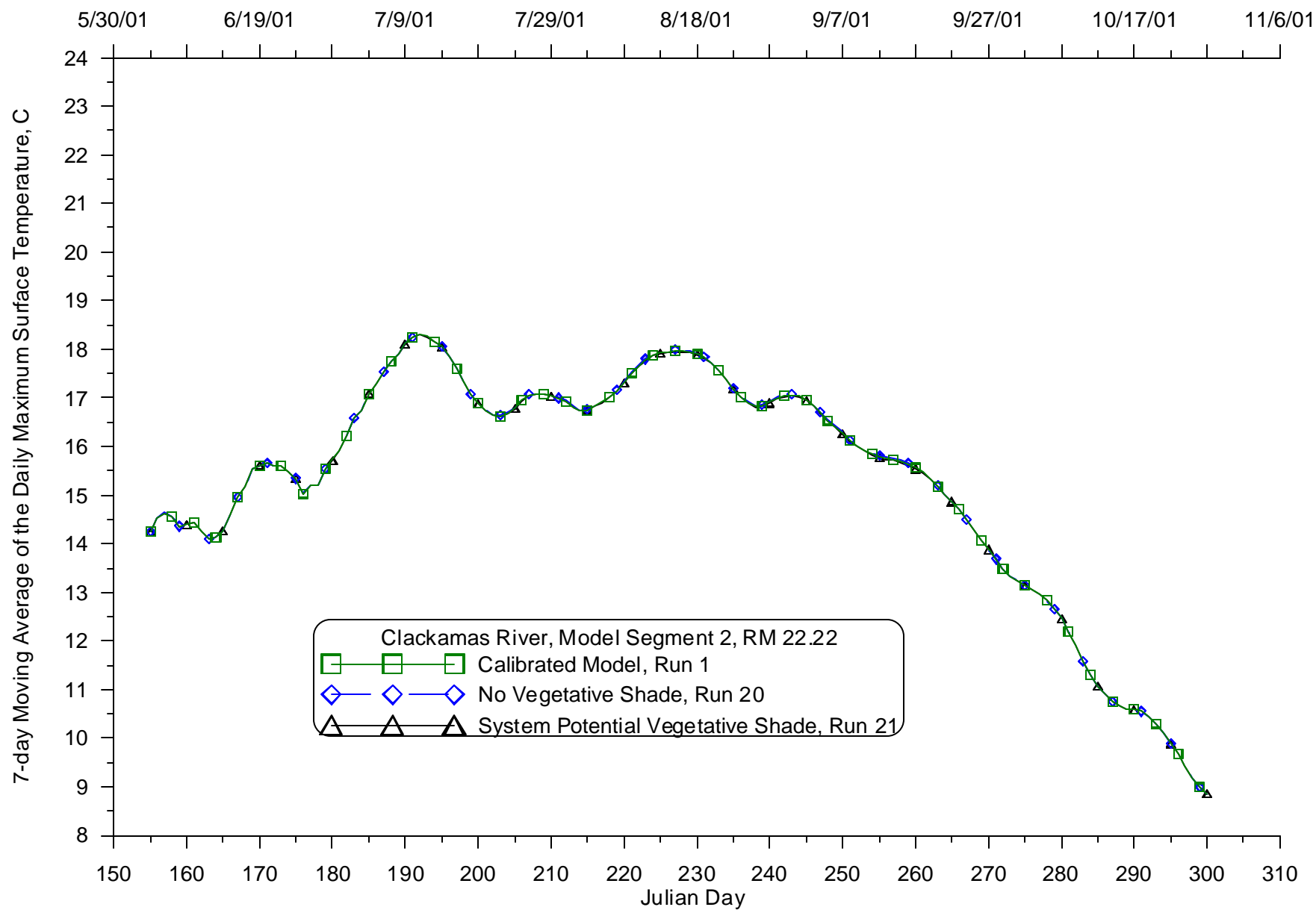


Figure 700: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Clackamas River at RM 22.22

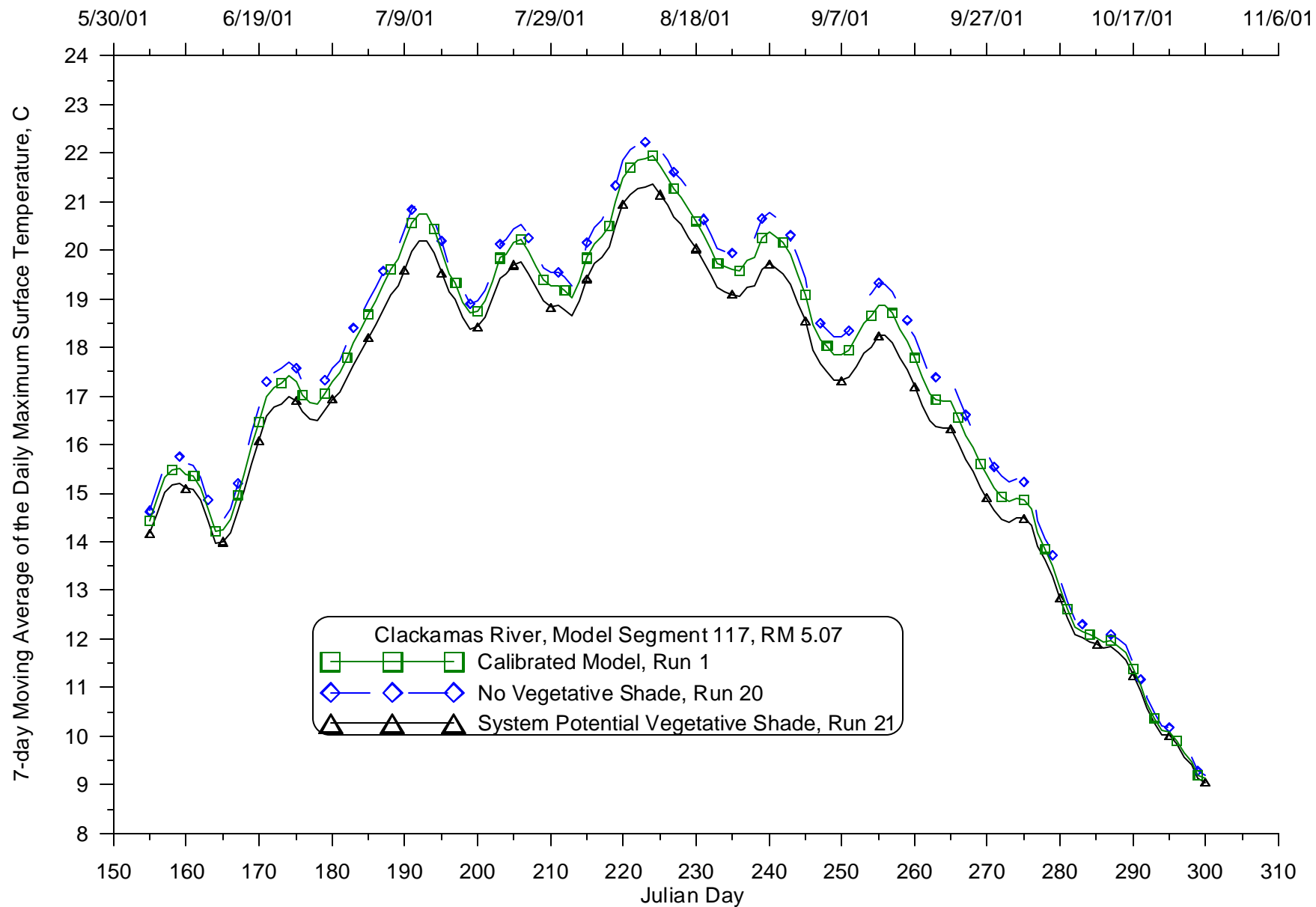
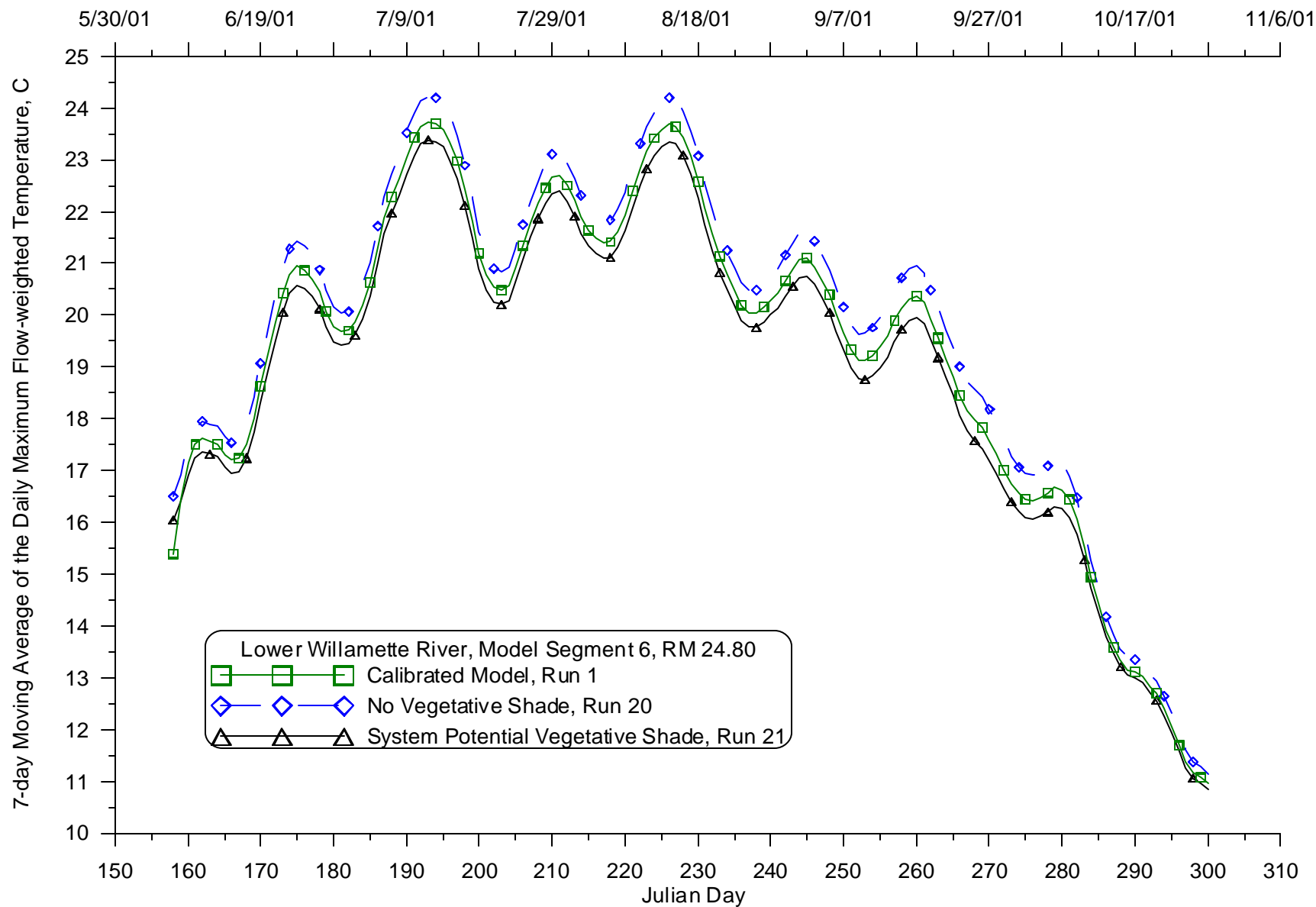


Figure 701: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Clackamas River at RM 5.07



**Figure 702: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 24.8**



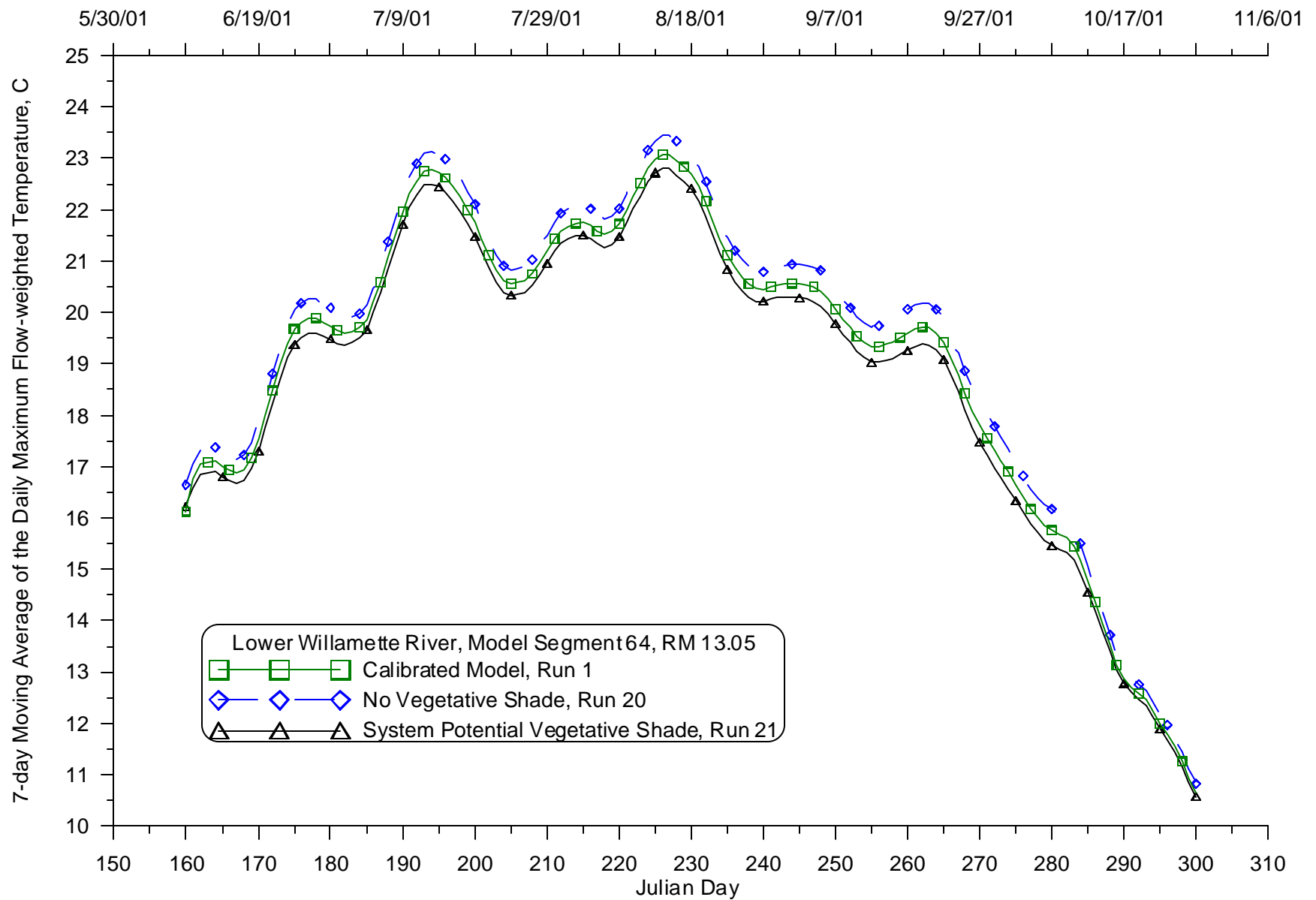


Figure 703: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 13.05

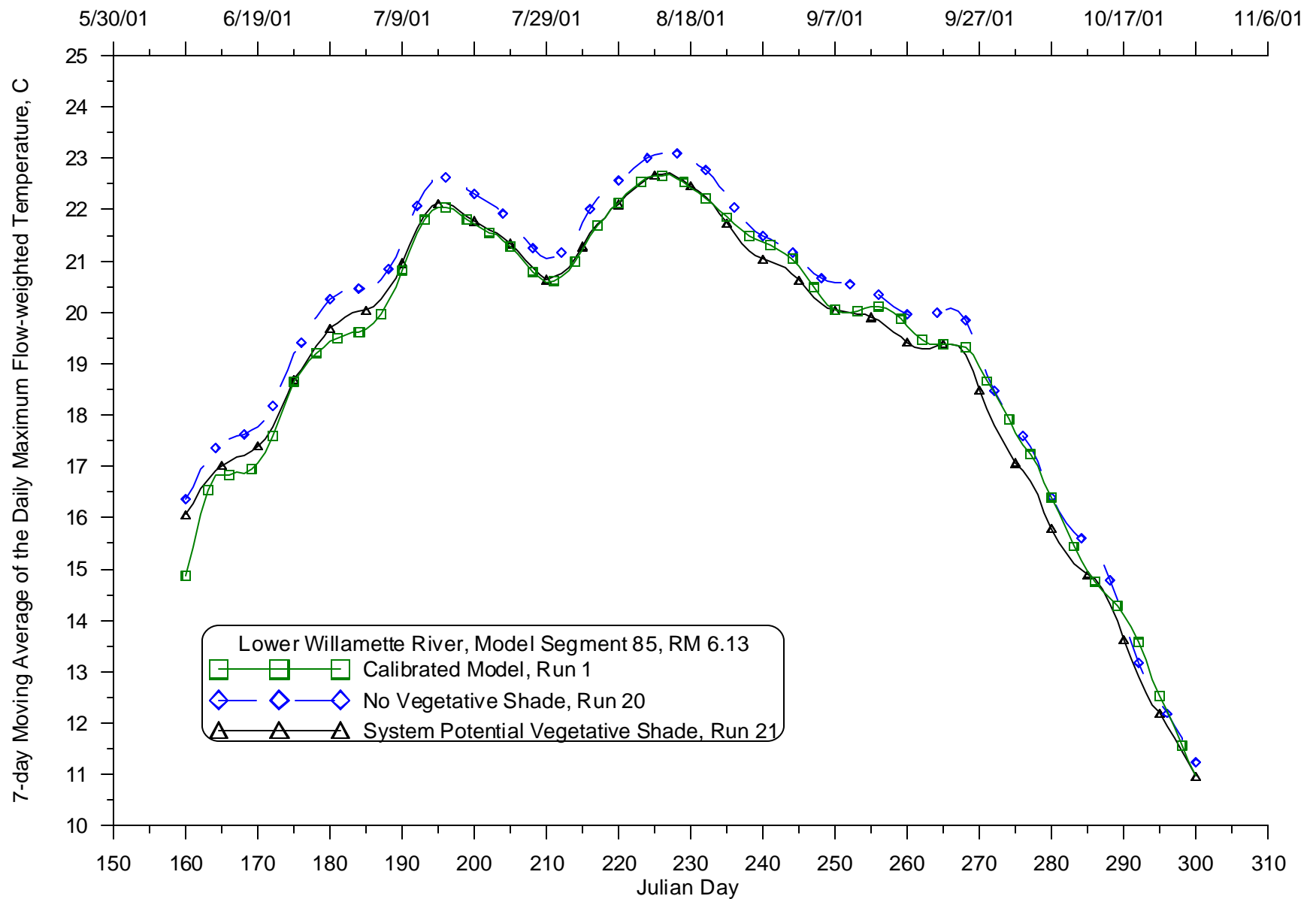


Figure 704: Calibrated model compared with varying vegetative shade, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 6.13

**Daily seven day average flow**

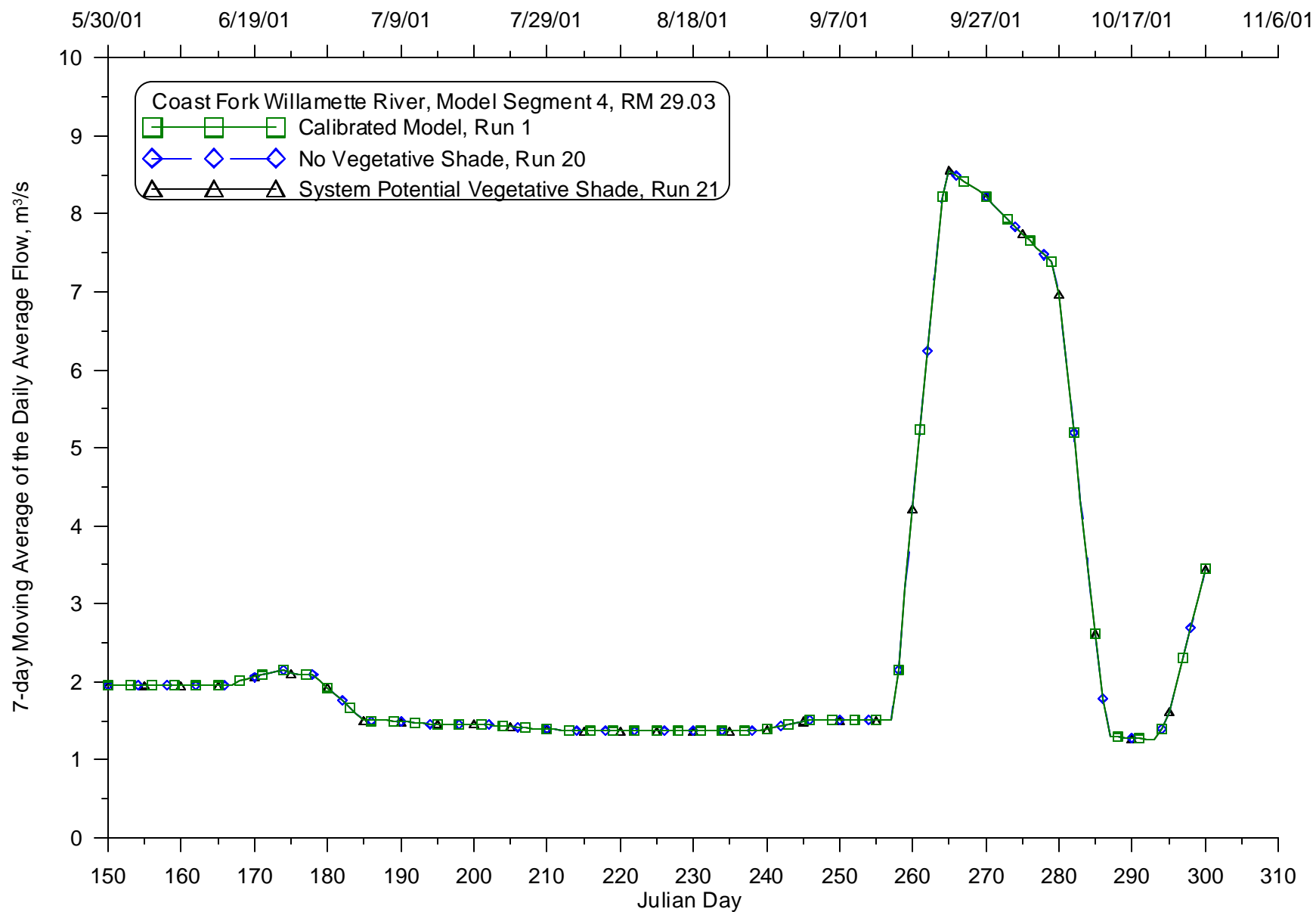


Figure 705: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 29.03

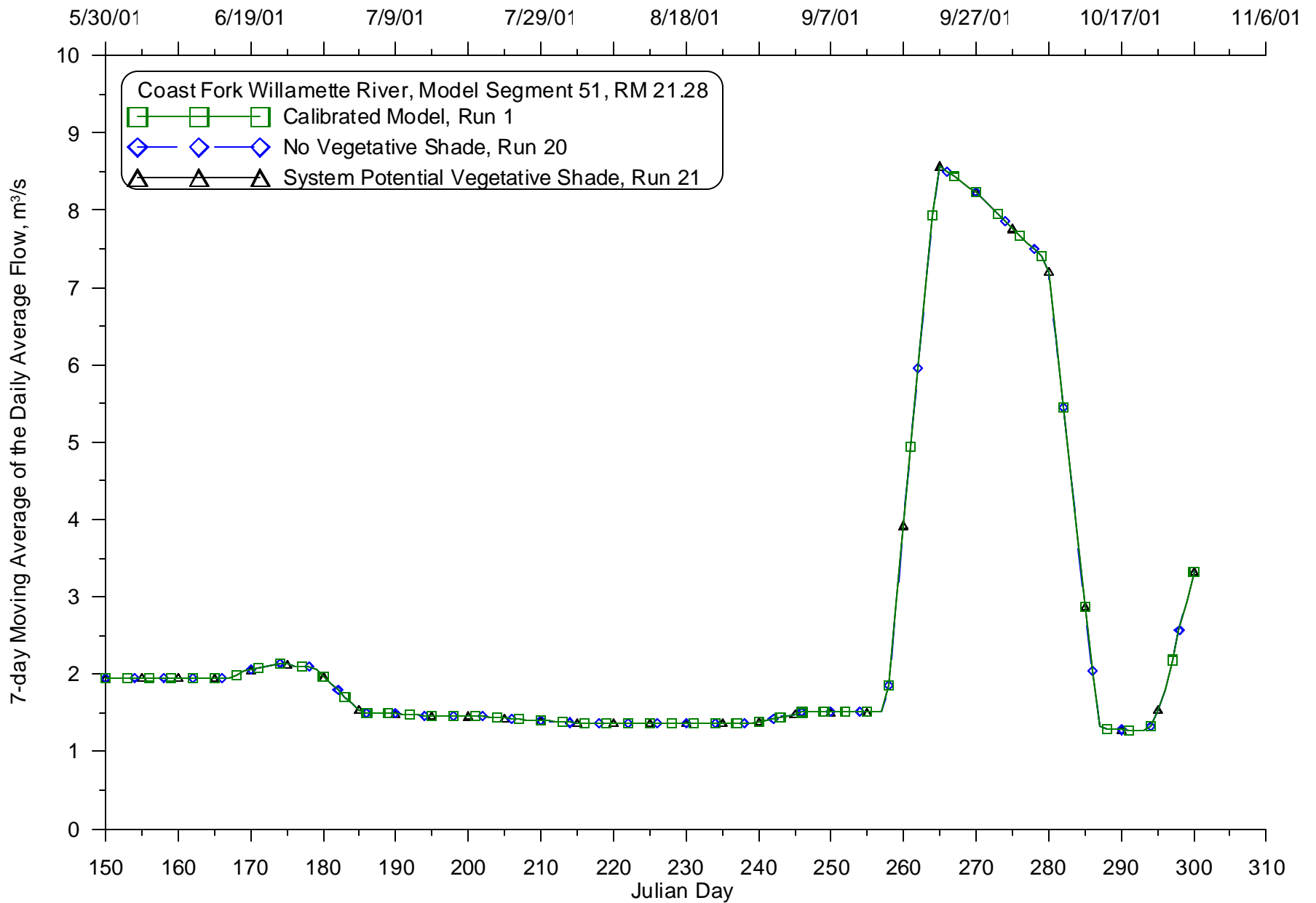


Figure 706: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 21.28

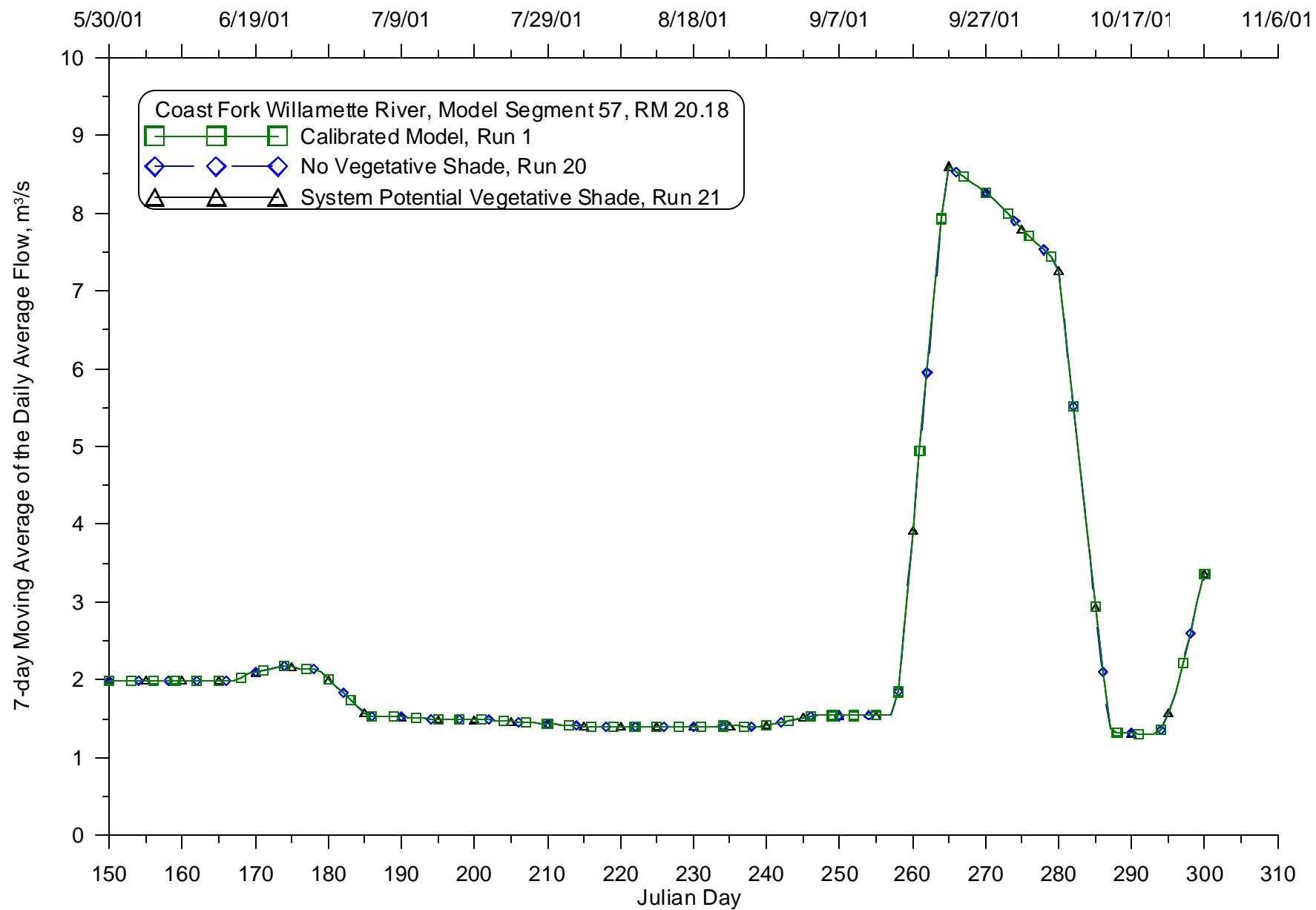


Figure 707: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 20.18

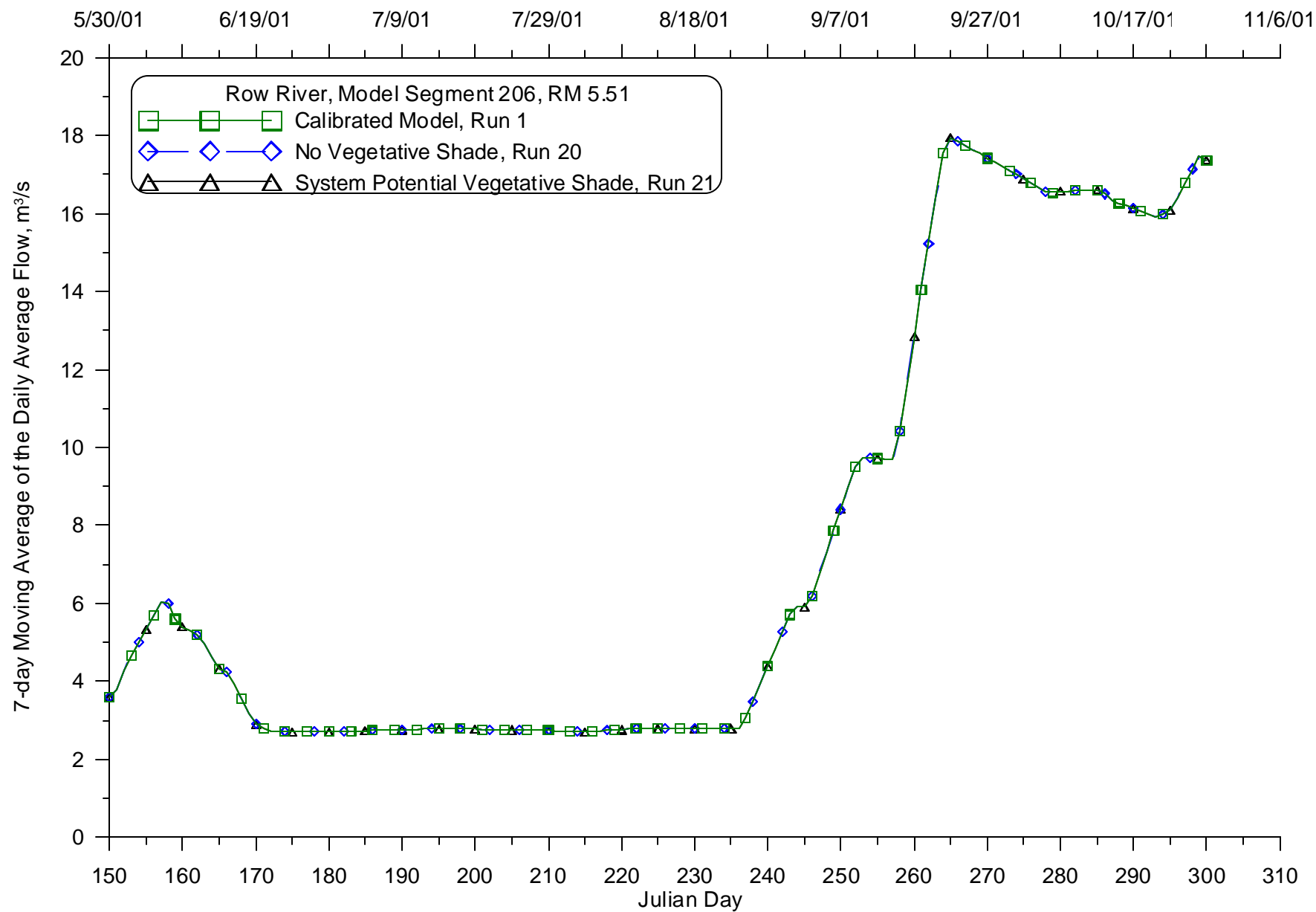
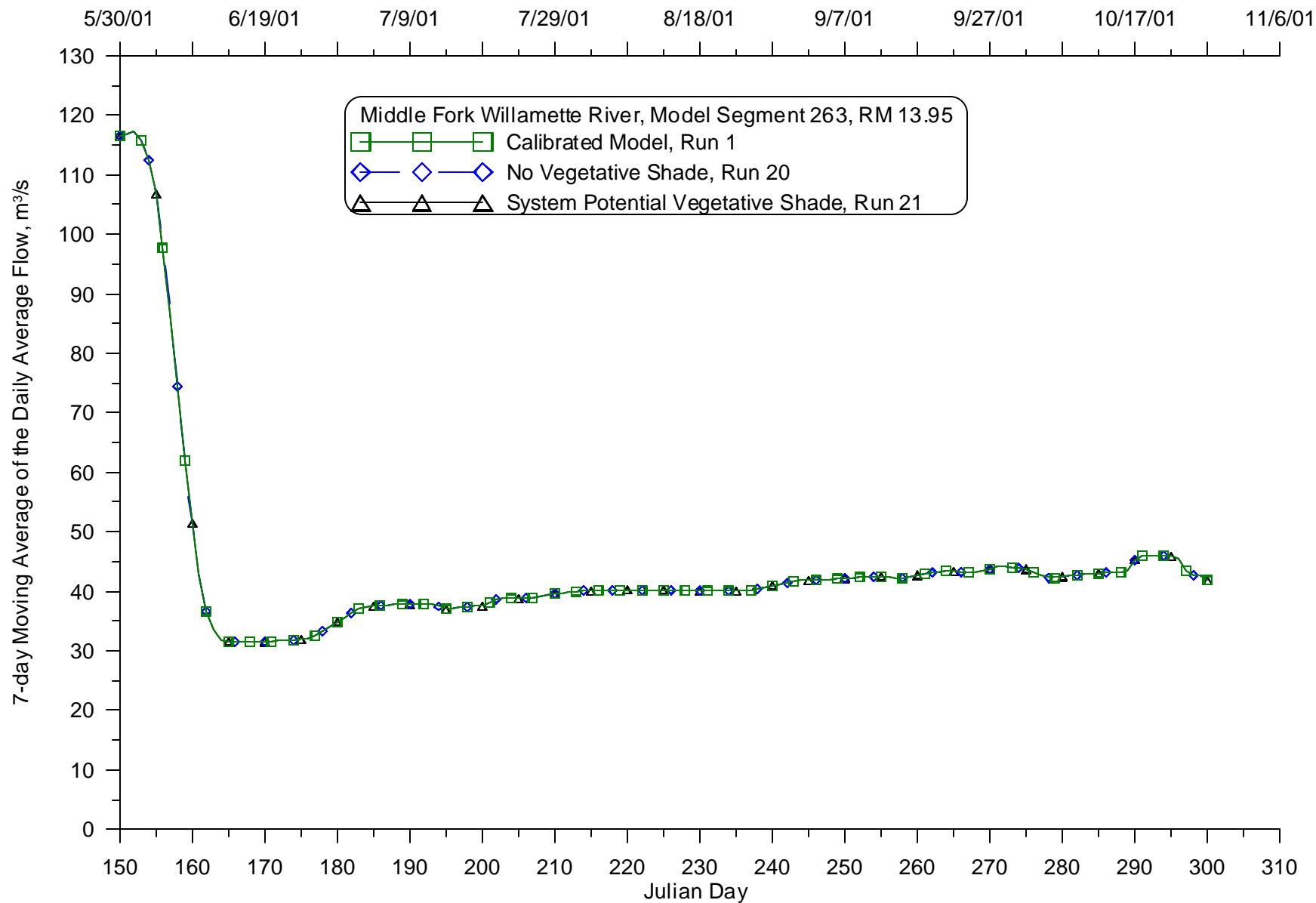


Figure 708: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Row River at RM 5.51



**Figure 709: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Middle Fork Willamette River at RM 13.95**



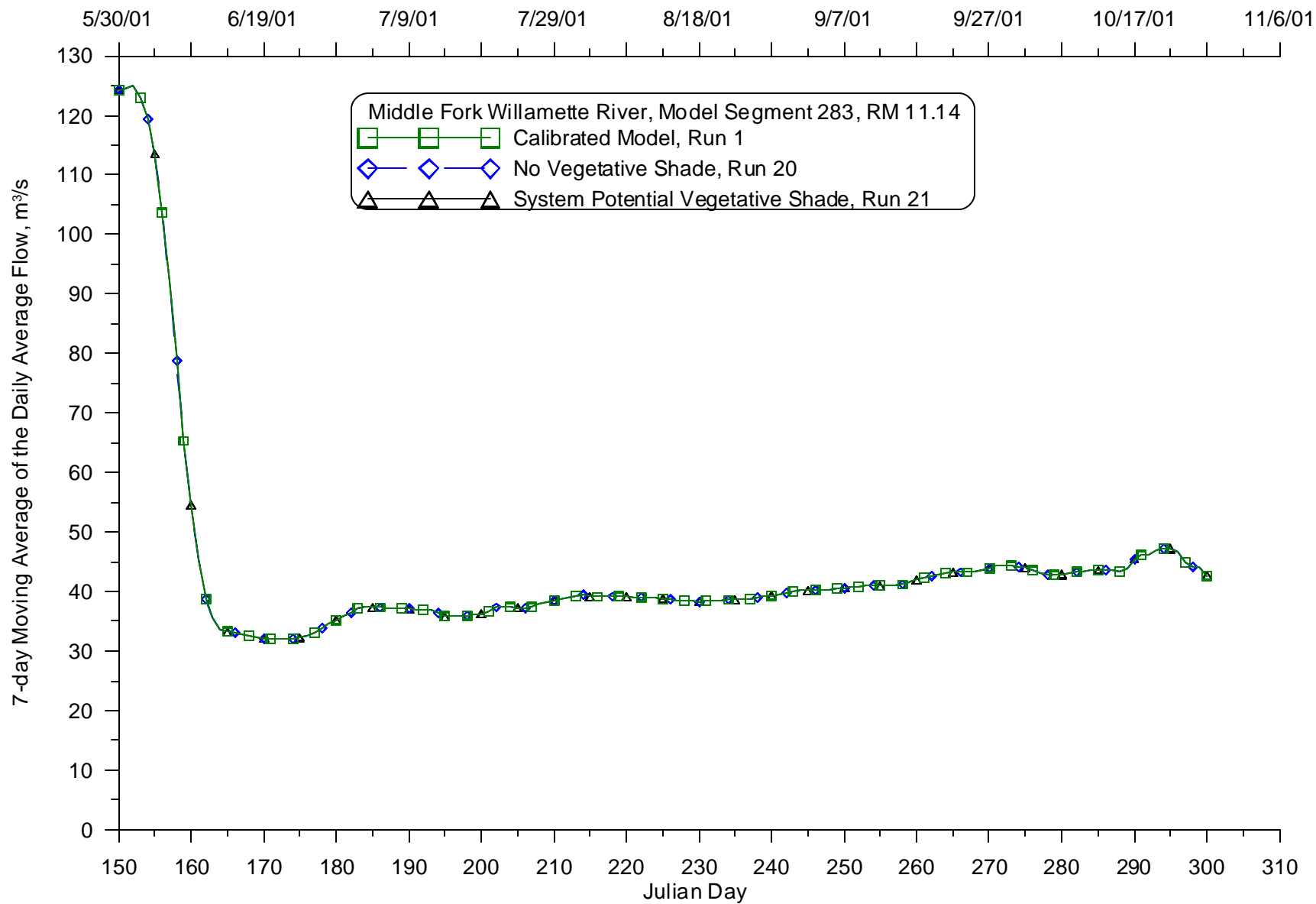


Figure 710: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Middle Fork Willamette River at RM 11.14

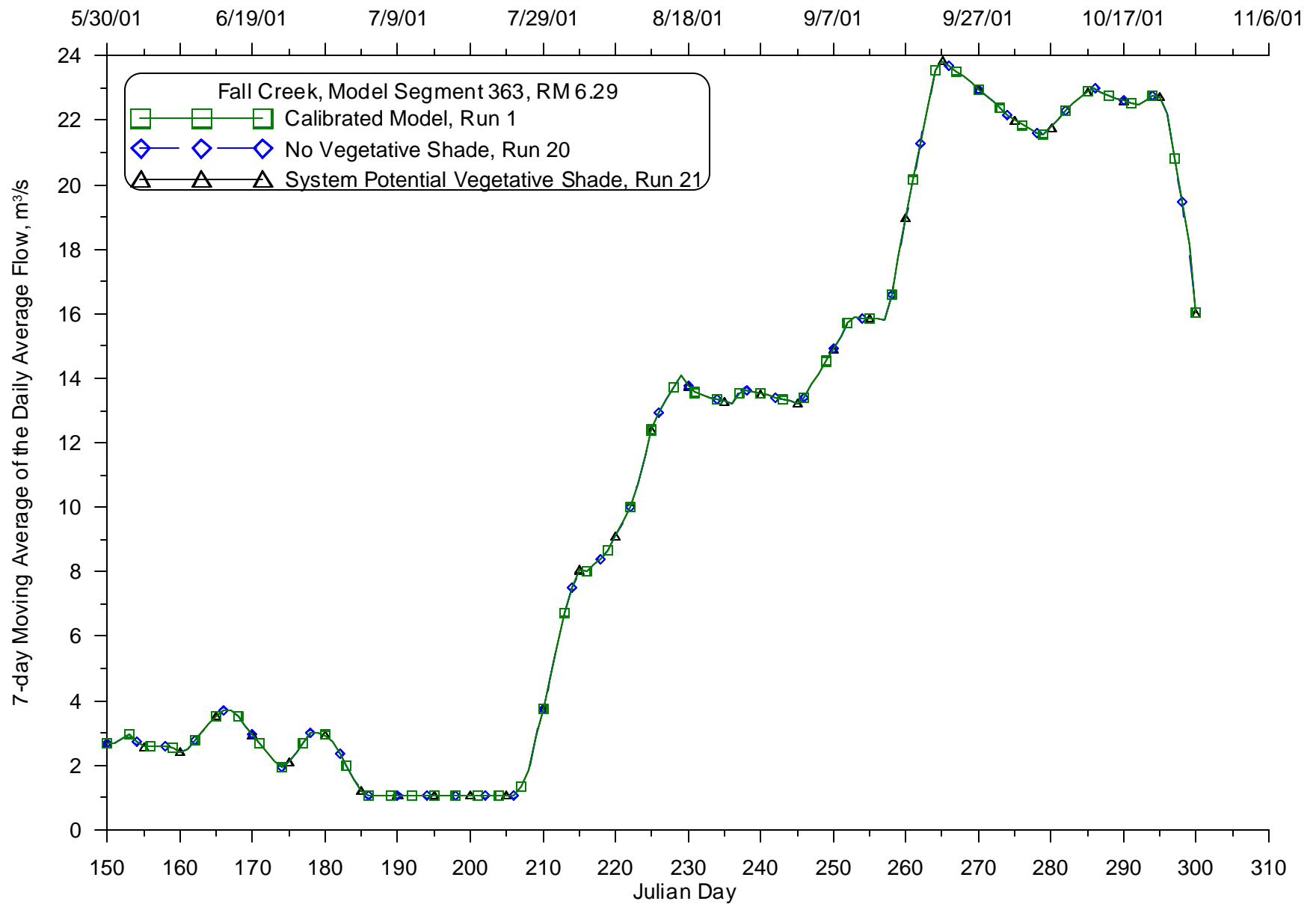


Figure 711: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for Fall Creek at RM 6.29

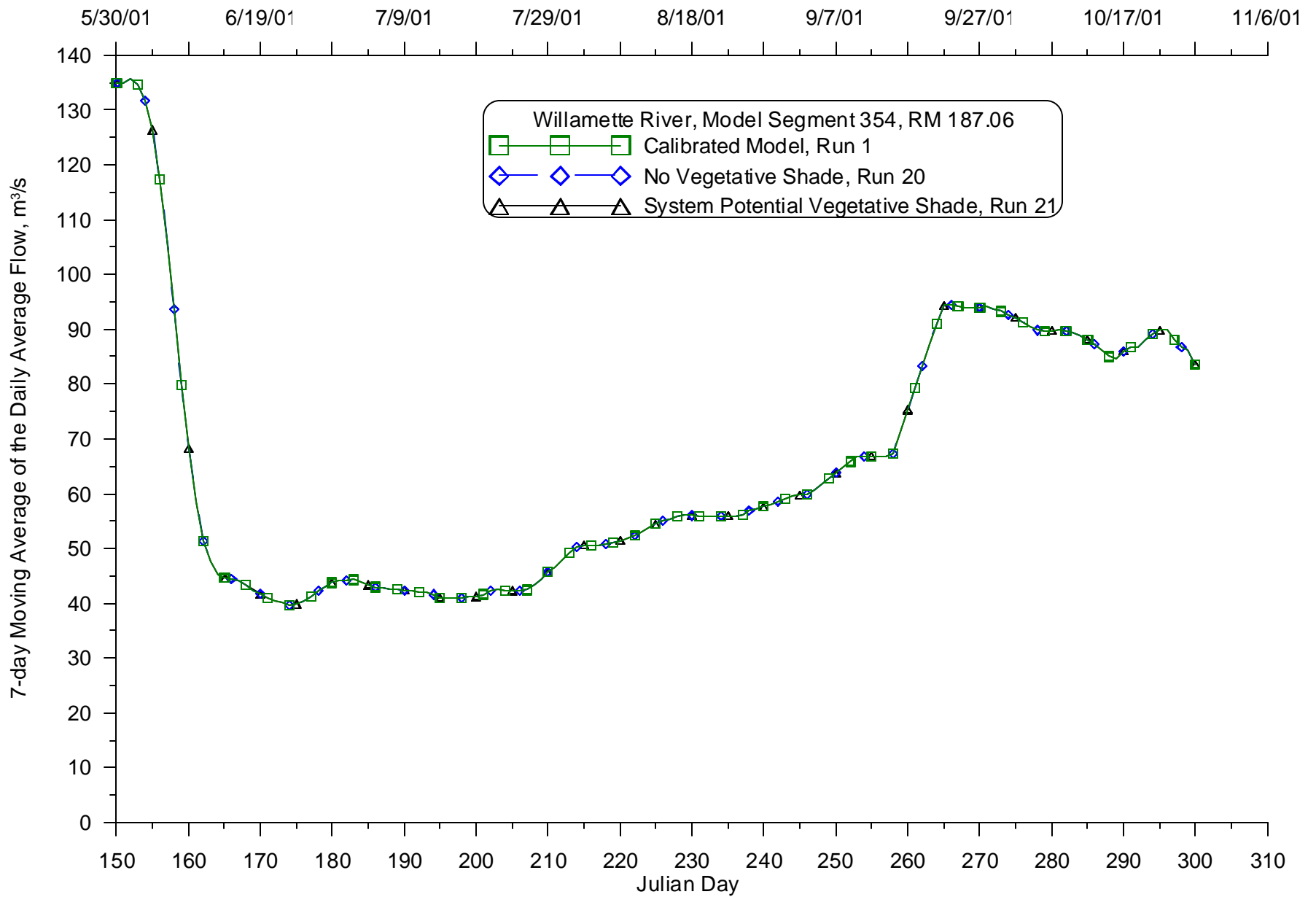


Figure 712: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 187.06

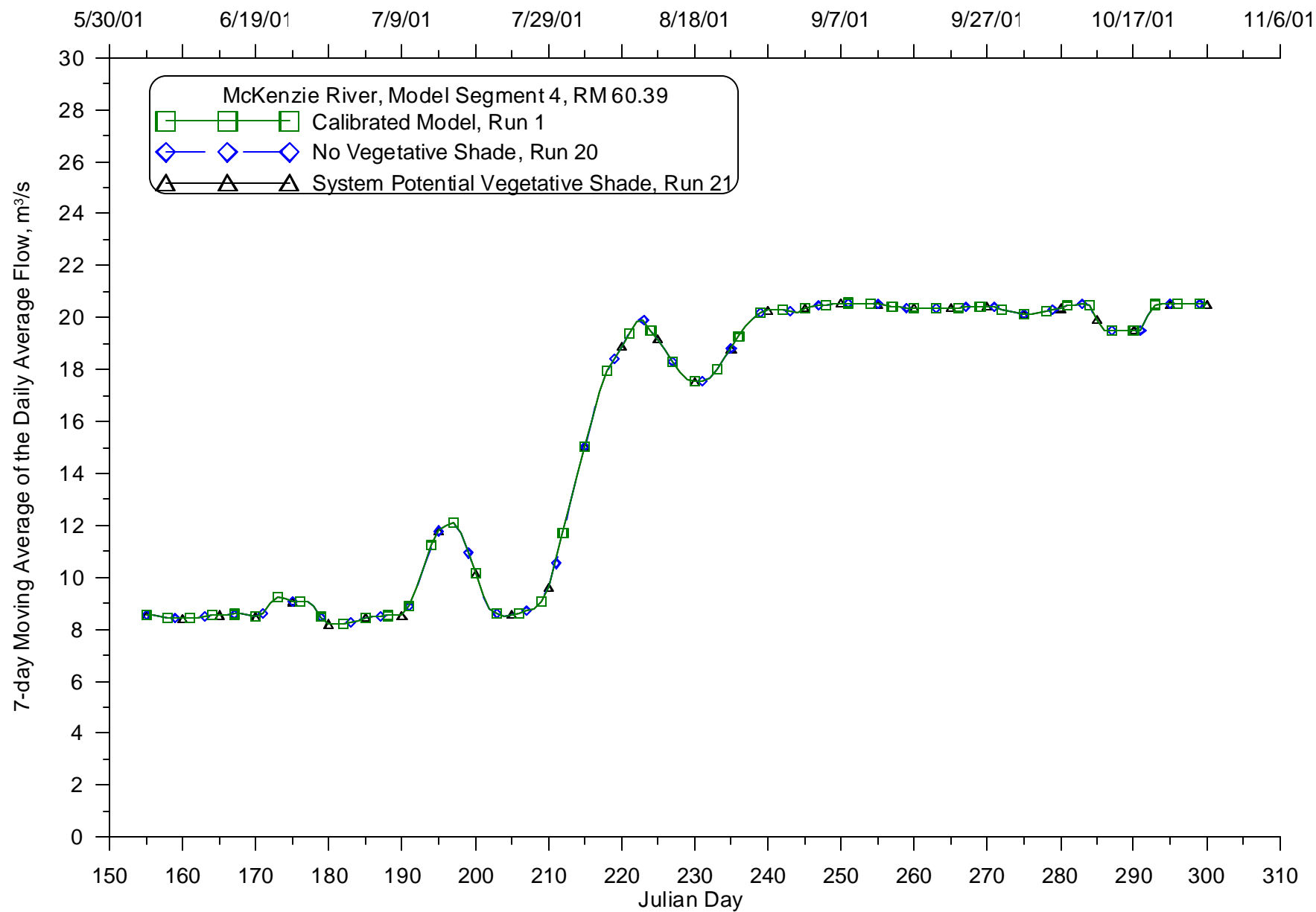


Figure 713: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the McKenzie River at RM 60.39

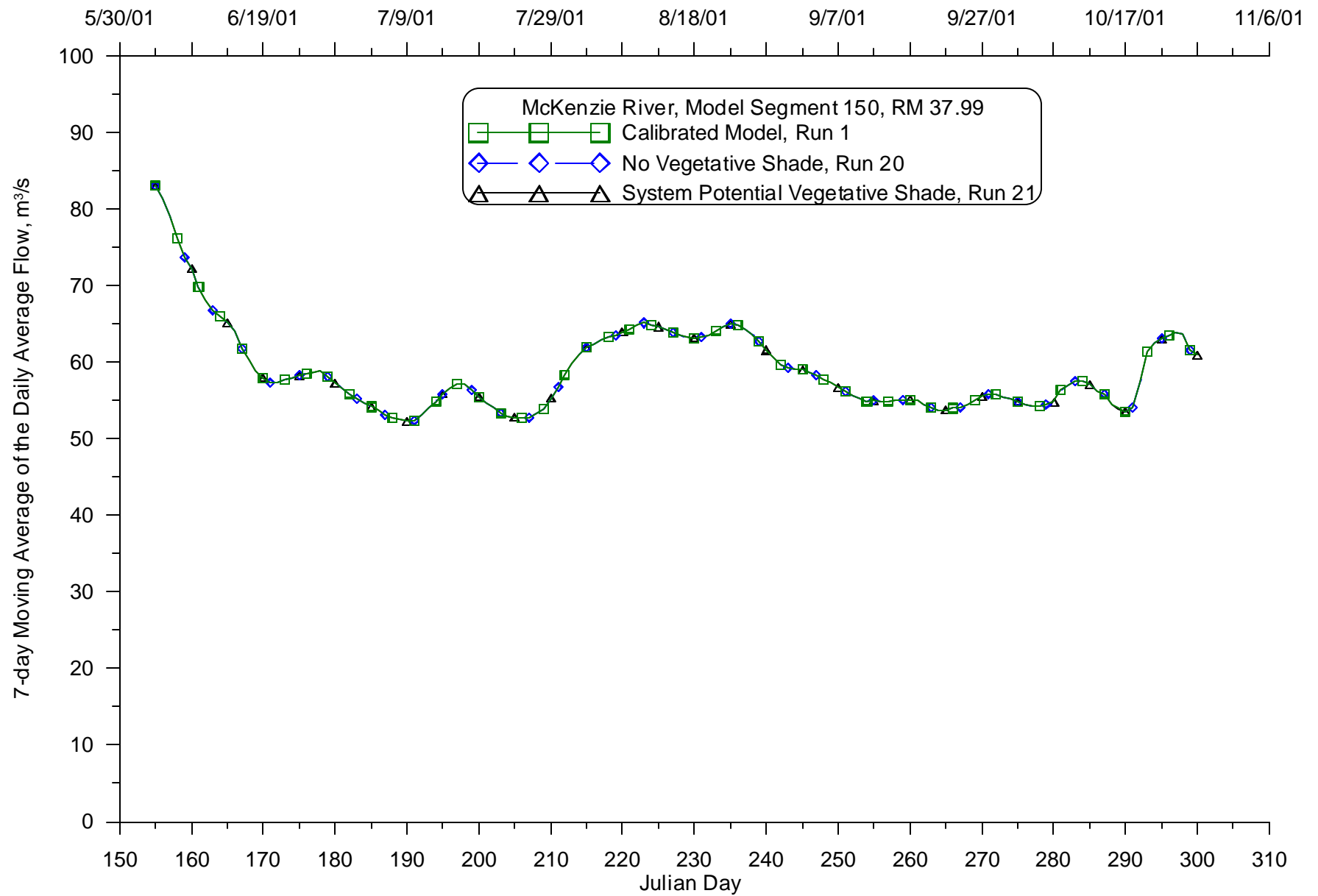


Figure 714: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the McKenzie River at RM 37.99

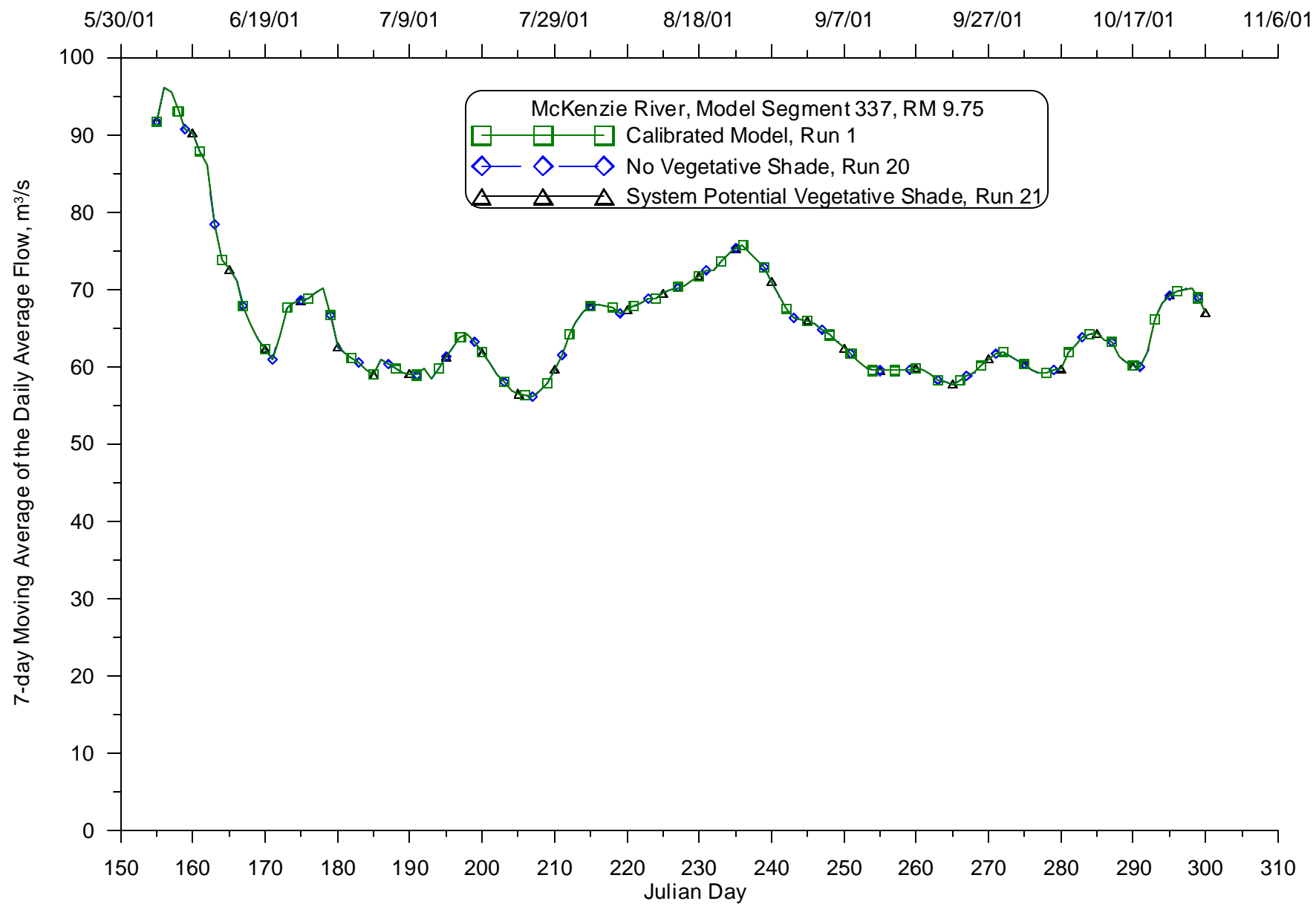


Figure 715: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the McKenzie River at RM 9.75

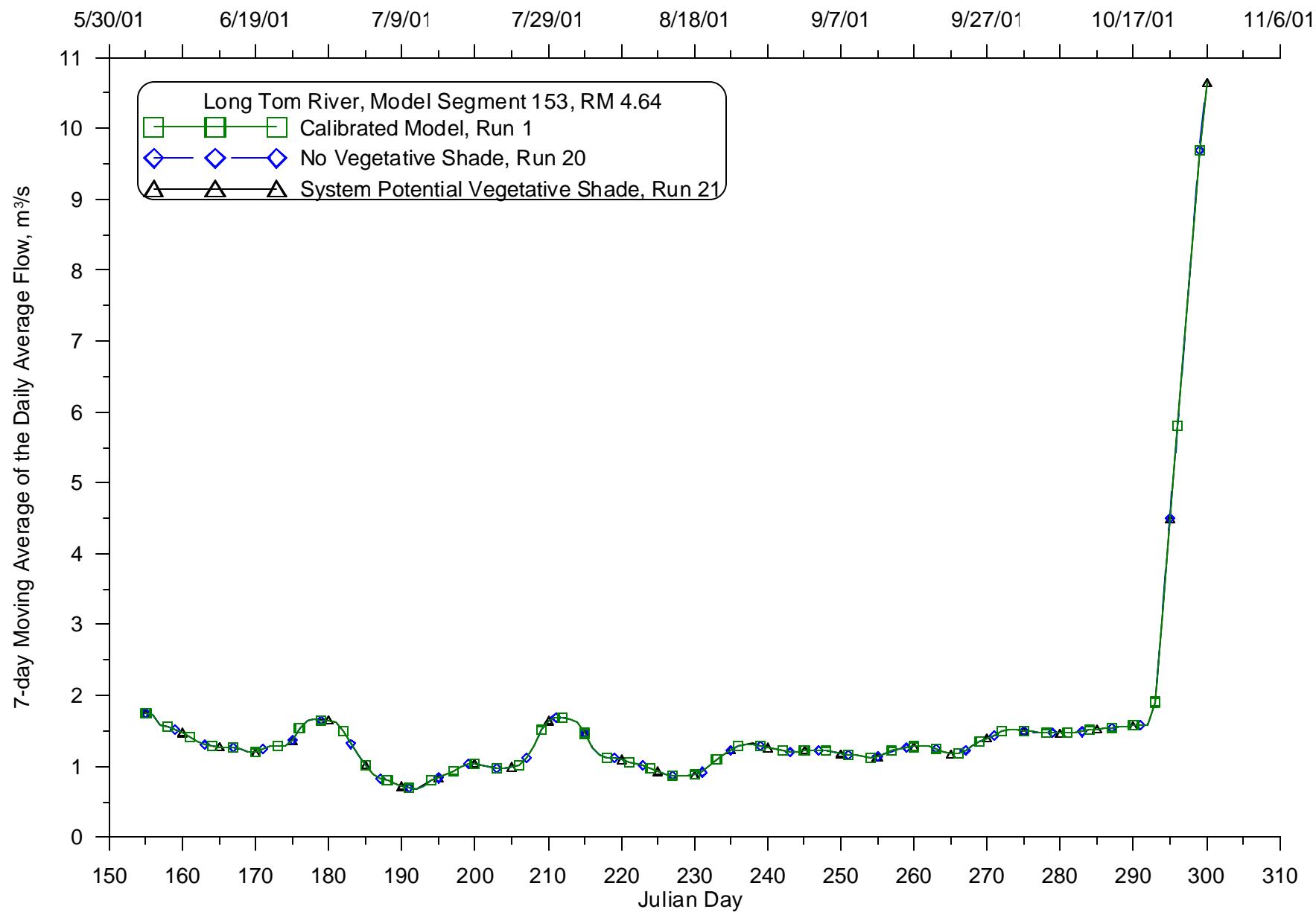


Figure 716: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Long Tom River at RM 4.64

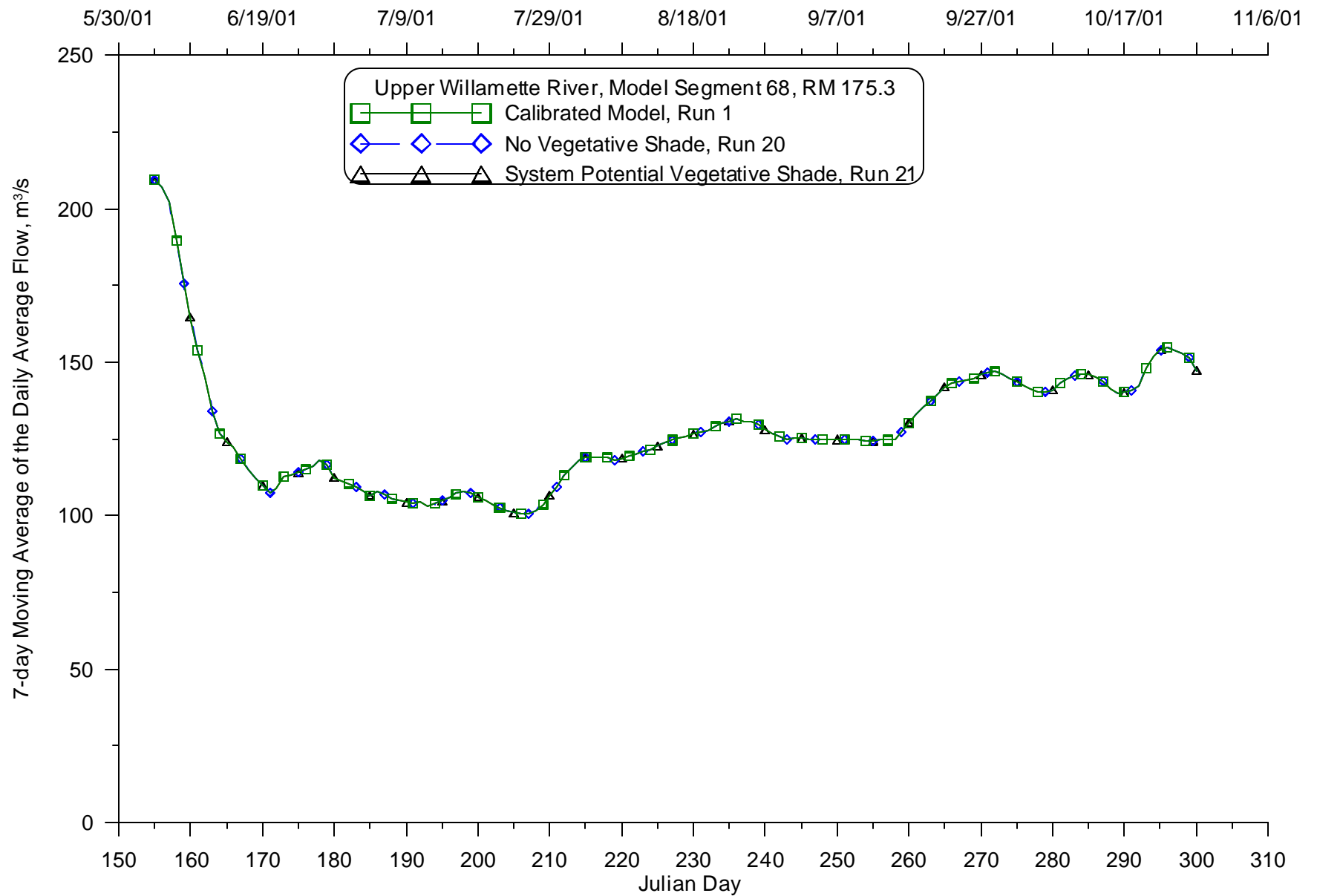


Figure 717: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 175.3



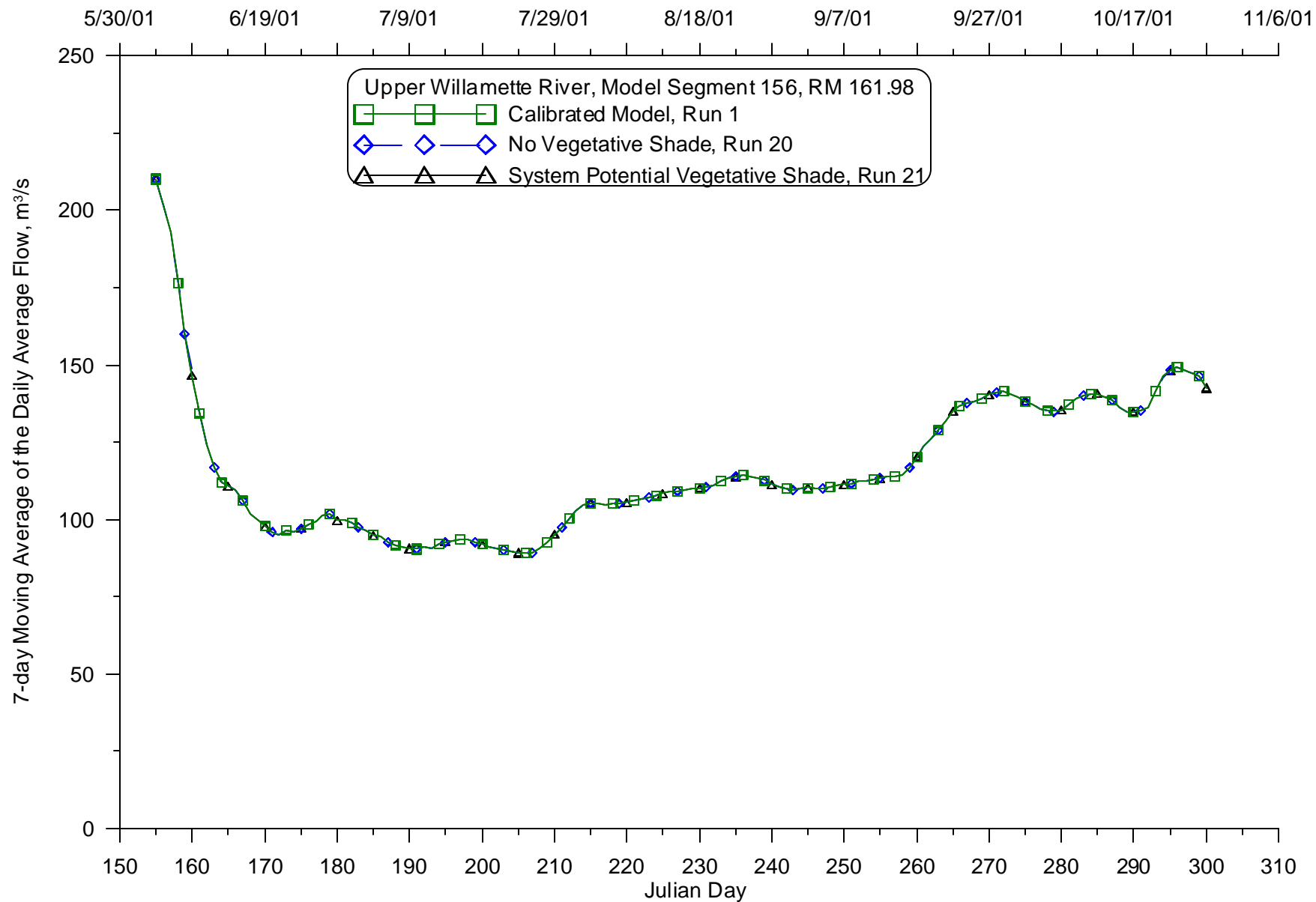


Figure 718: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 161.98

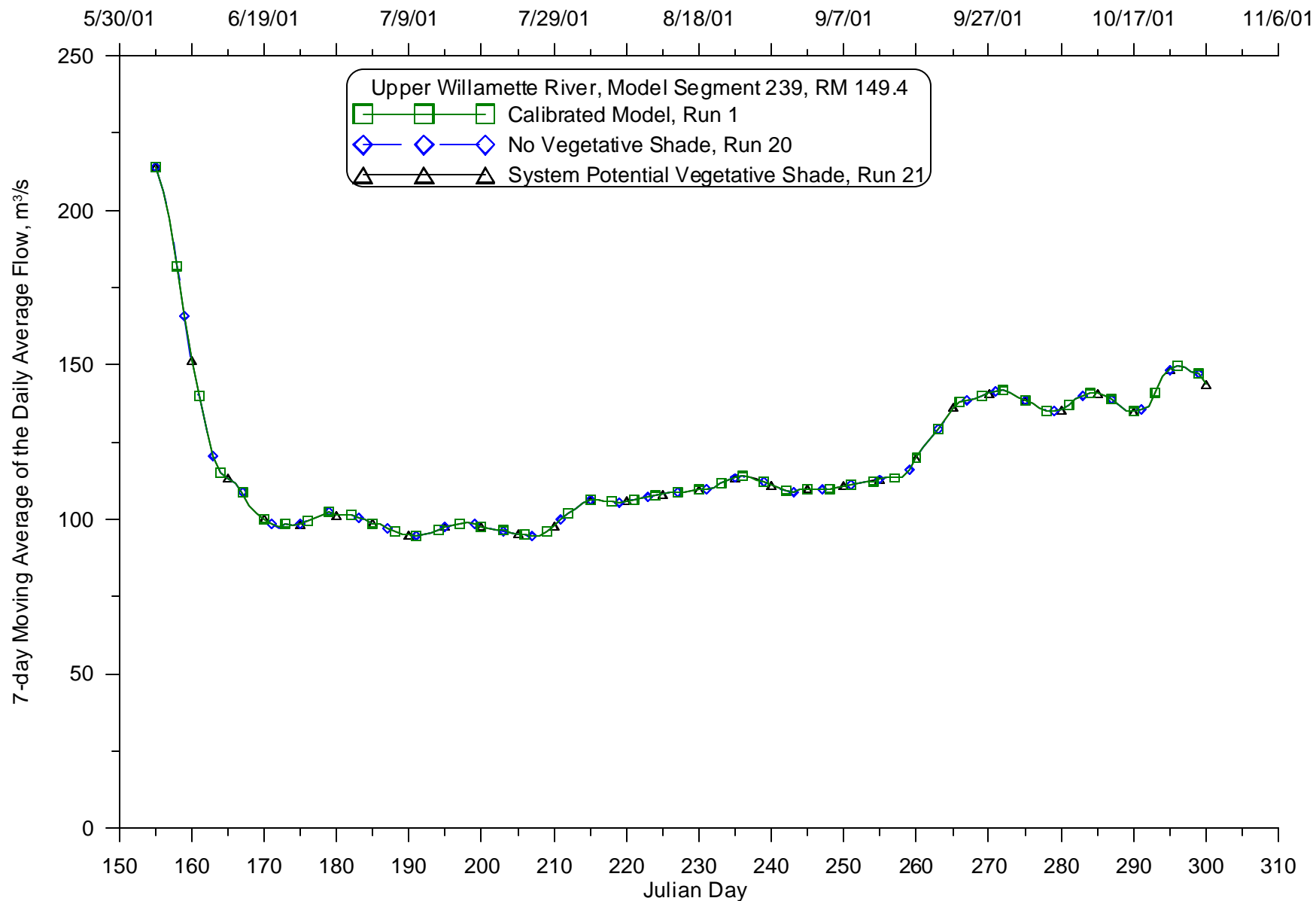


Figure 719: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 149.4

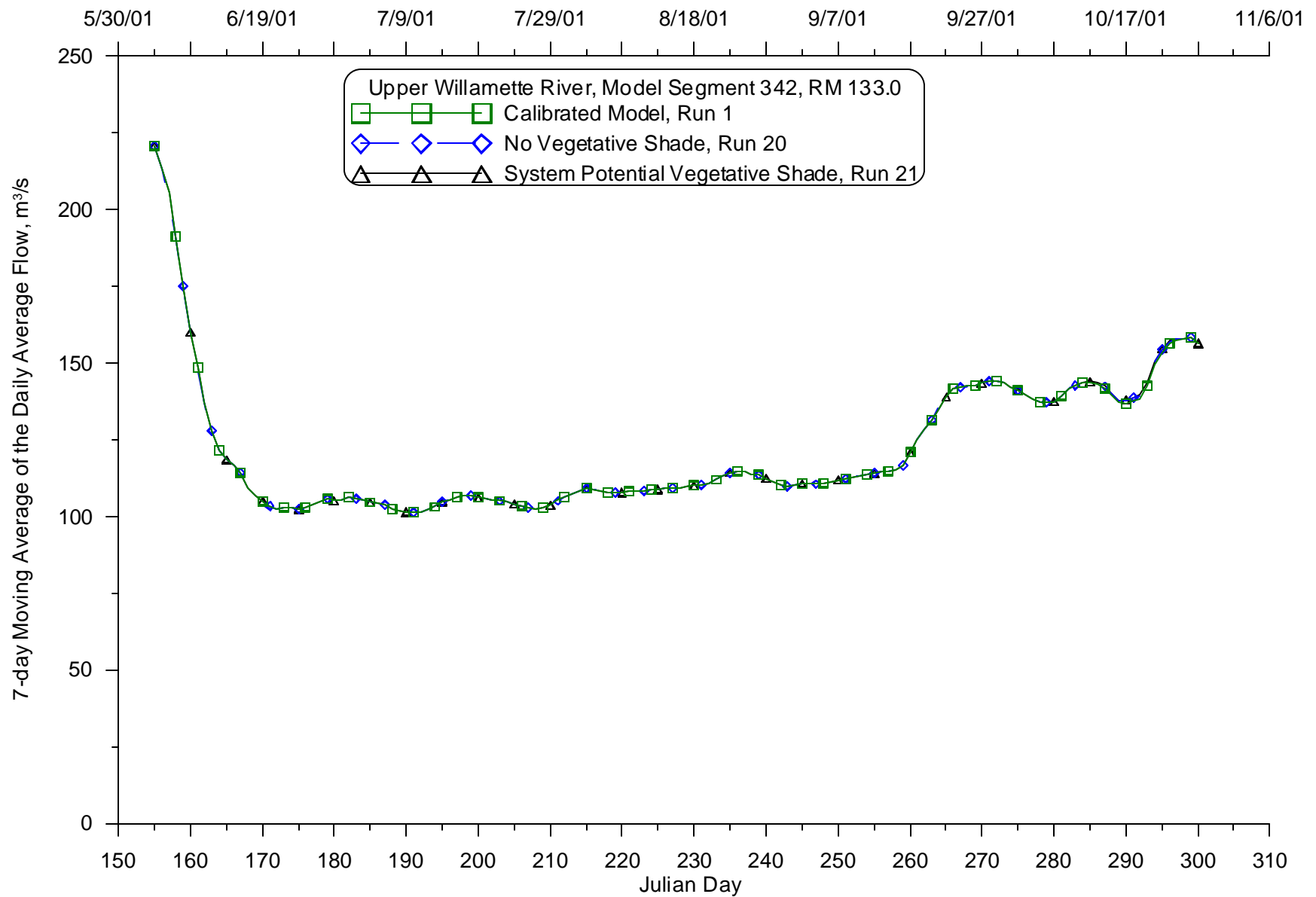


Figure 720: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 133

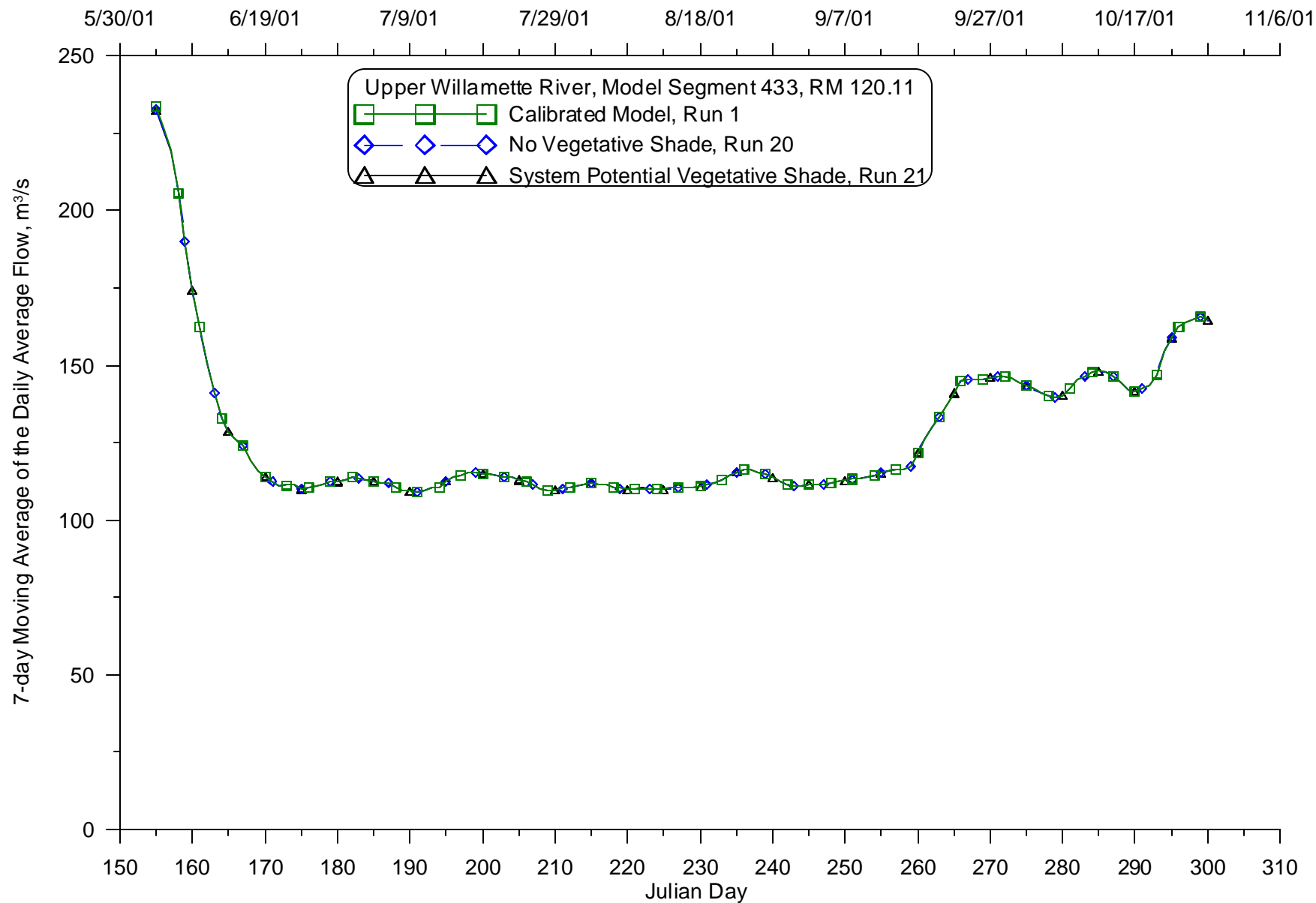


Figure 721: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 120.11

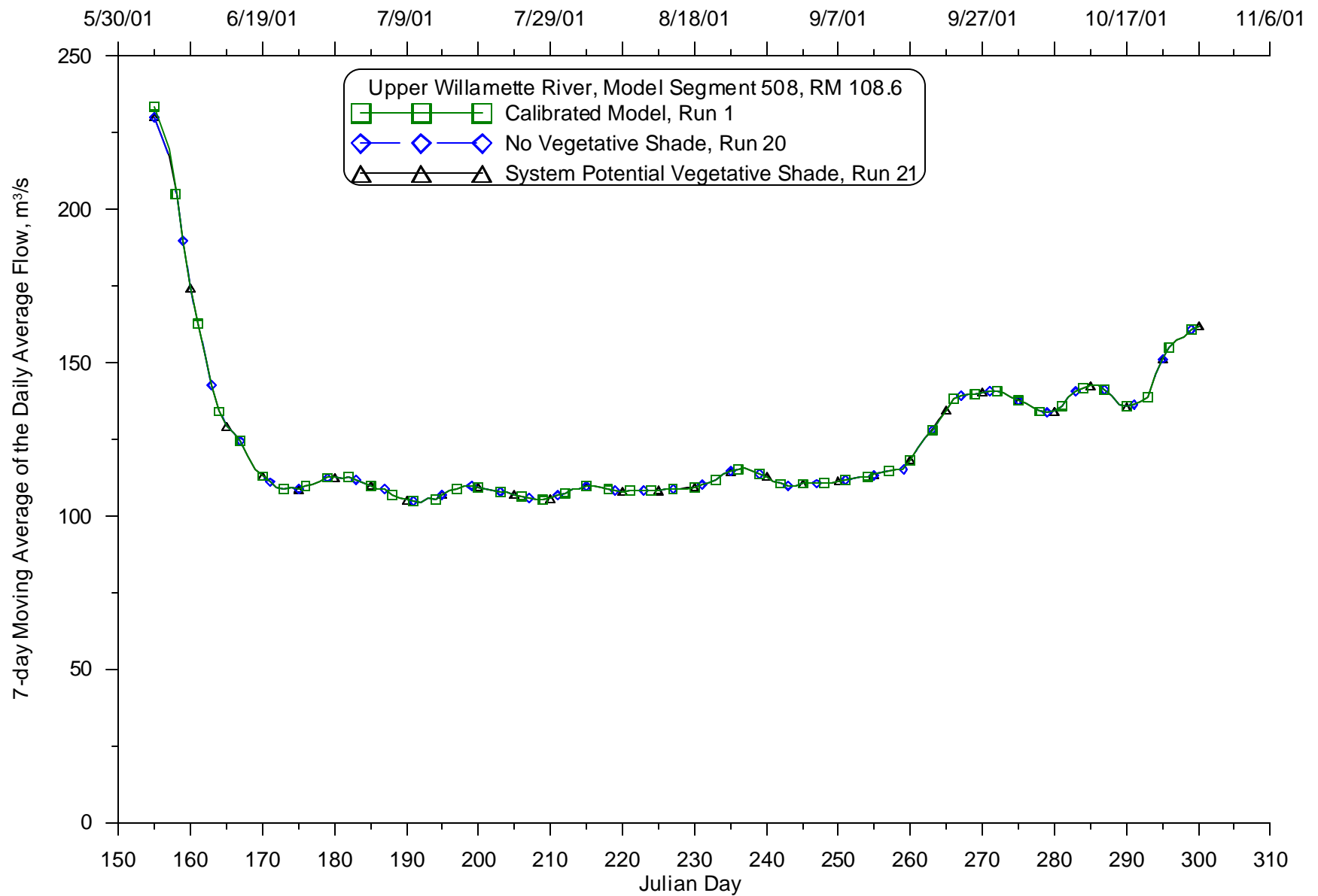


Figure 722: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 108.6

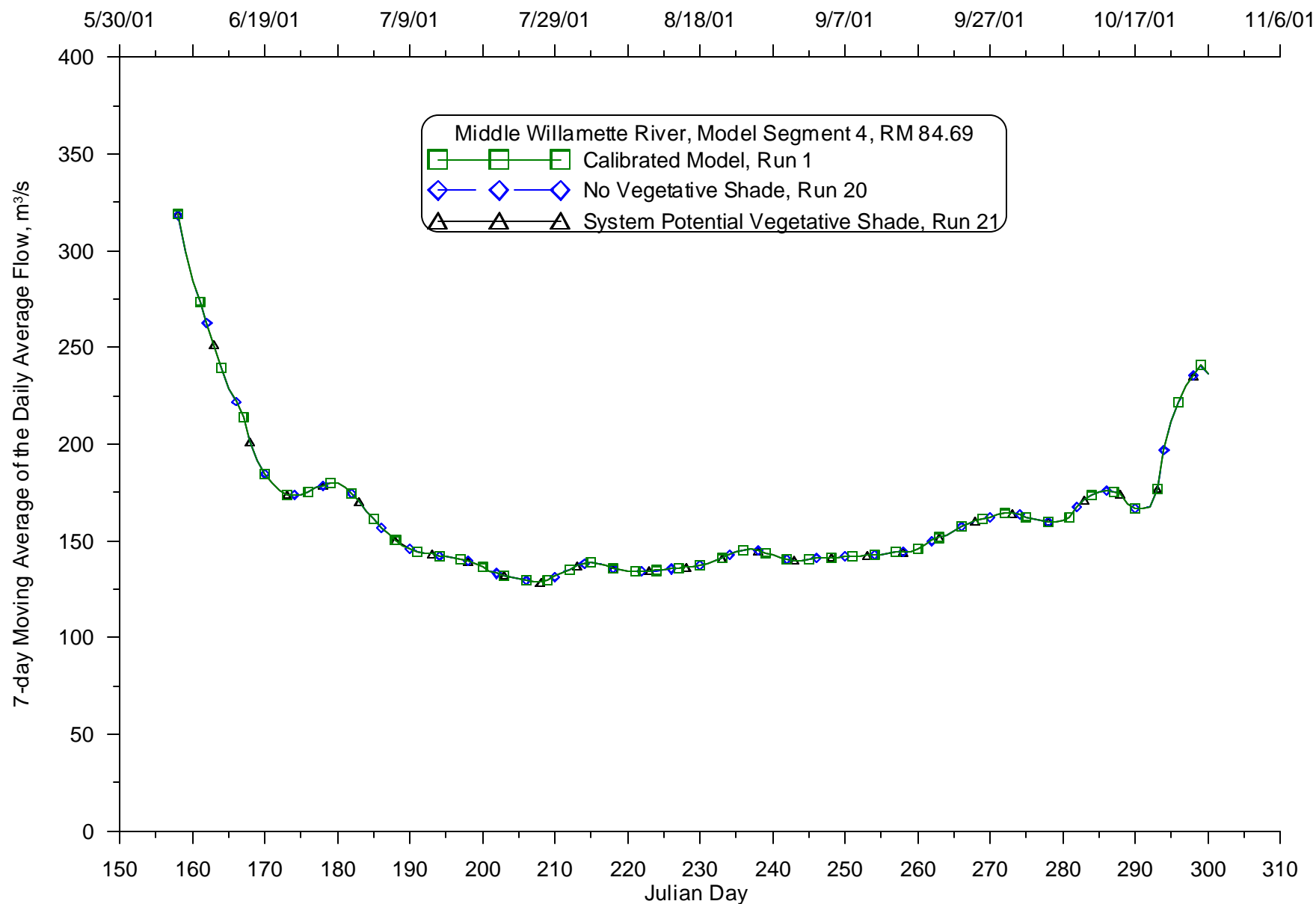


Figure 723: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 84.69

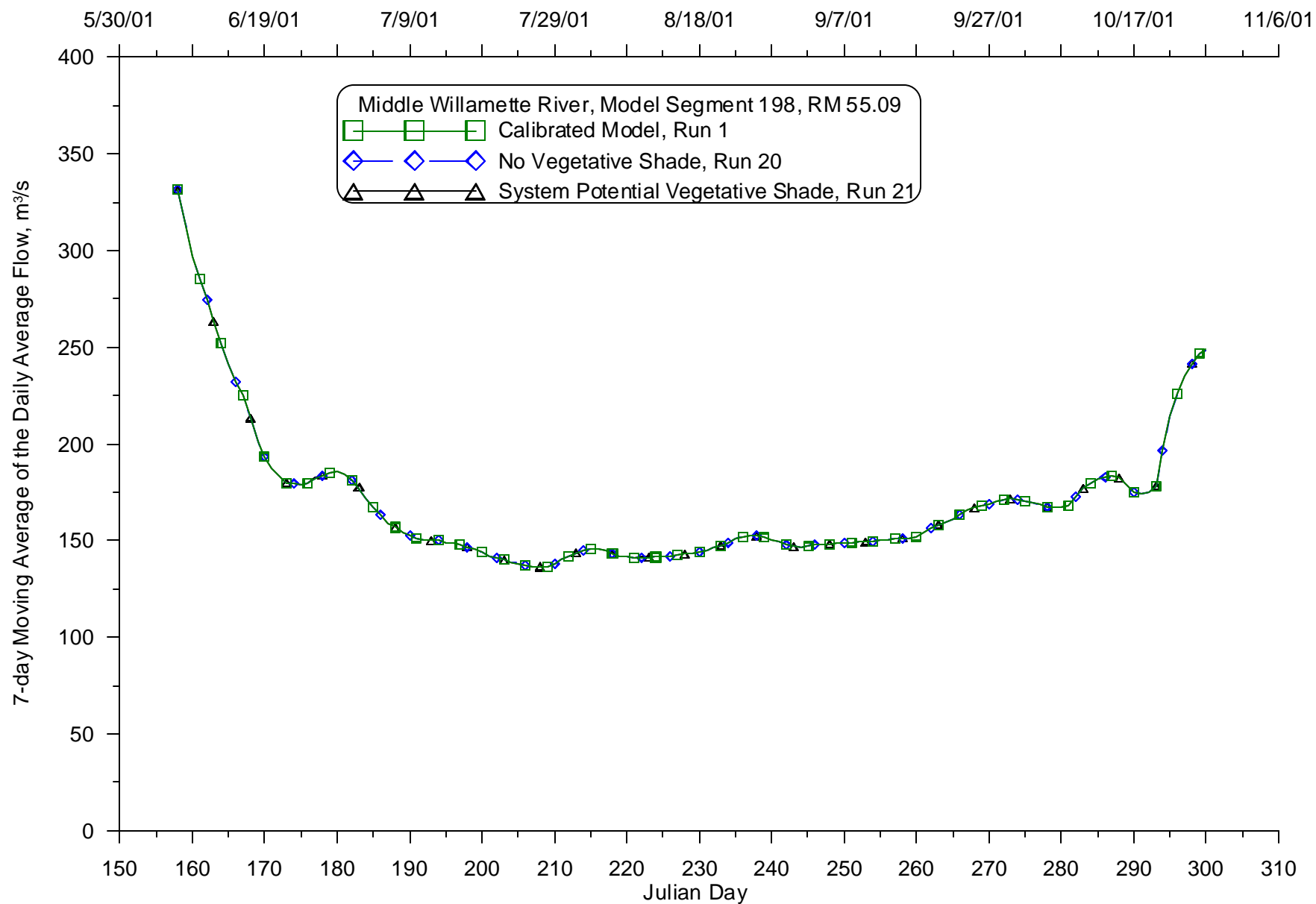


Figure 724: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 55.09

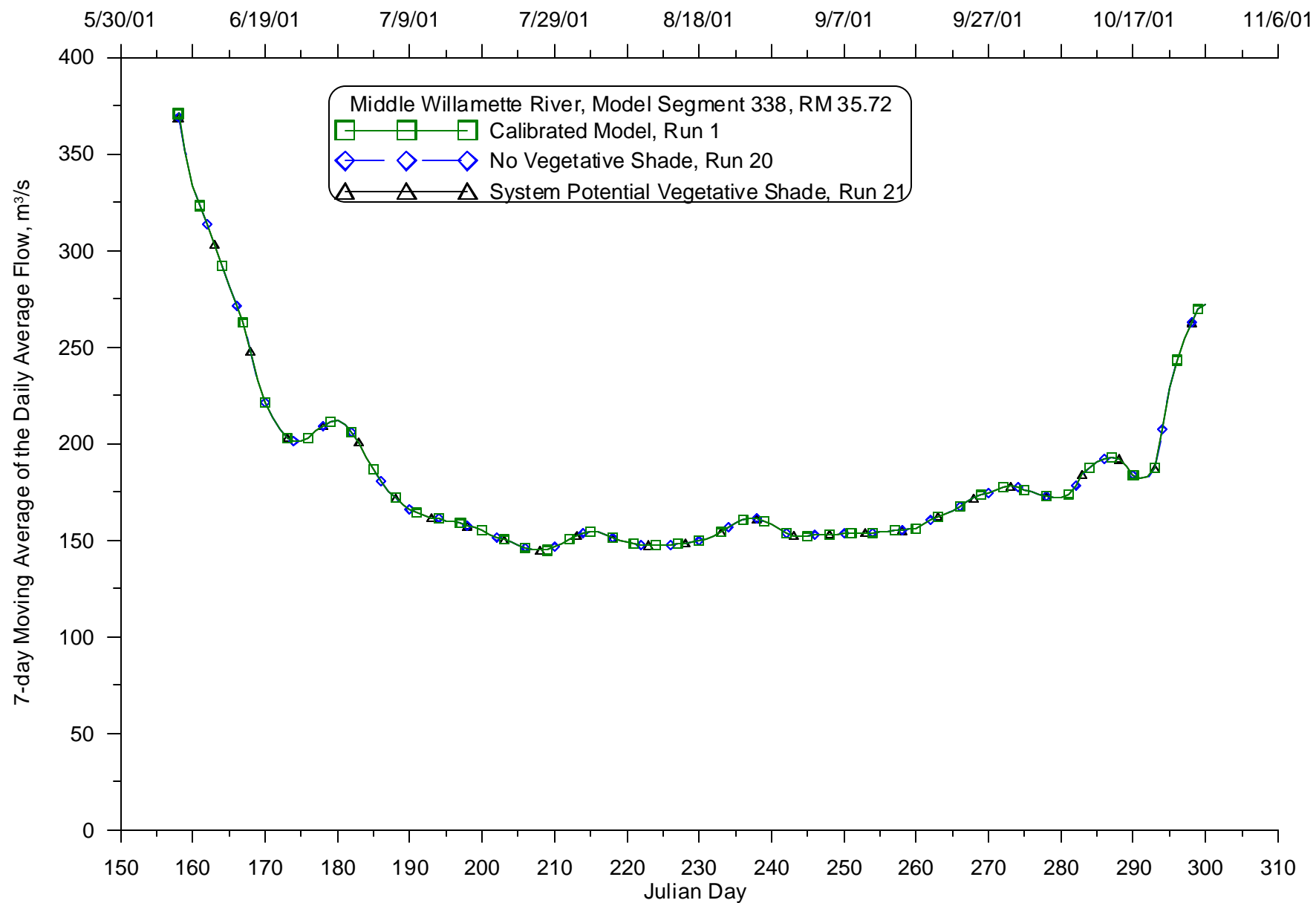


Figure 725: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 35.72



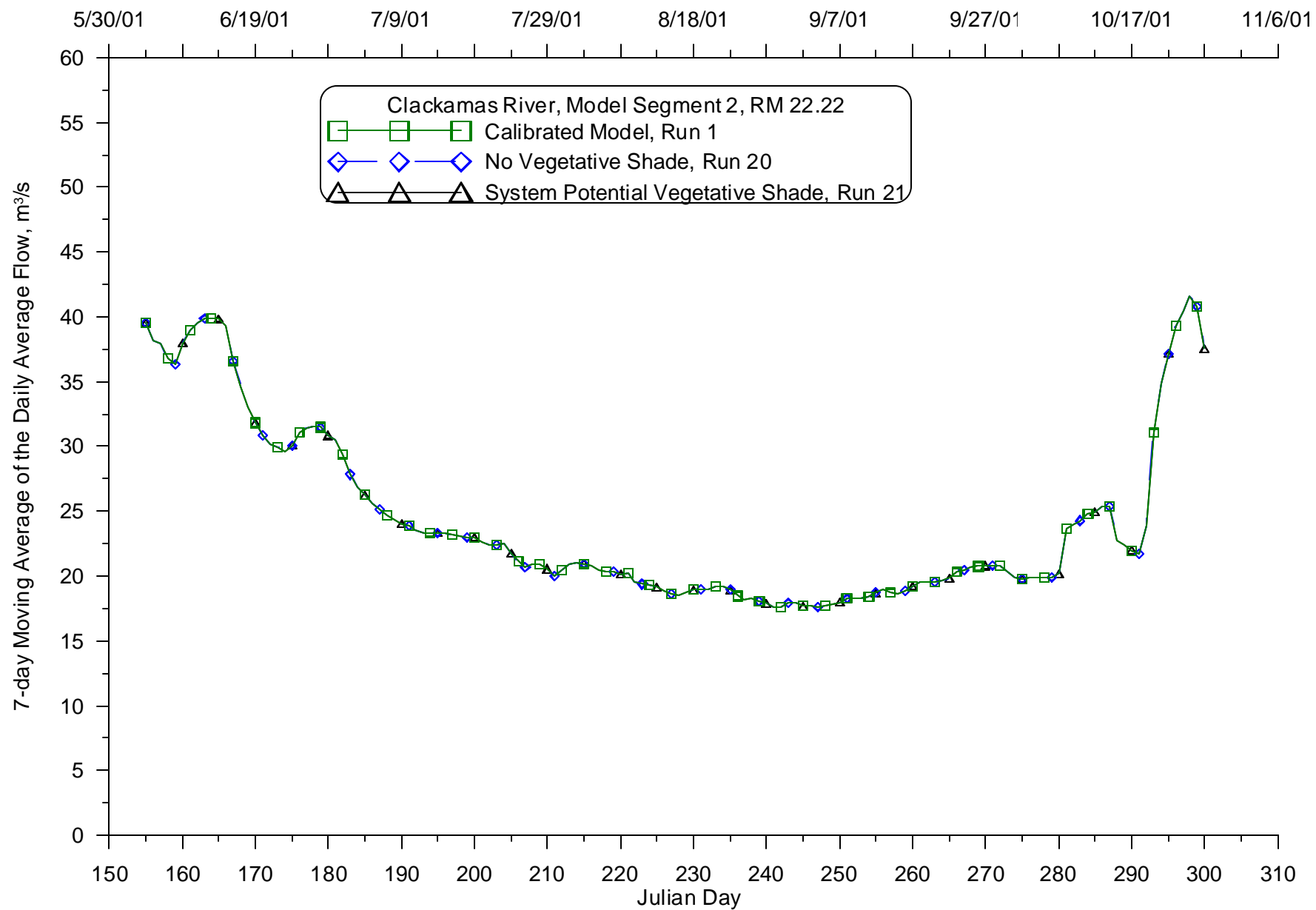


Figure 726: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Clackamas River at RM 22.22

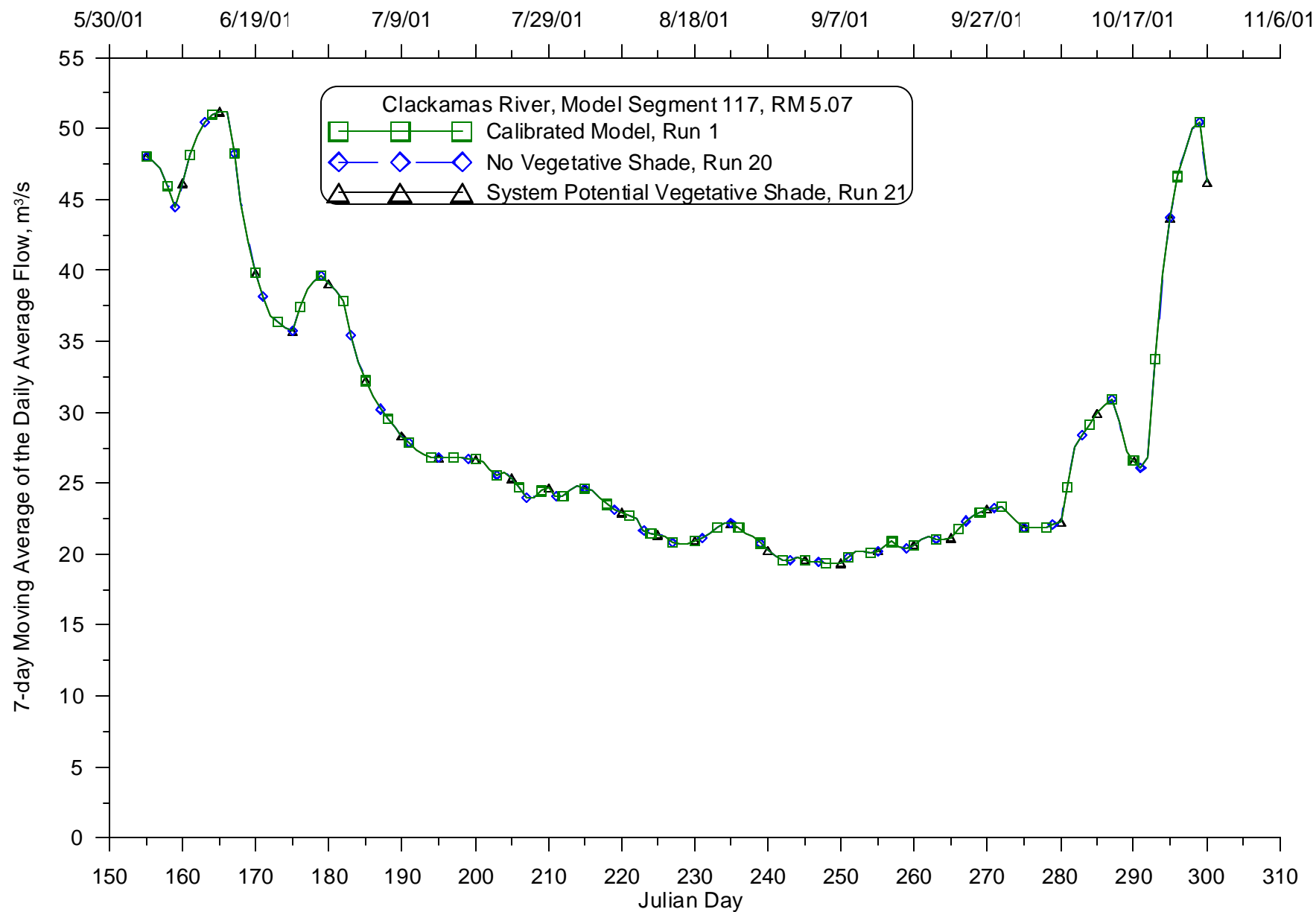


Figure 727: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Clackamas River at RM 5.07

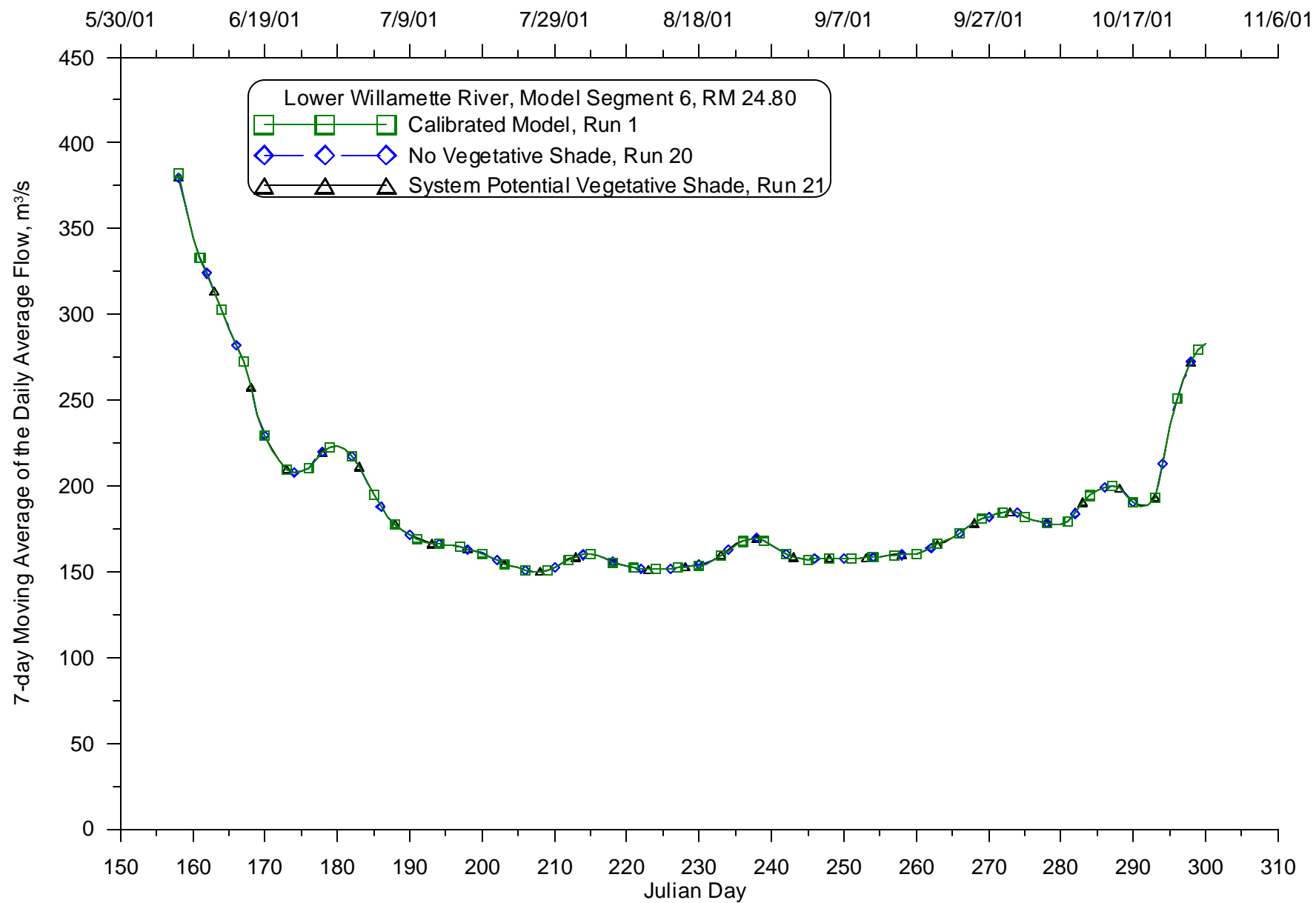


Figure 728: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 24.8

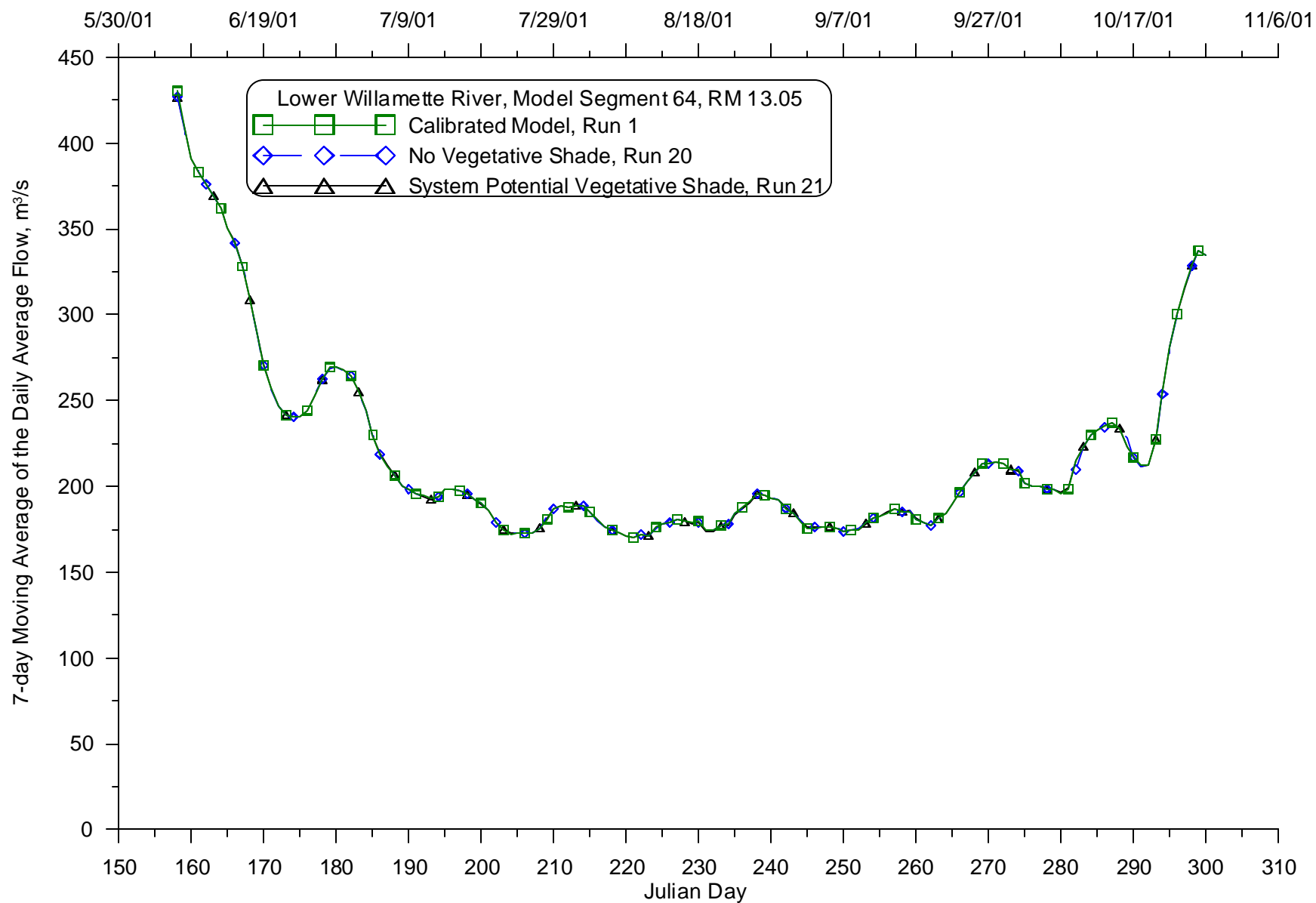


Figure 729: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 13.05

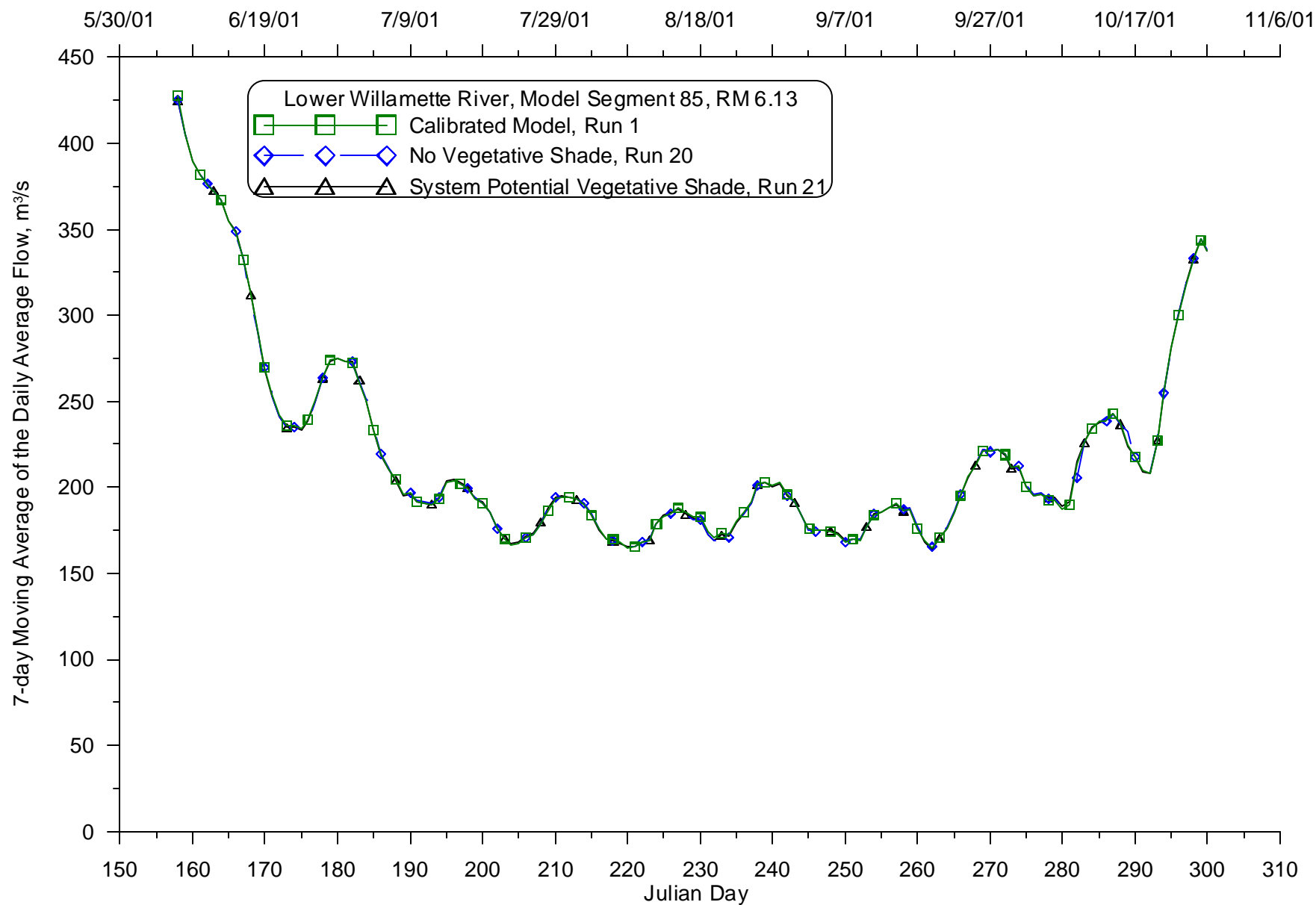
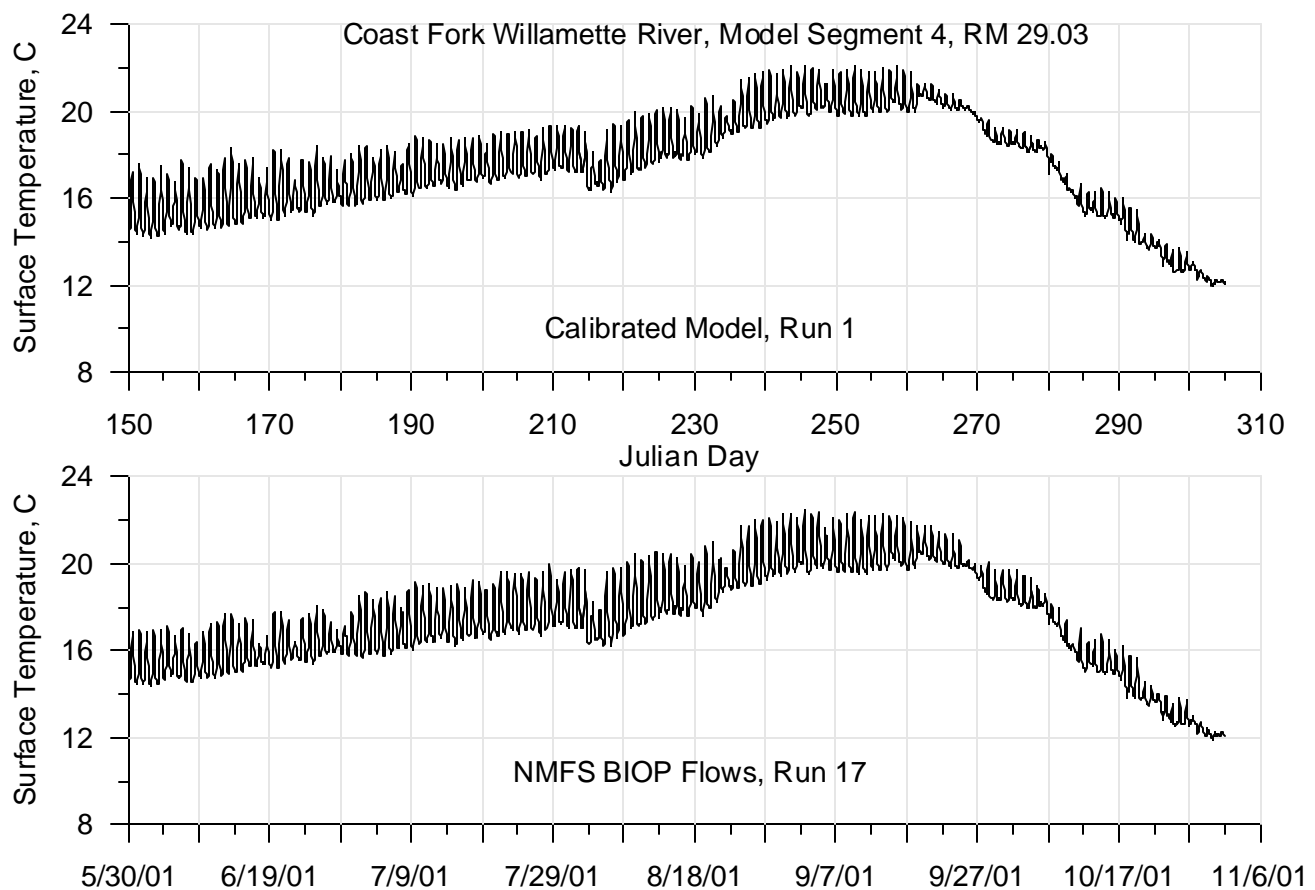


Figure 730: Calibrated model compared with varying vegetative shade, 7-day average of the daily average flow for 2001 for the Willamette River at RM 6.13

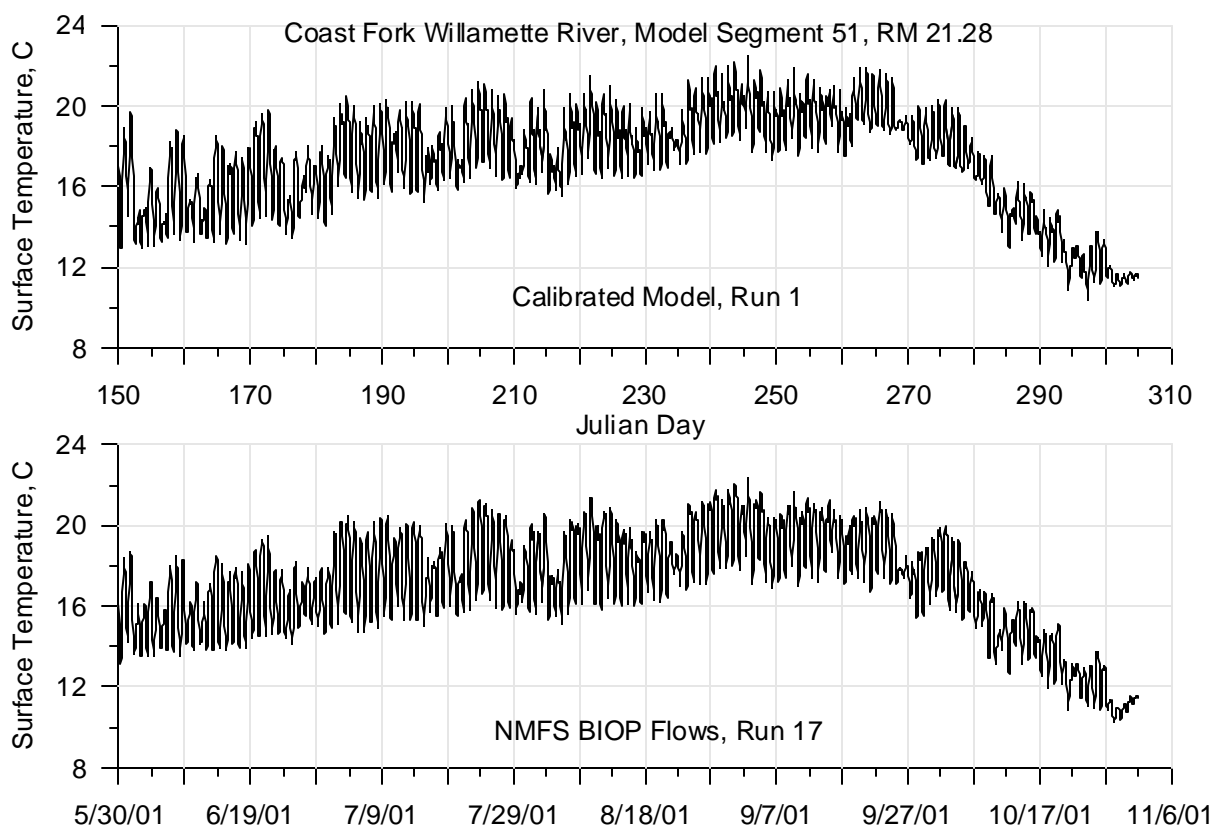
## ***Sensitivity to biological opinion flows***

The sensitivity of the model to using the National Marine Fisheries Service Biological Opinion (NMFS BIOP) flows for the upstream boundary flow condition was examined by simulating the summer of 2001. The results were then compared with the results of the calibrated model in a series of time series plots. There are four types of time series output for each of the 21 locations identified above in Table 2: continuous temperature, continuous flow, the seven-day moving average of the daily maximum temperature, and the seven-day average of daily average flow.

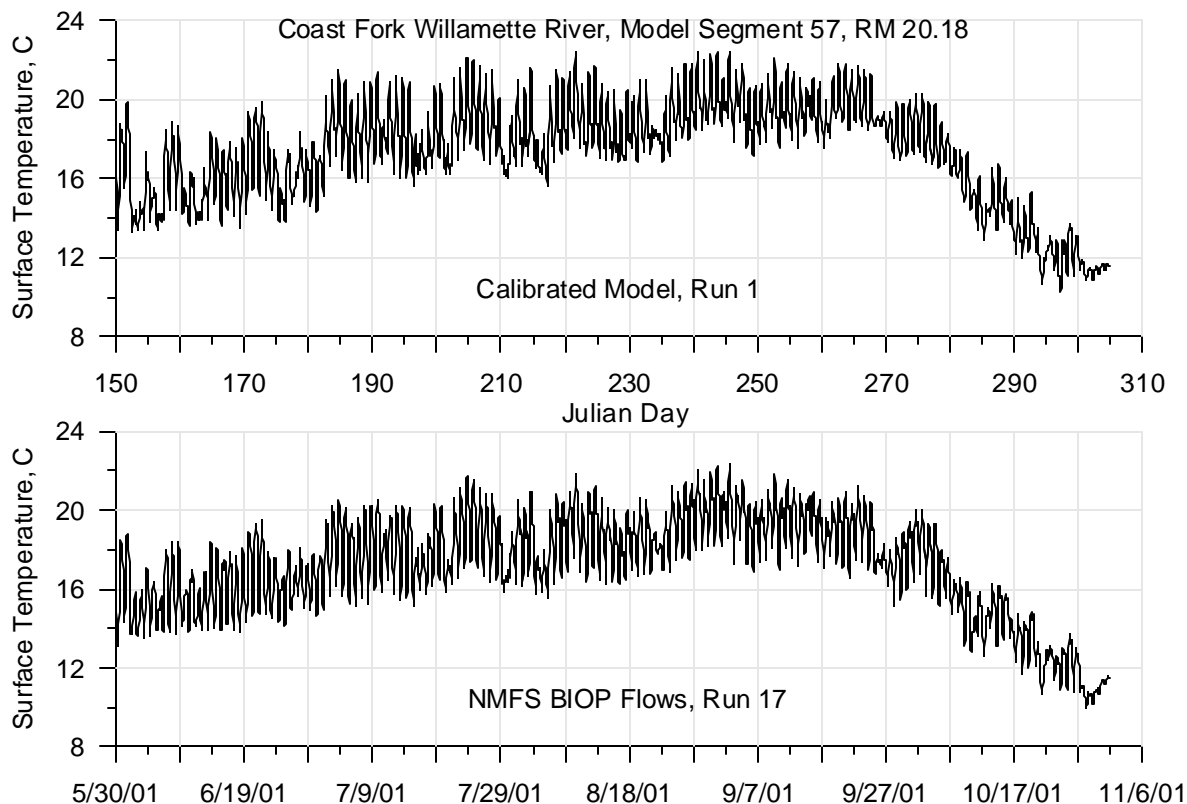
### **Continuous Temperature**



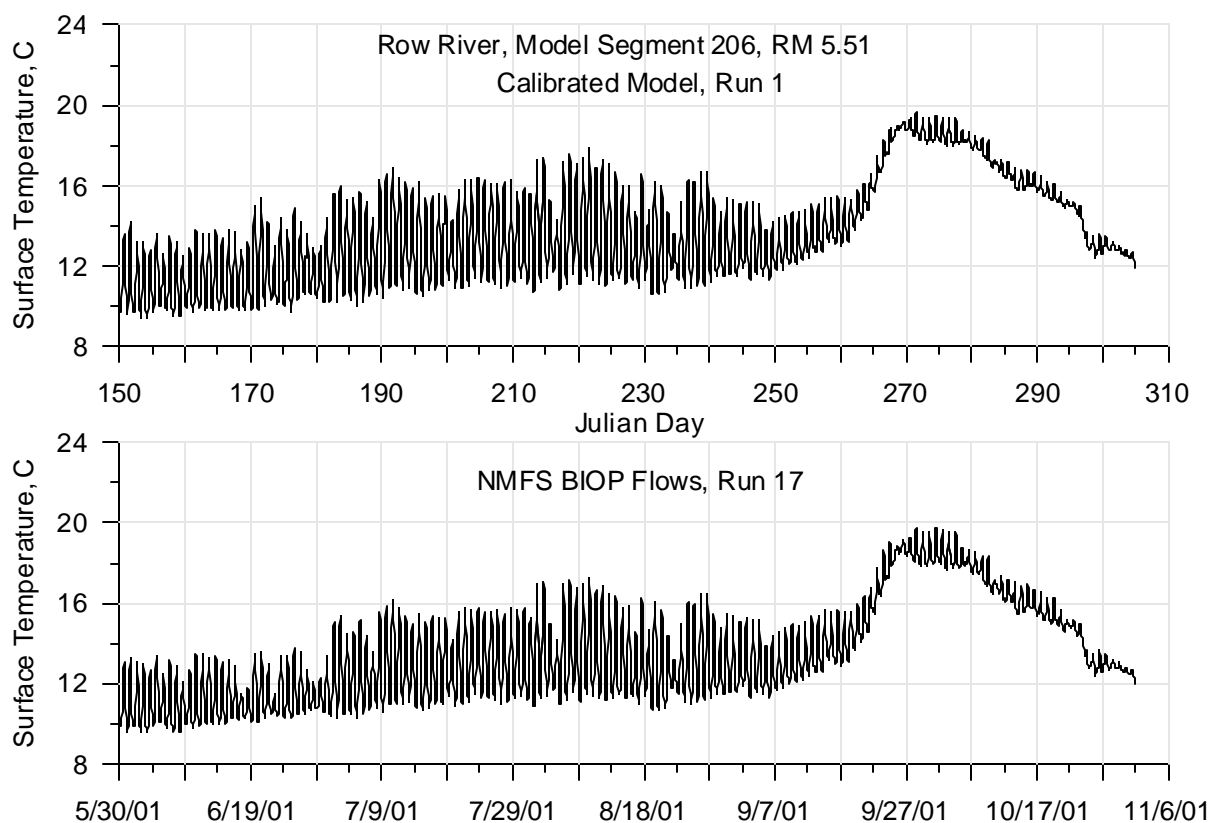
**Figure 731: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Coast Fork Willamette River at RM 29.03**



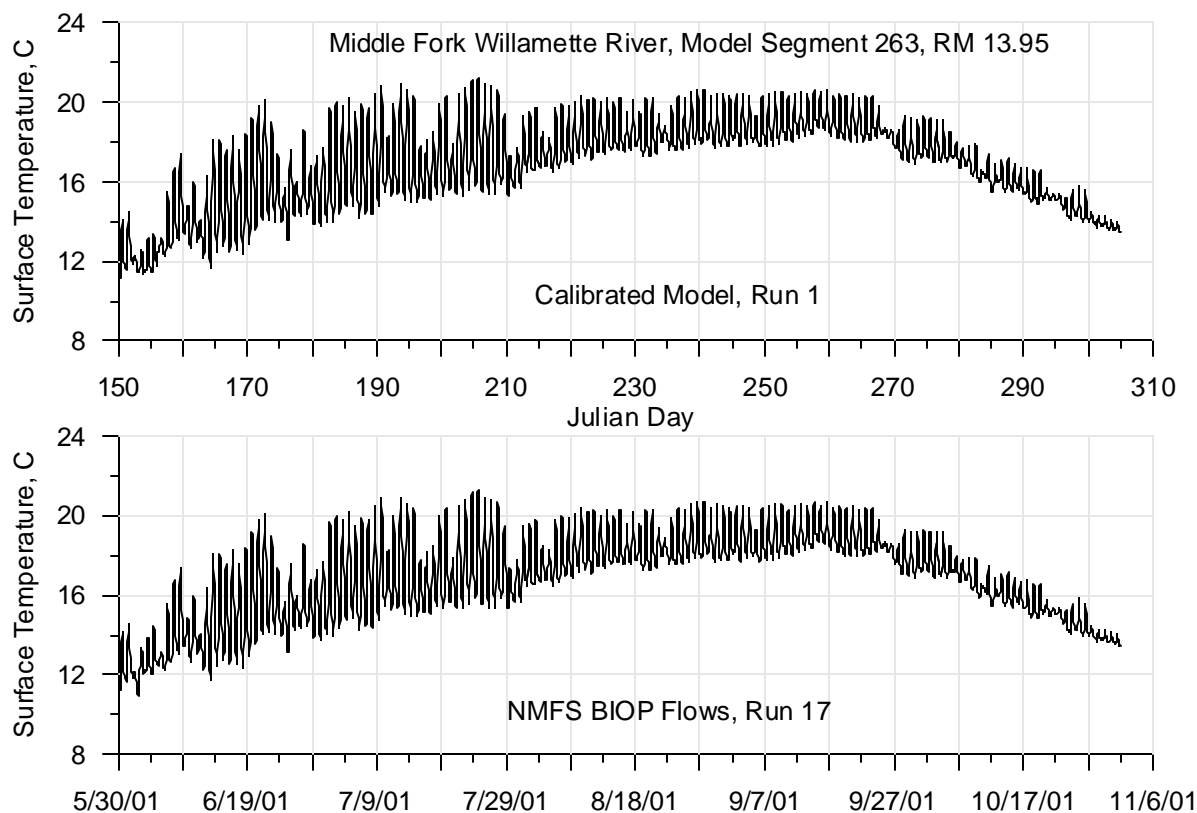
**Figure 732: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Coast Fork Willamette River at RM 21.28**



**Figure 733: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Coast Fork Willamette River at RM 20.18**

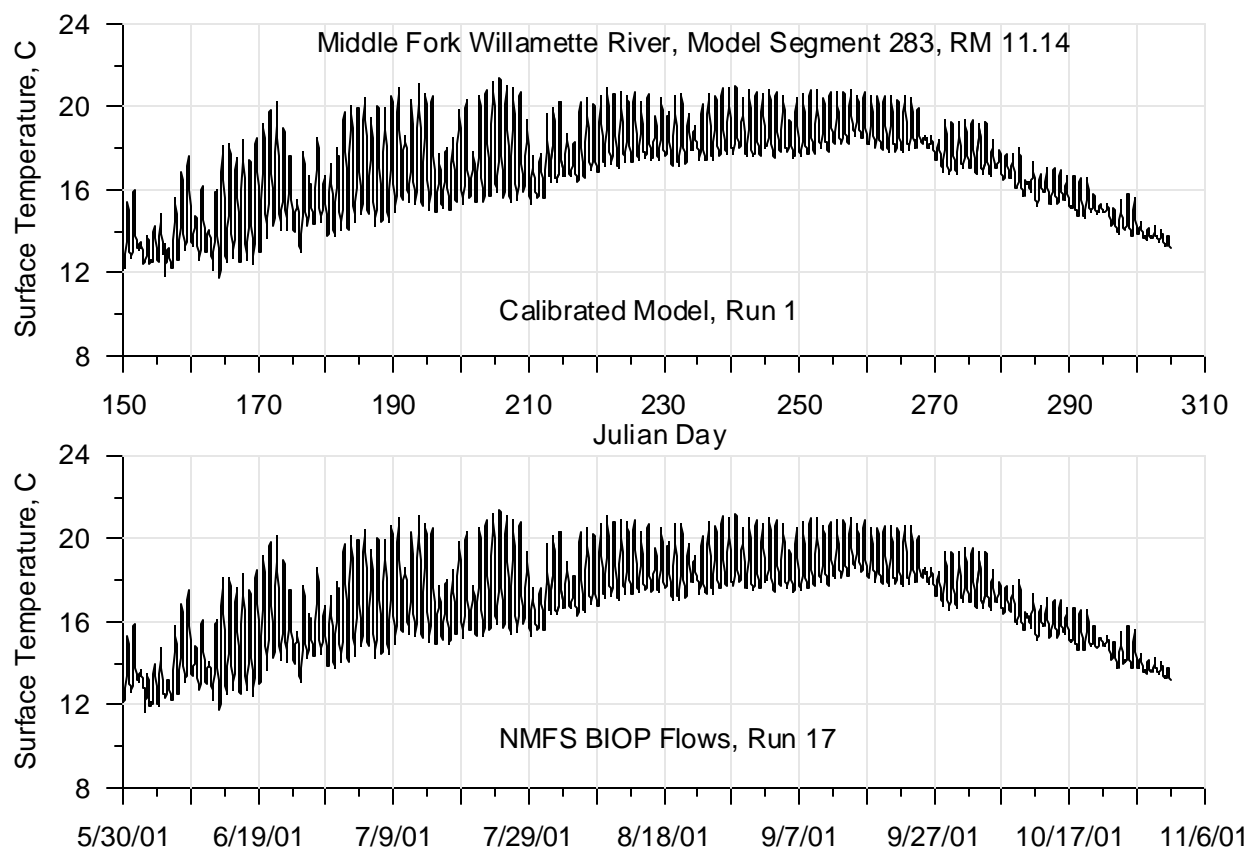


**Figure 734: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Row River at RM 5.51**

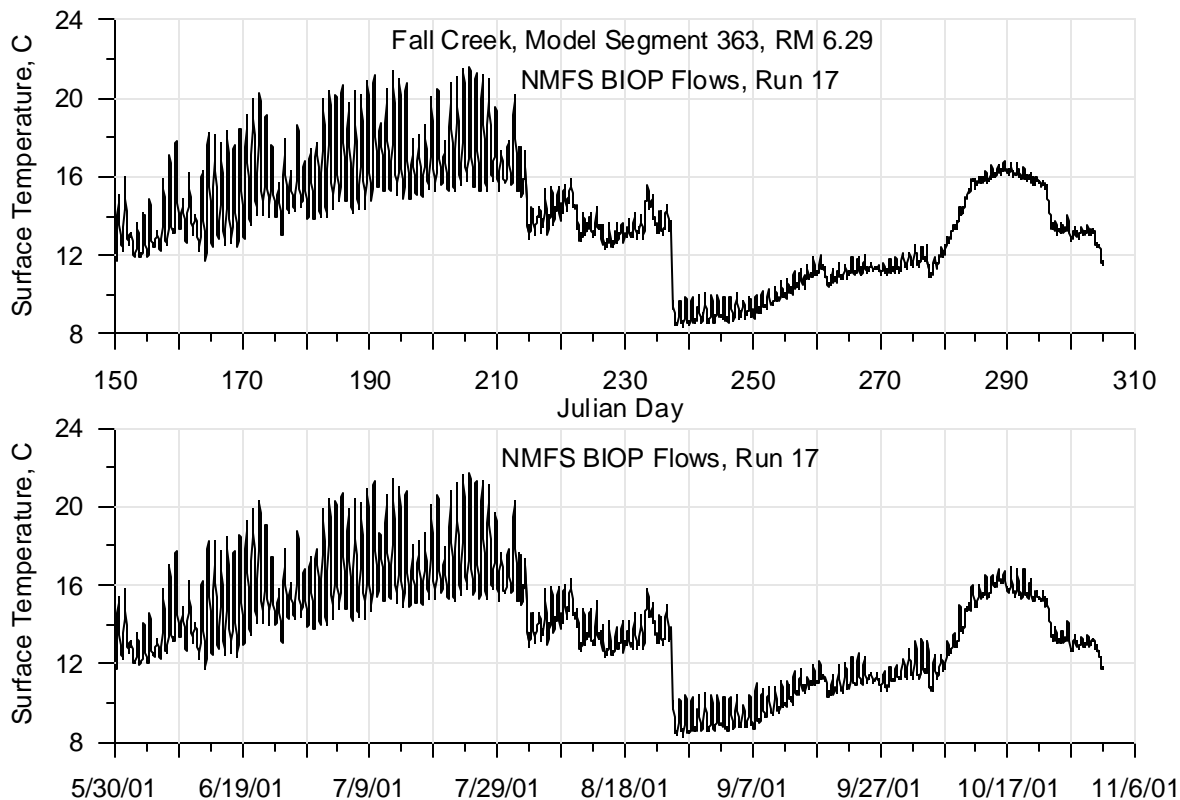


**Figure 735: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Middle Fork Willamette River at RM 13.95**

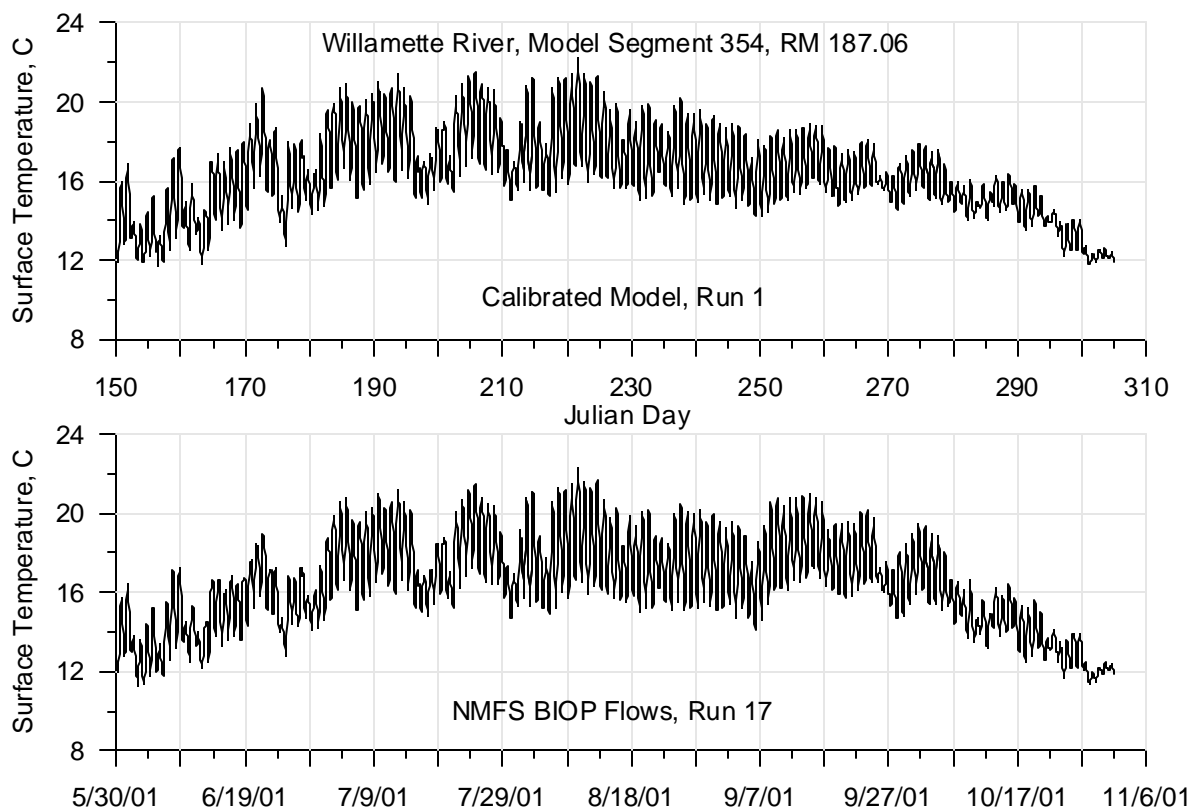




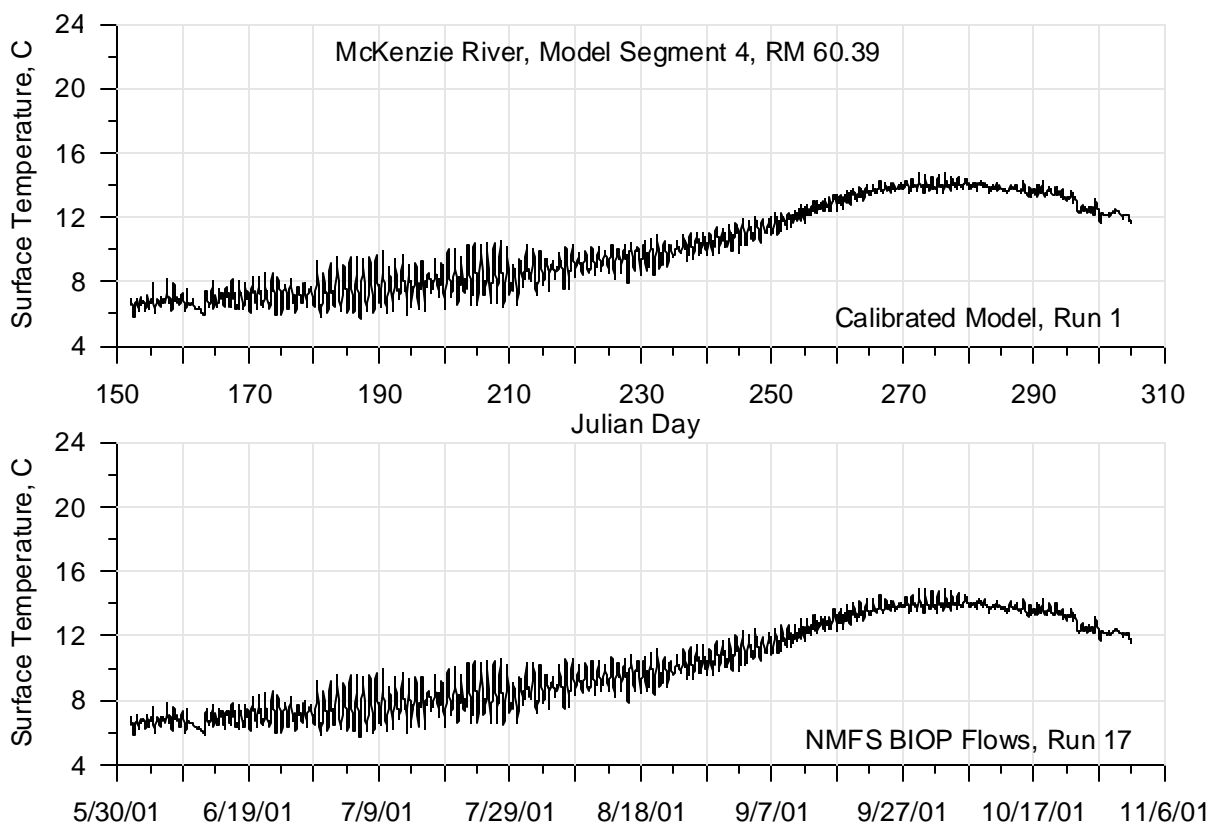
**Figure 736: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Middle Fork Willamette River at RM 11.14**



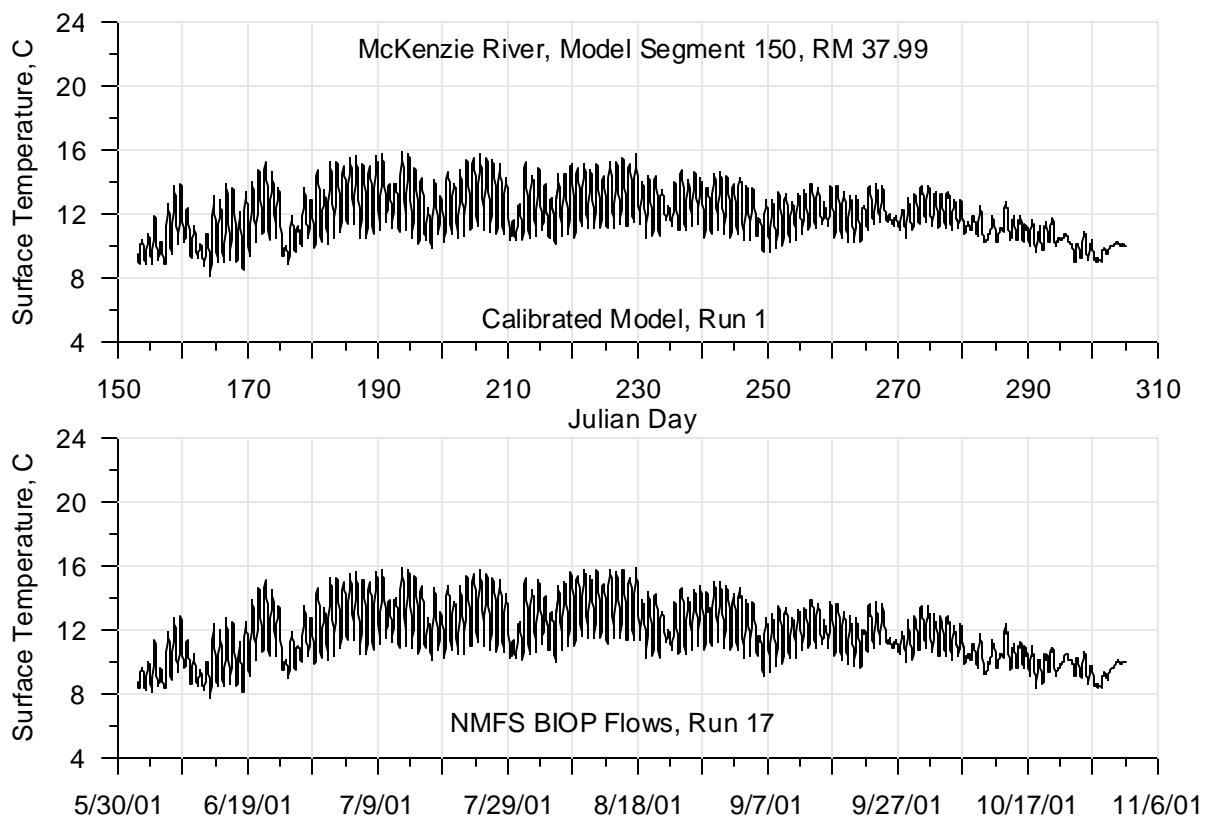
**Figure 737: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for Fall Creek at RM 6.29**



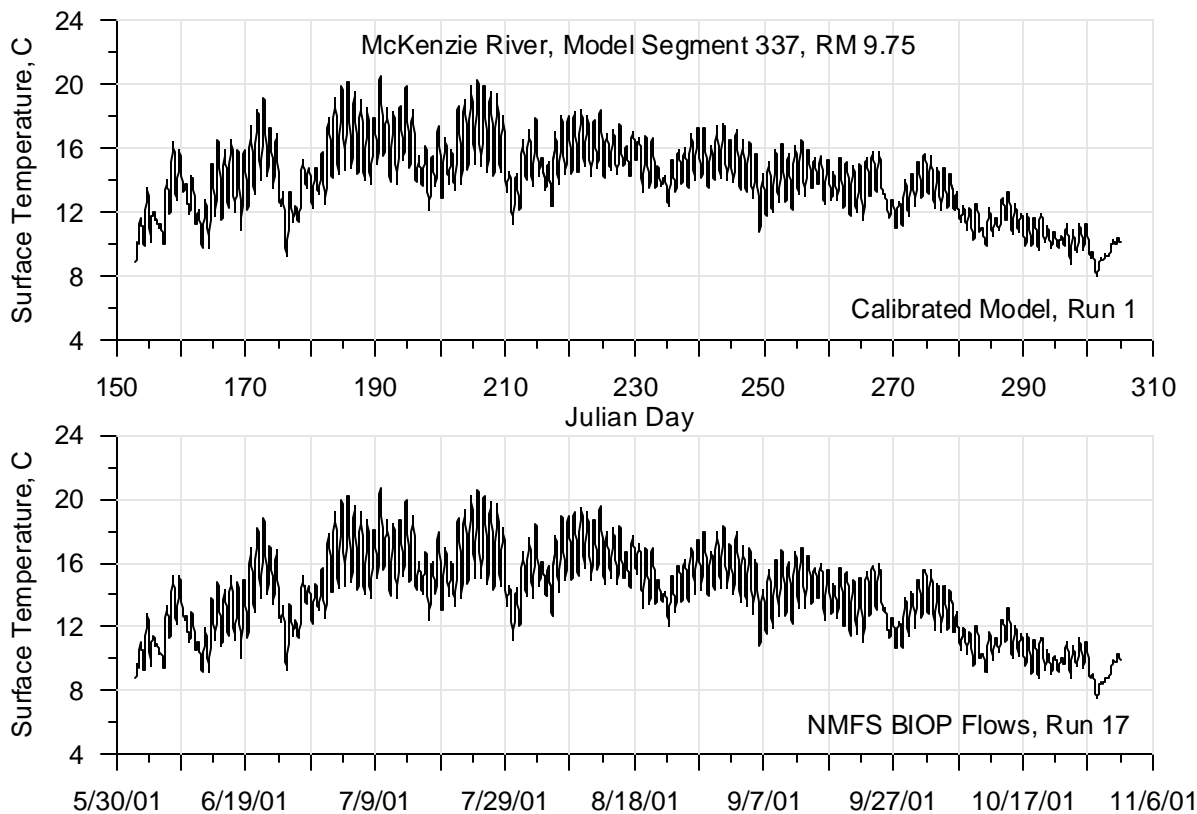
**Figure 738: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 187.06**



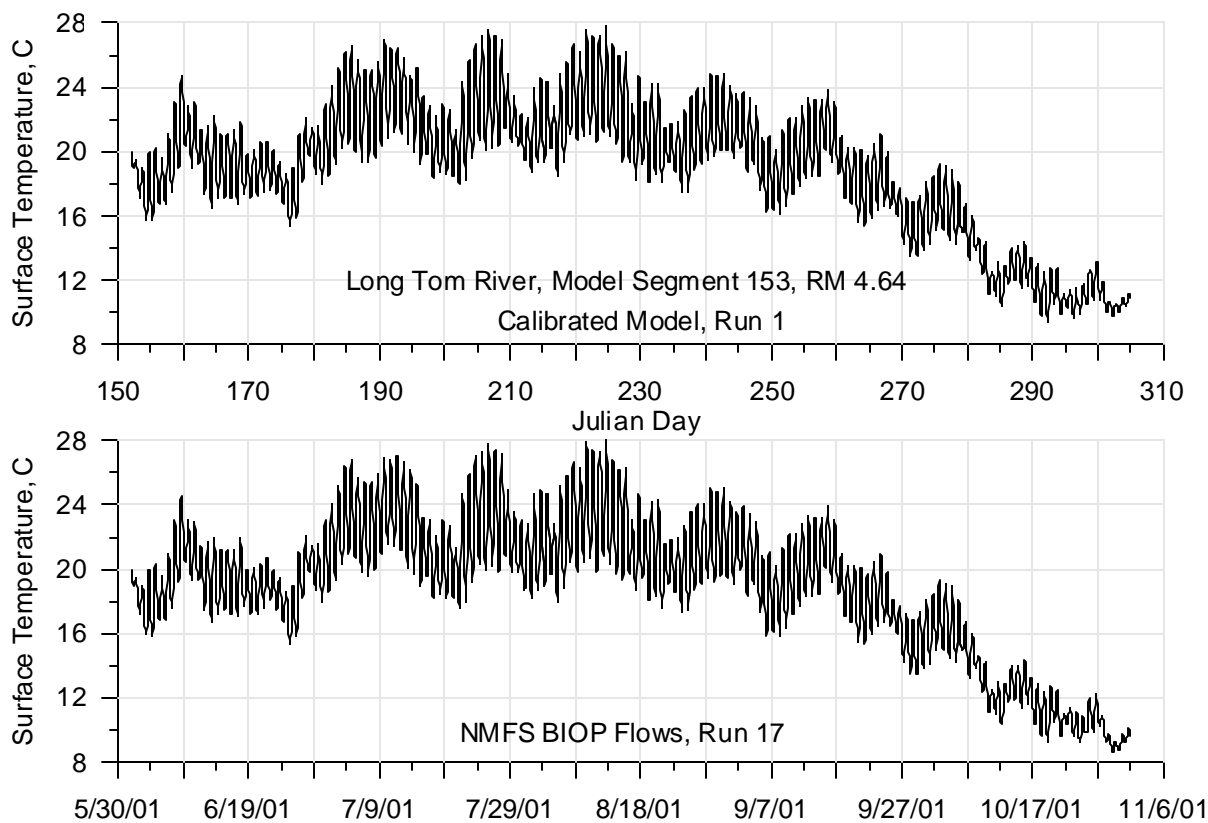
**Figure 739: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the McKenzie River at RM 60.39**



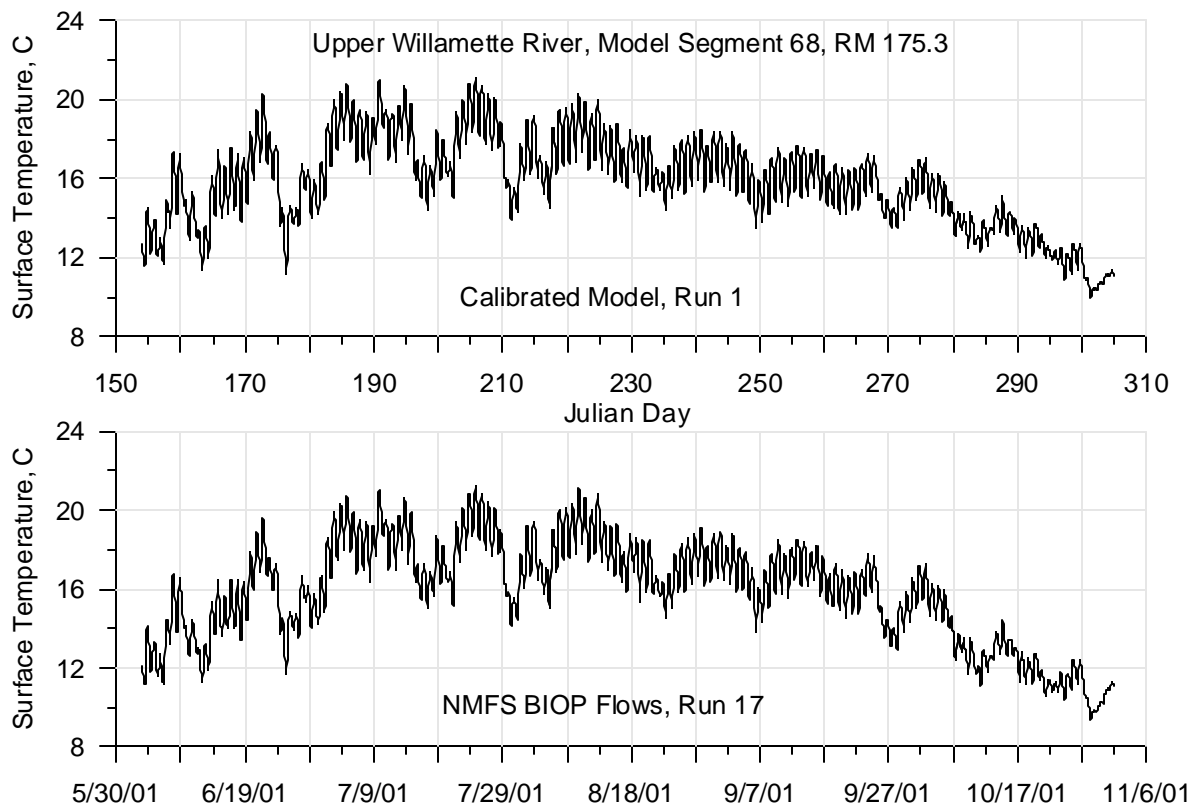
**Figure 740: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the McKenzie River at RM 37.99**



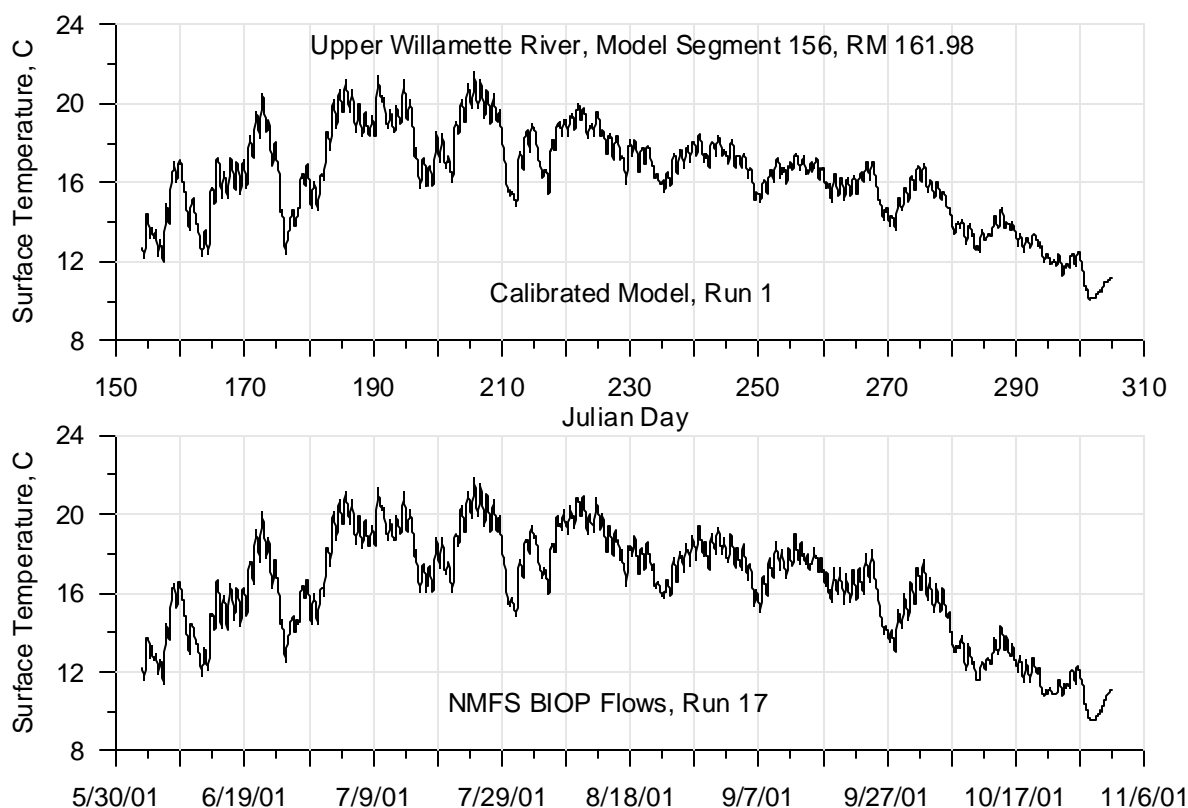
**Figure 741: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the McKenzie River at RM 9.75**



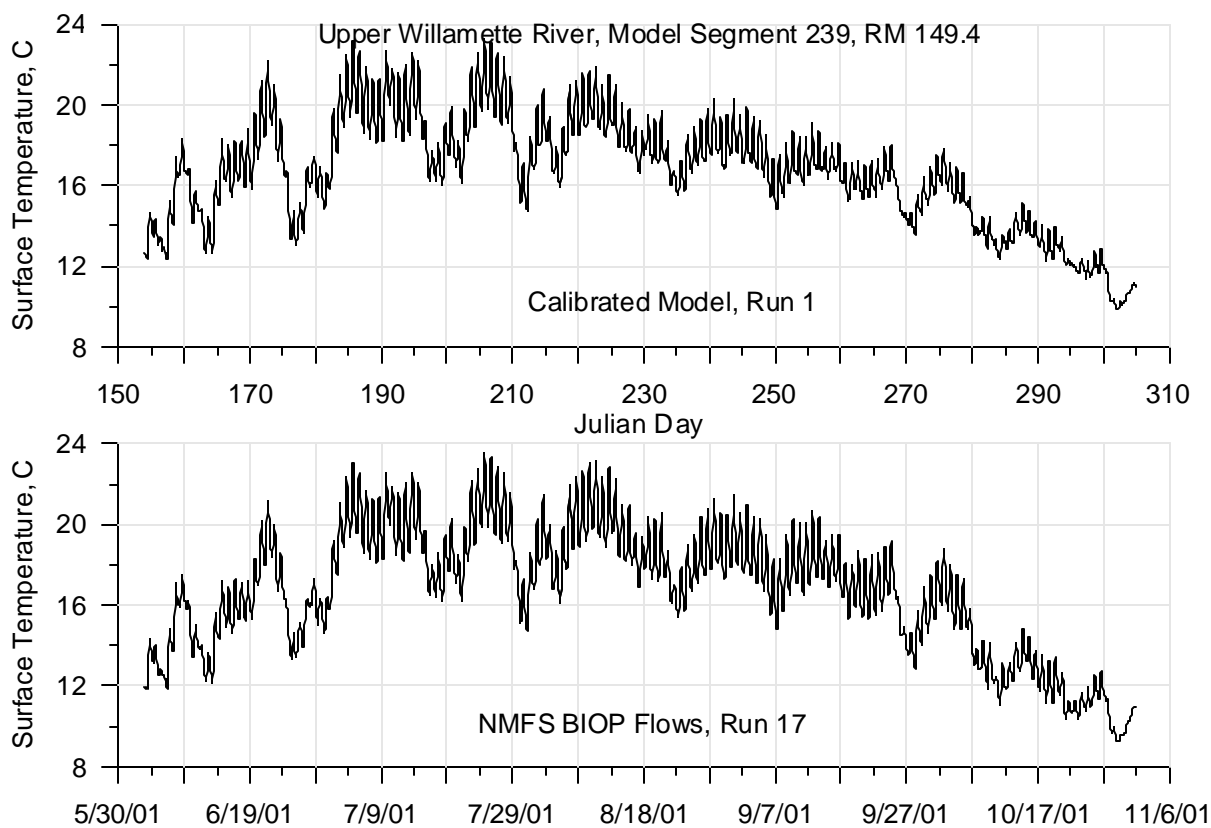
**Figure 742: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Long Tom River at RM 4.64**



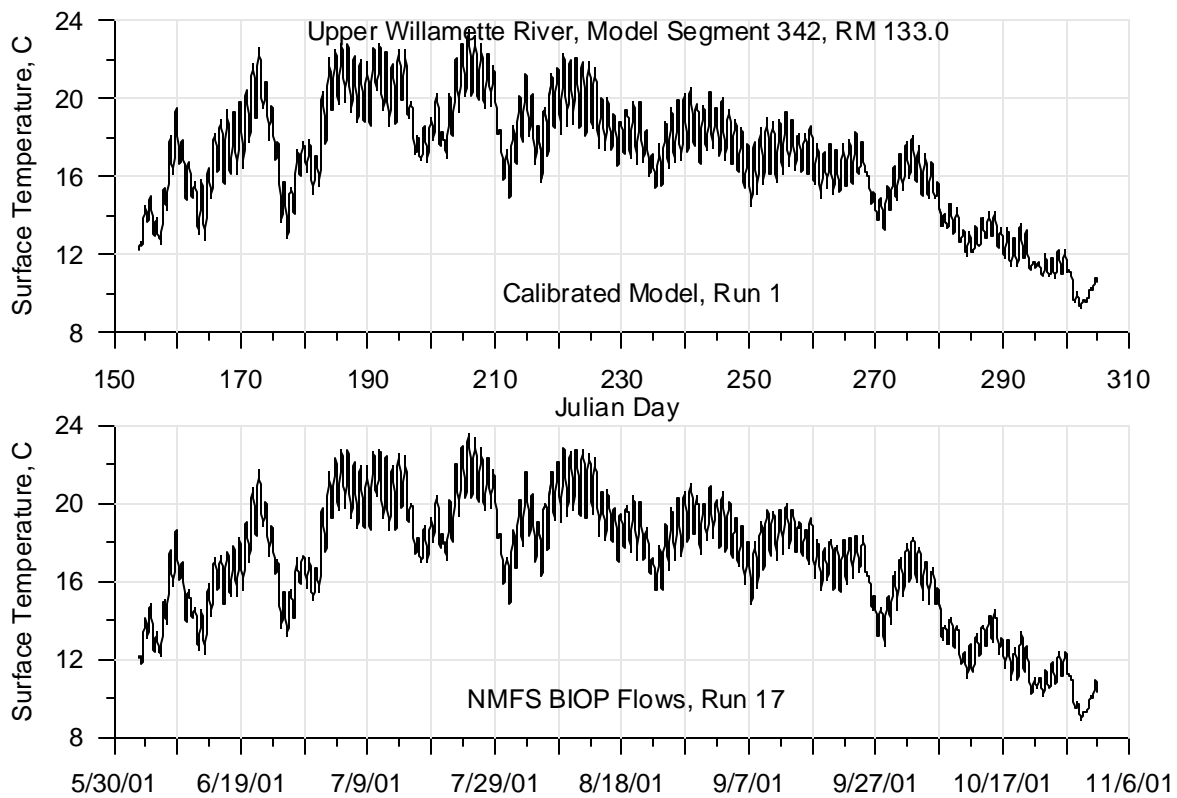
**Figure 743: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 175.3**



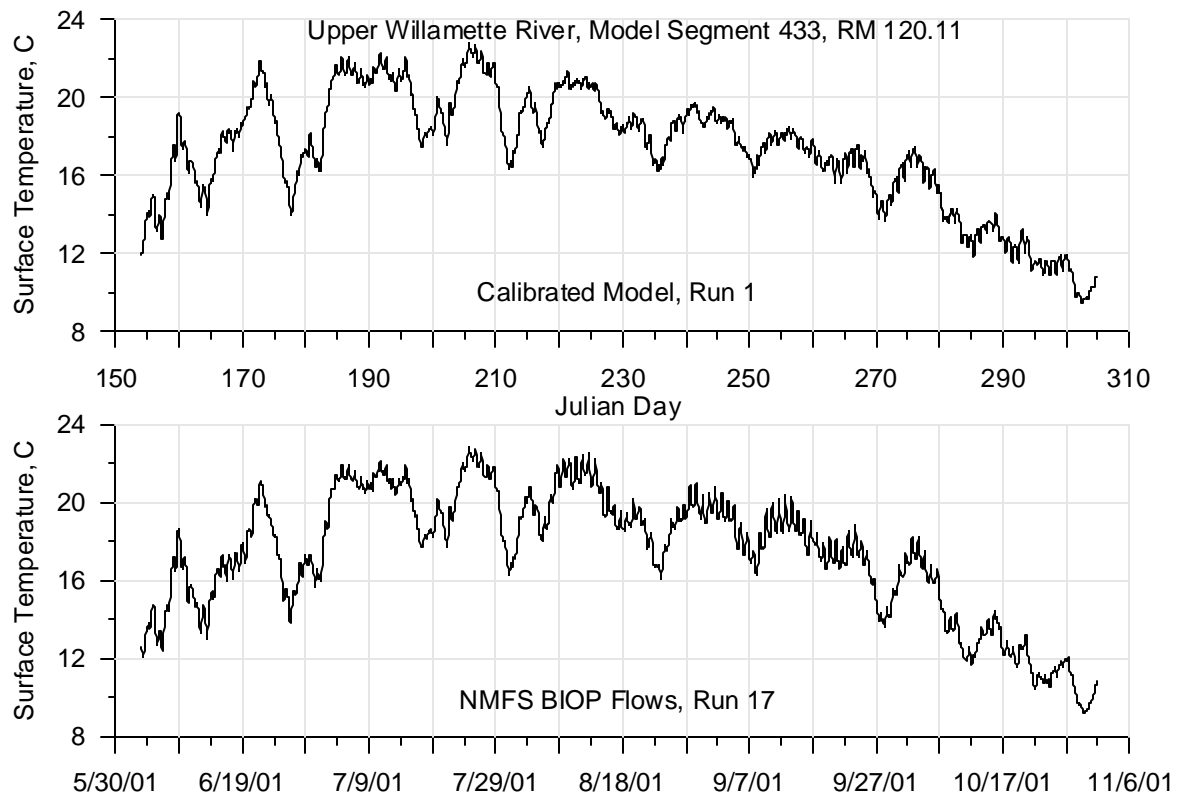
**Figure 744: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 161.98**



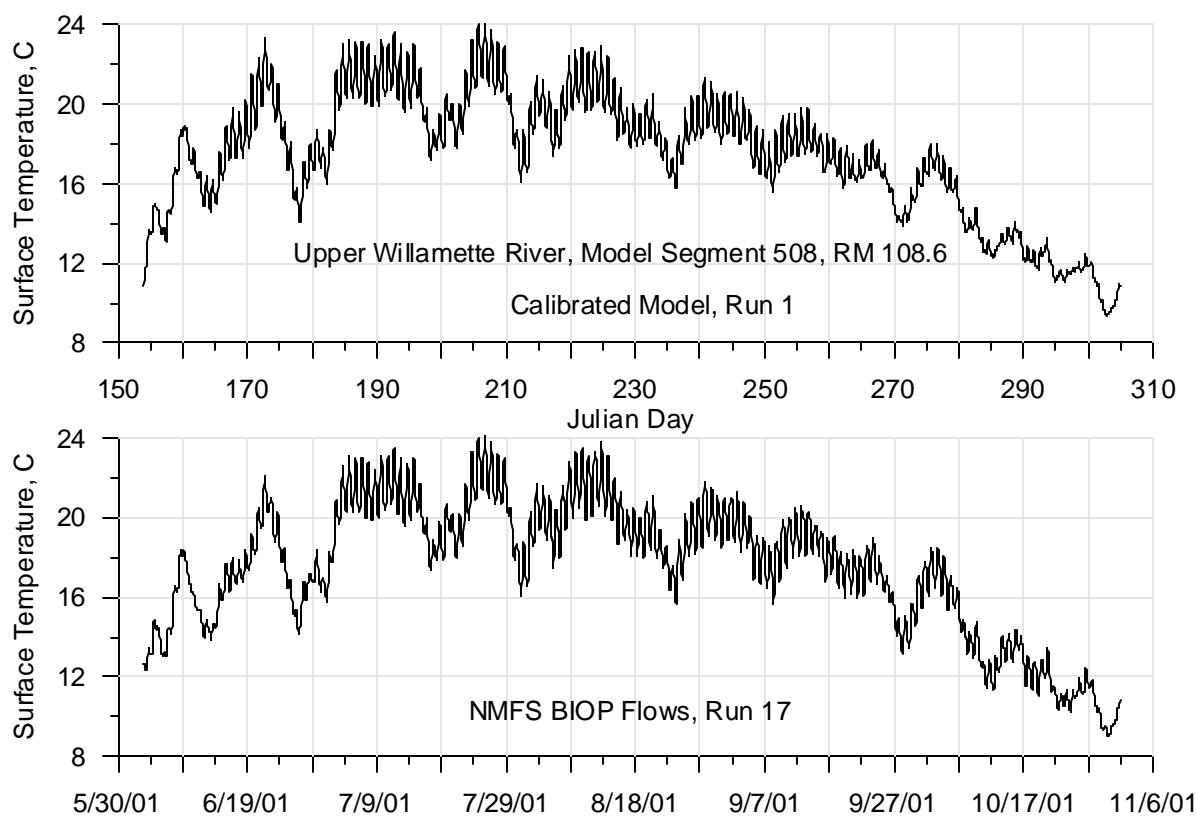
**Figure 745: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 149.4**



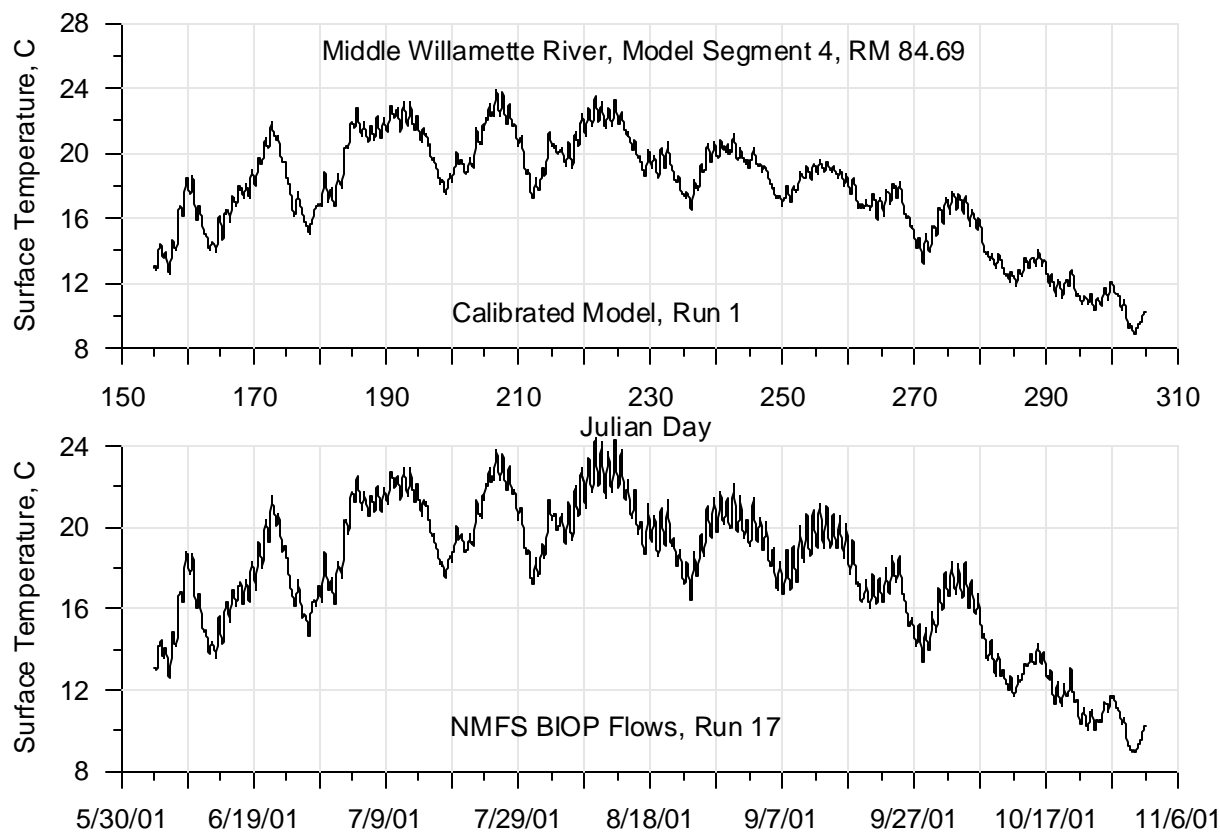
**Figure 746: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 133**



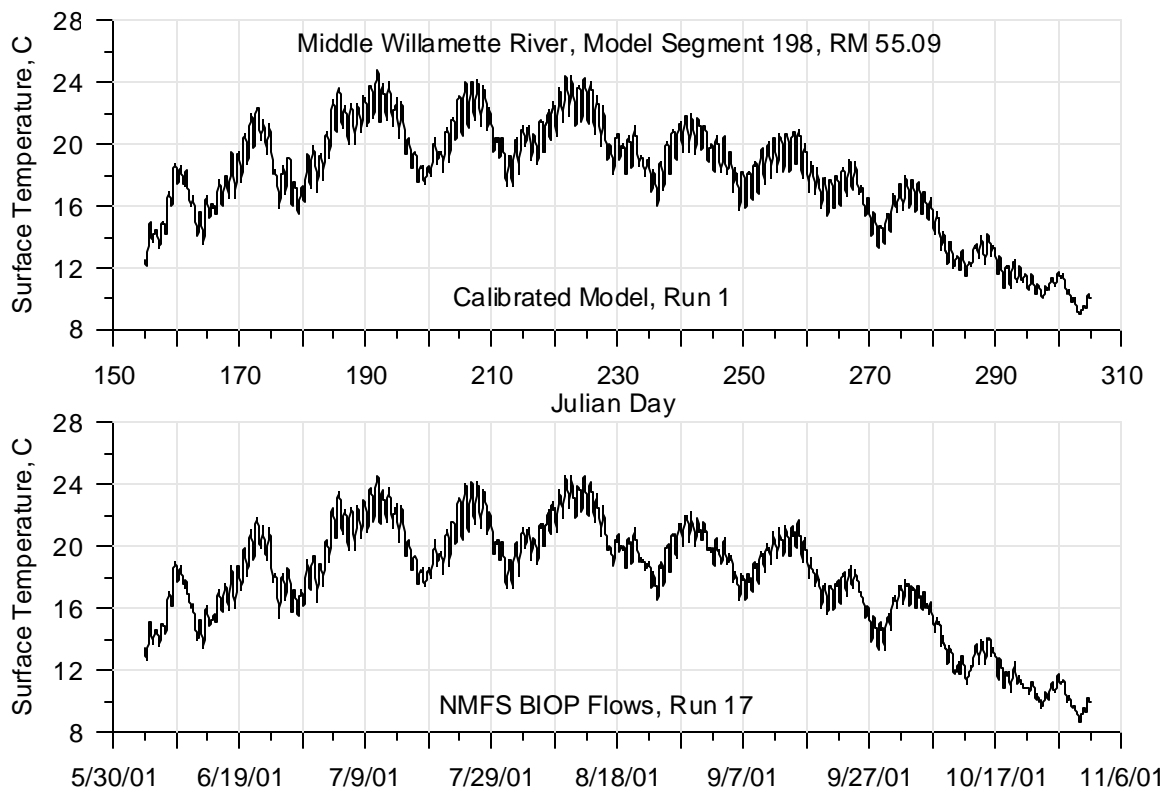
**Figure 747: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 120.11**



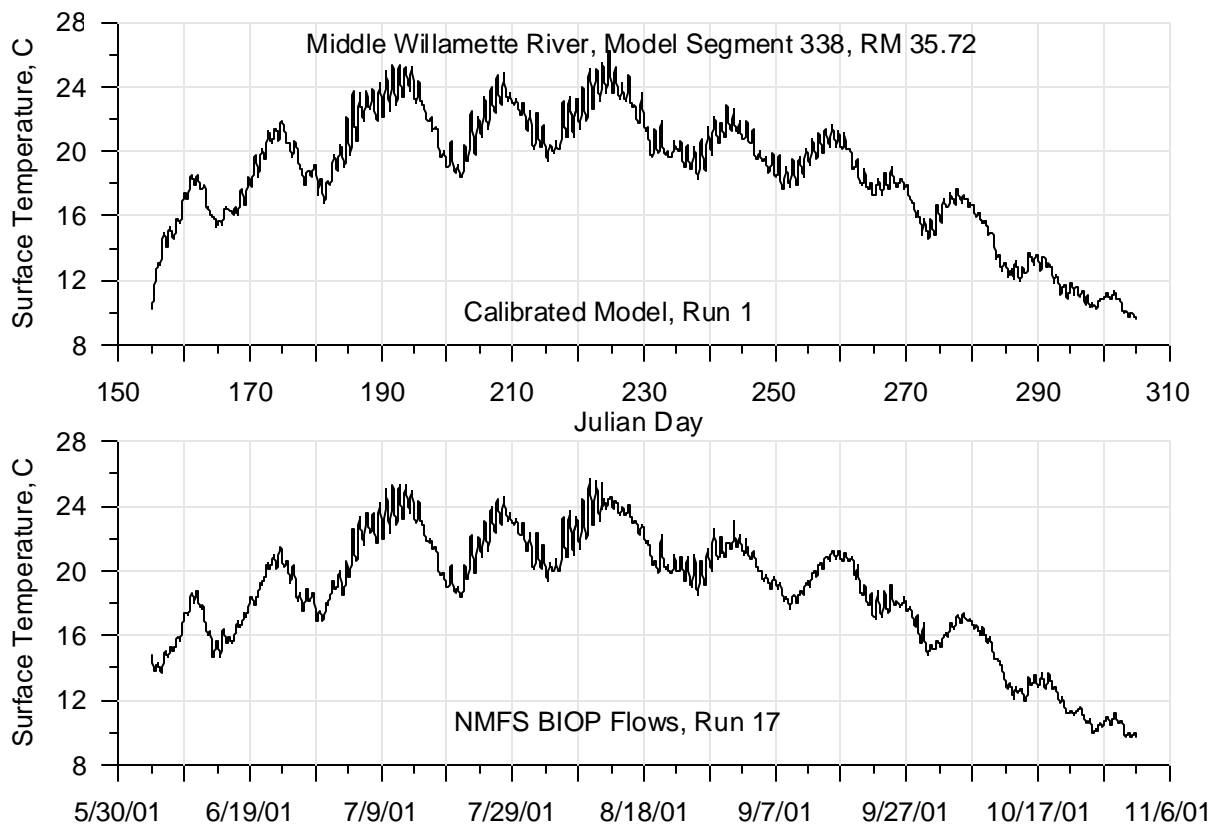
**Figure 748: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 108.6**



**Figure 749: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 84.69**

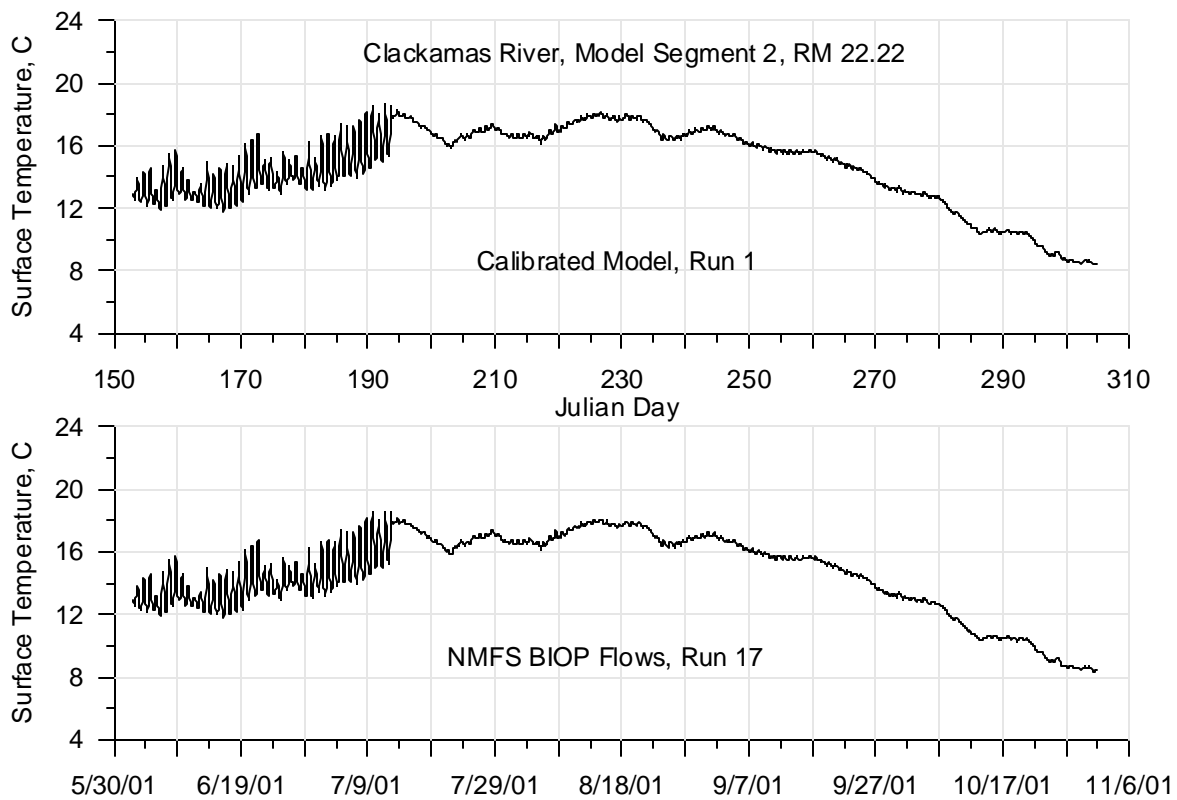


**Figure 750: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 55.09**

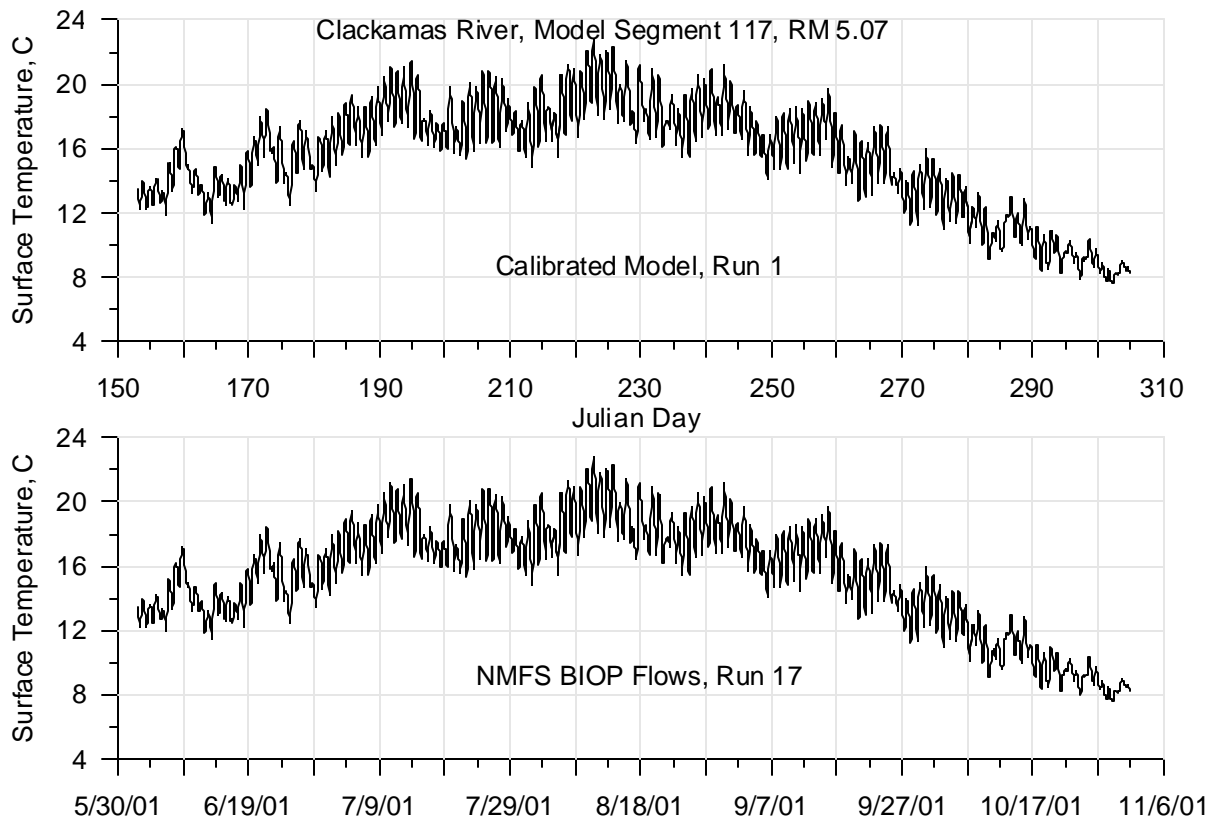


**Figure 751: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 35.72**

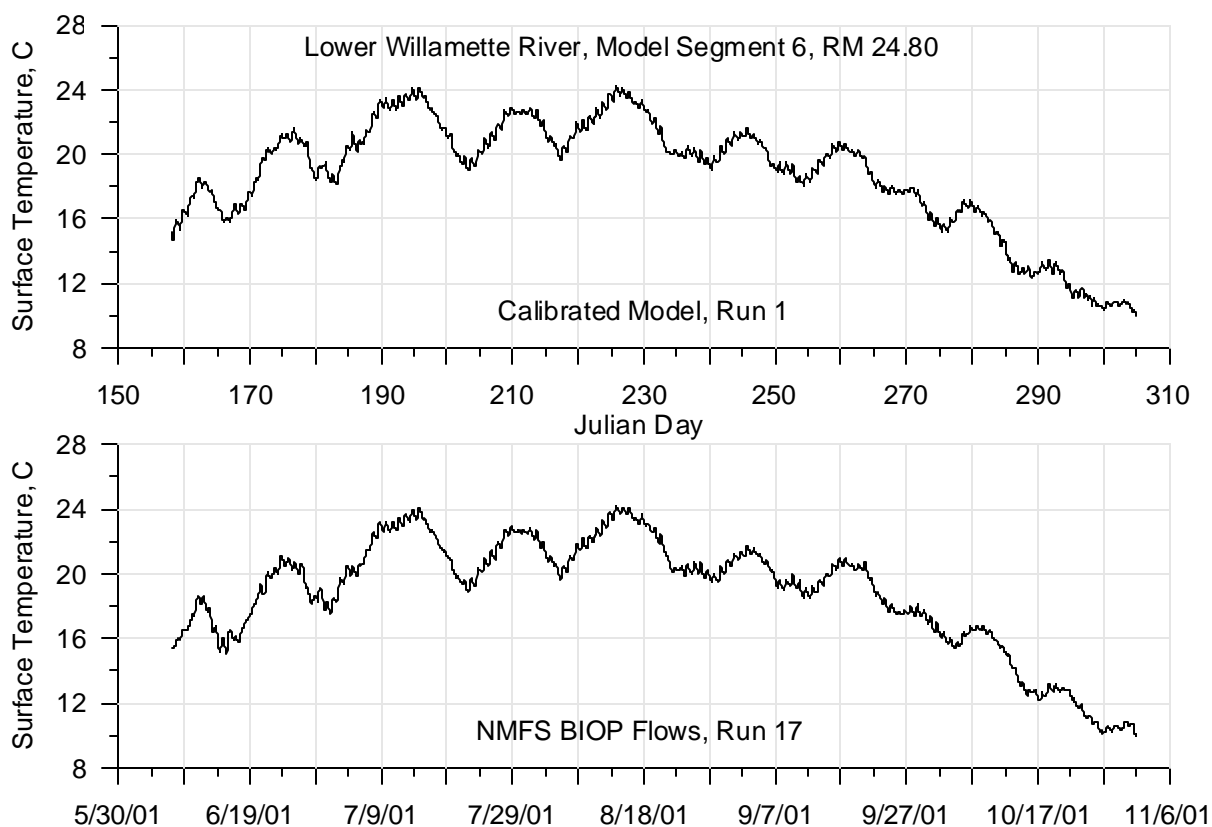




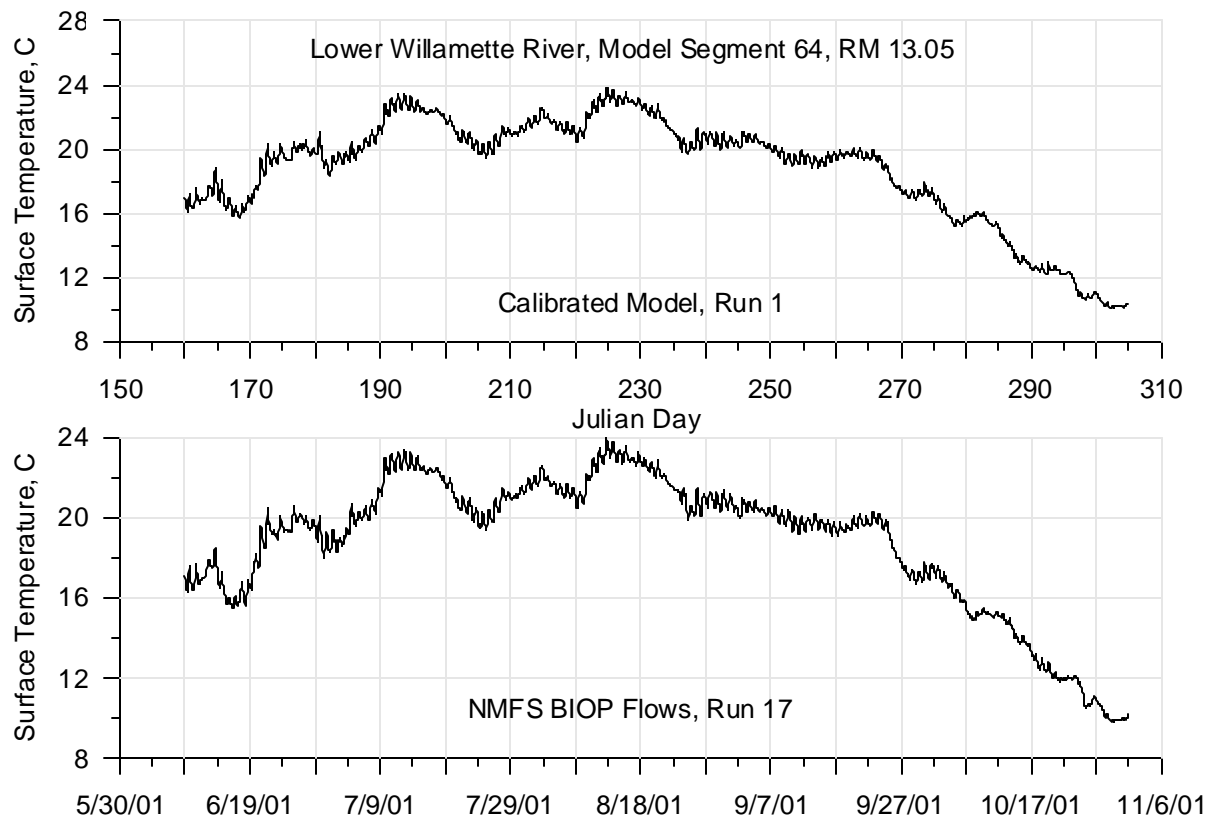
**Figure 752: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Clackamas River at RM 22.22**



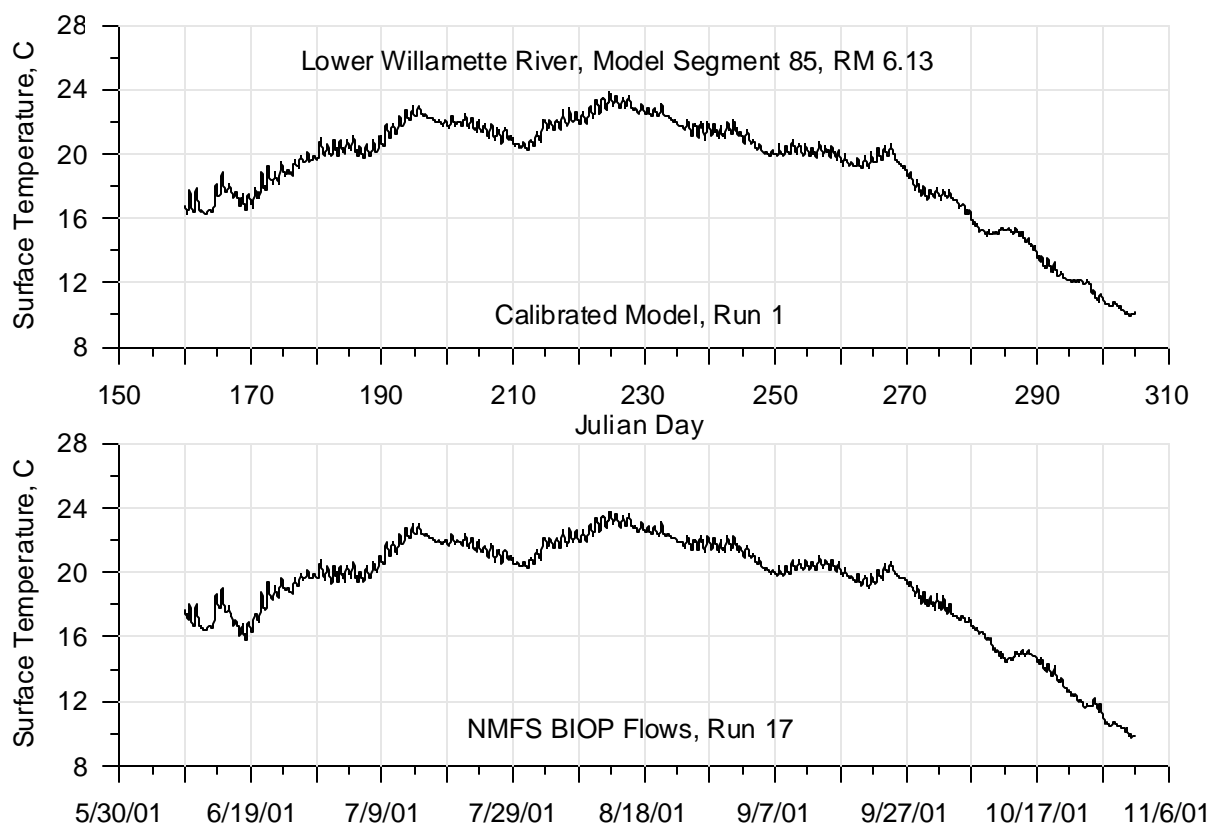
**Figure 753: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 5.07**



**Figure 754: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 24.8**

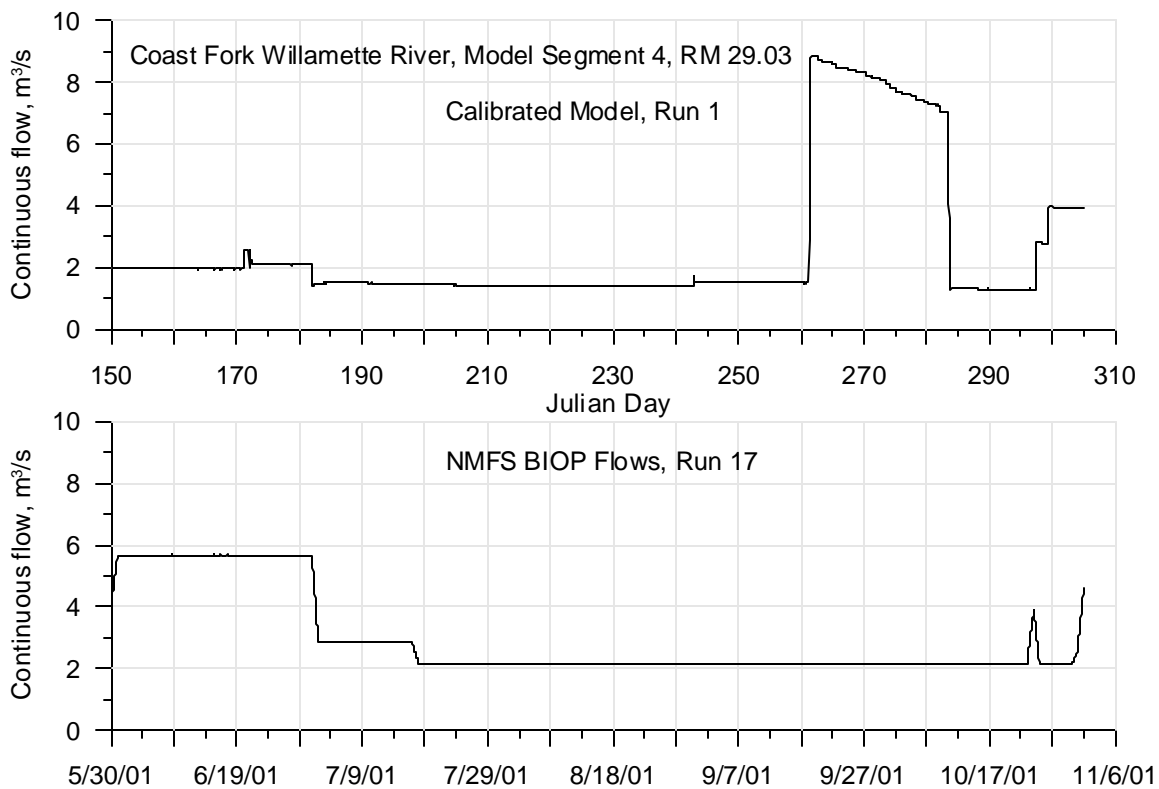


**Figure 755: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 13.05**

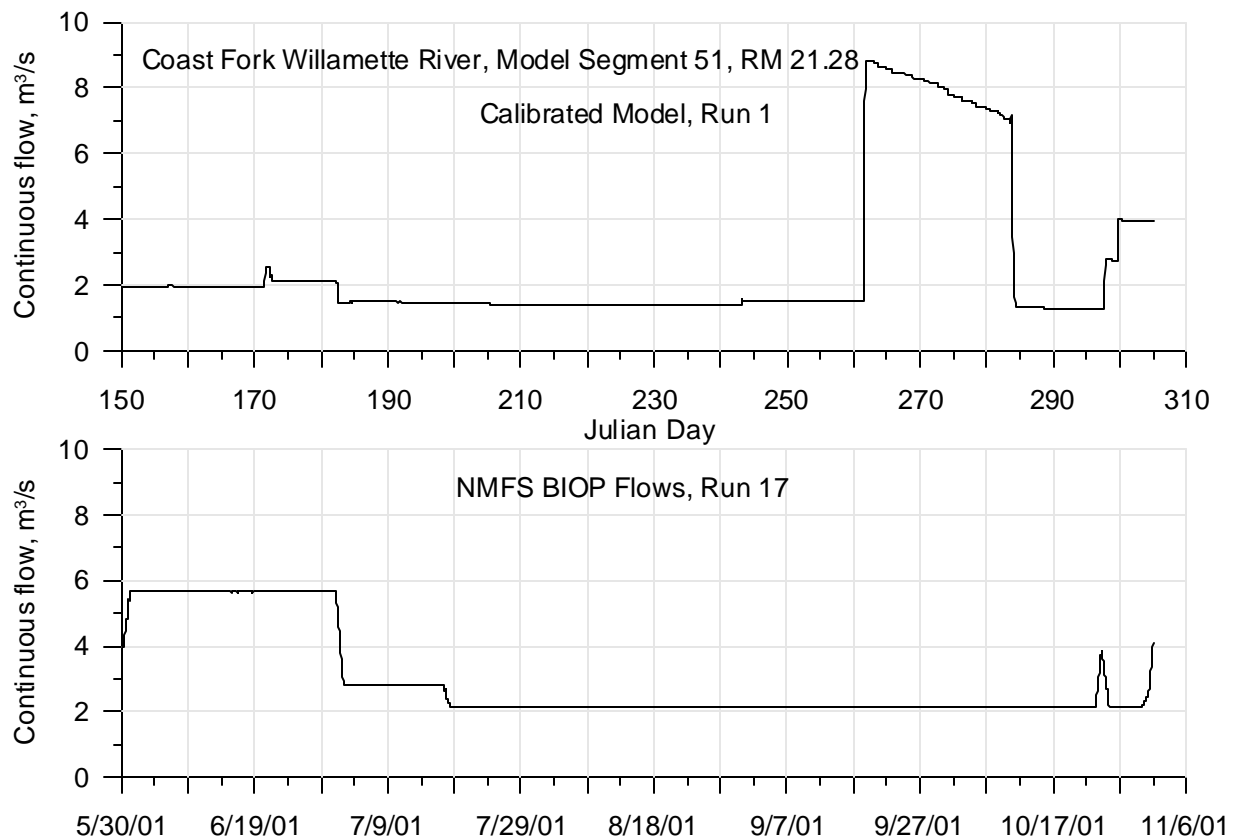


**Figure 756: Calibrated model compared with NMFS Biological Opinion flows, continuous temperature for 2001 for the Willamette River at RM 6.13**

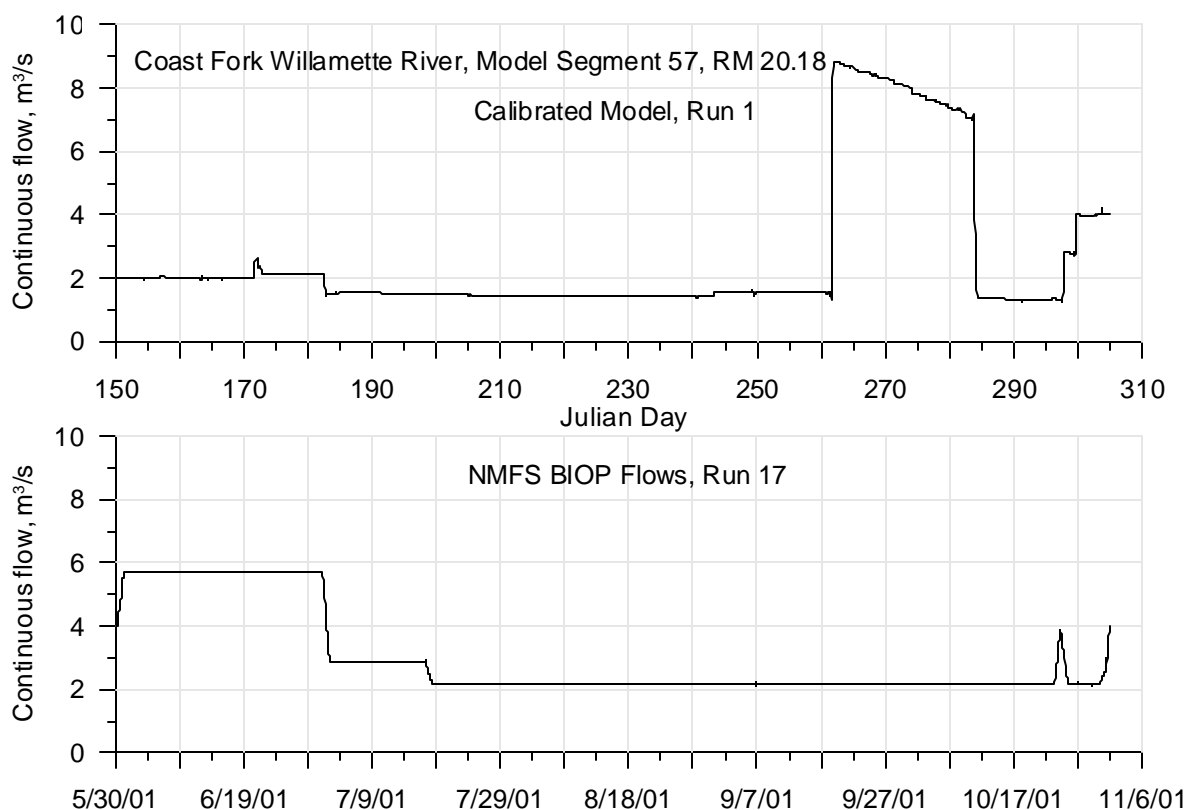
## Continuous Flow



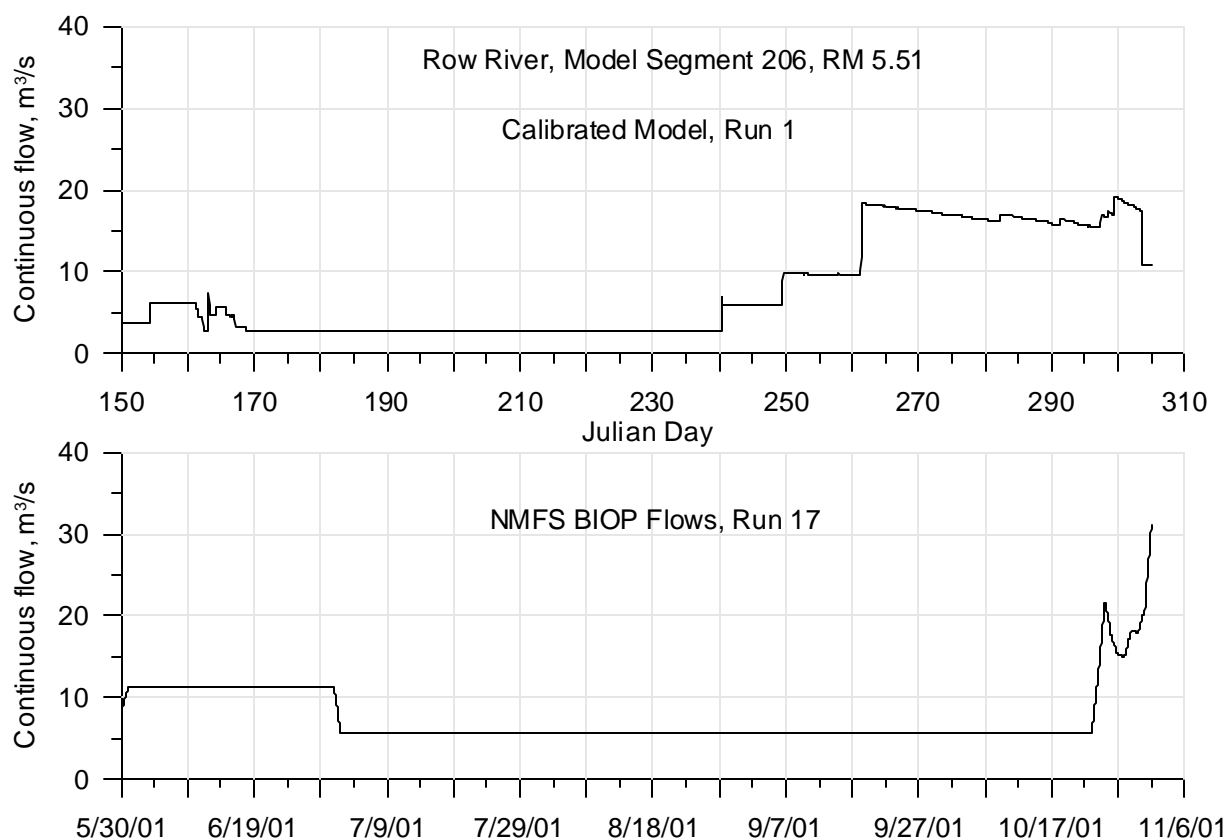
**Figure 757: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Coast Fork Willamette River at RM 29.03**



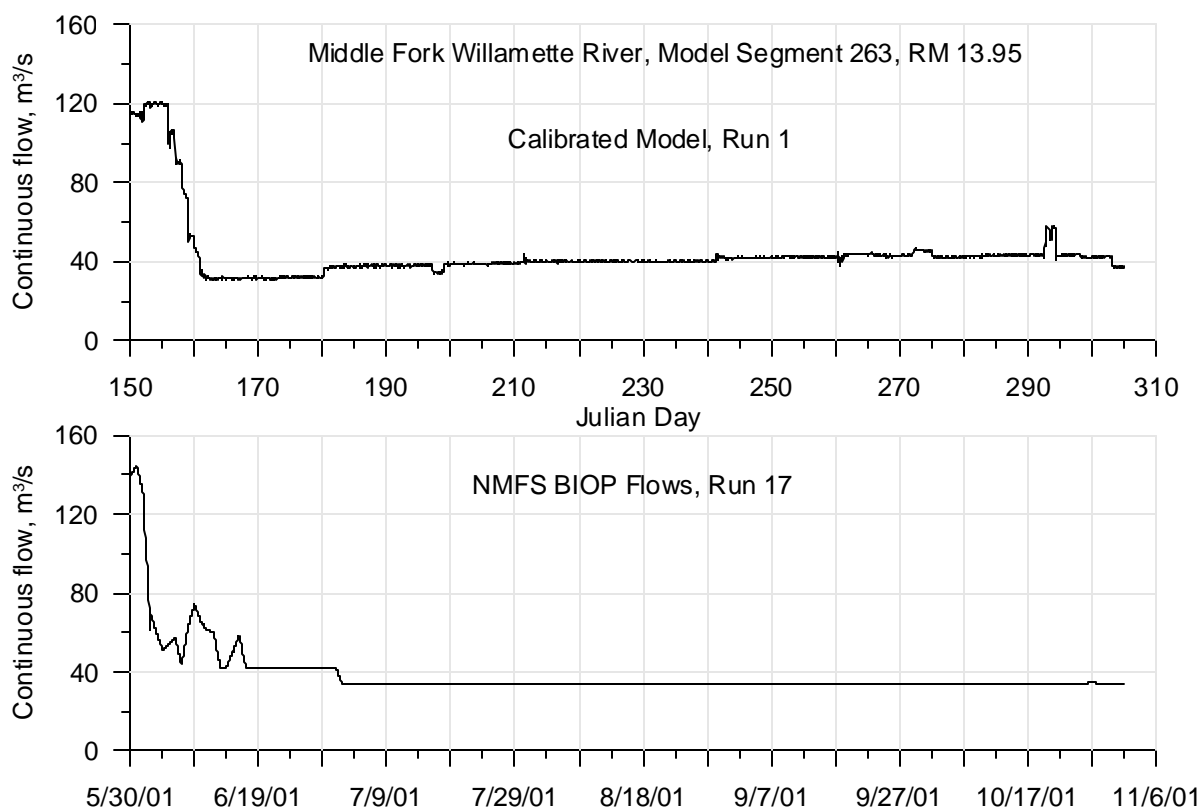
**Figure 758: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Coast Fork Willamette River at RM 21.28**



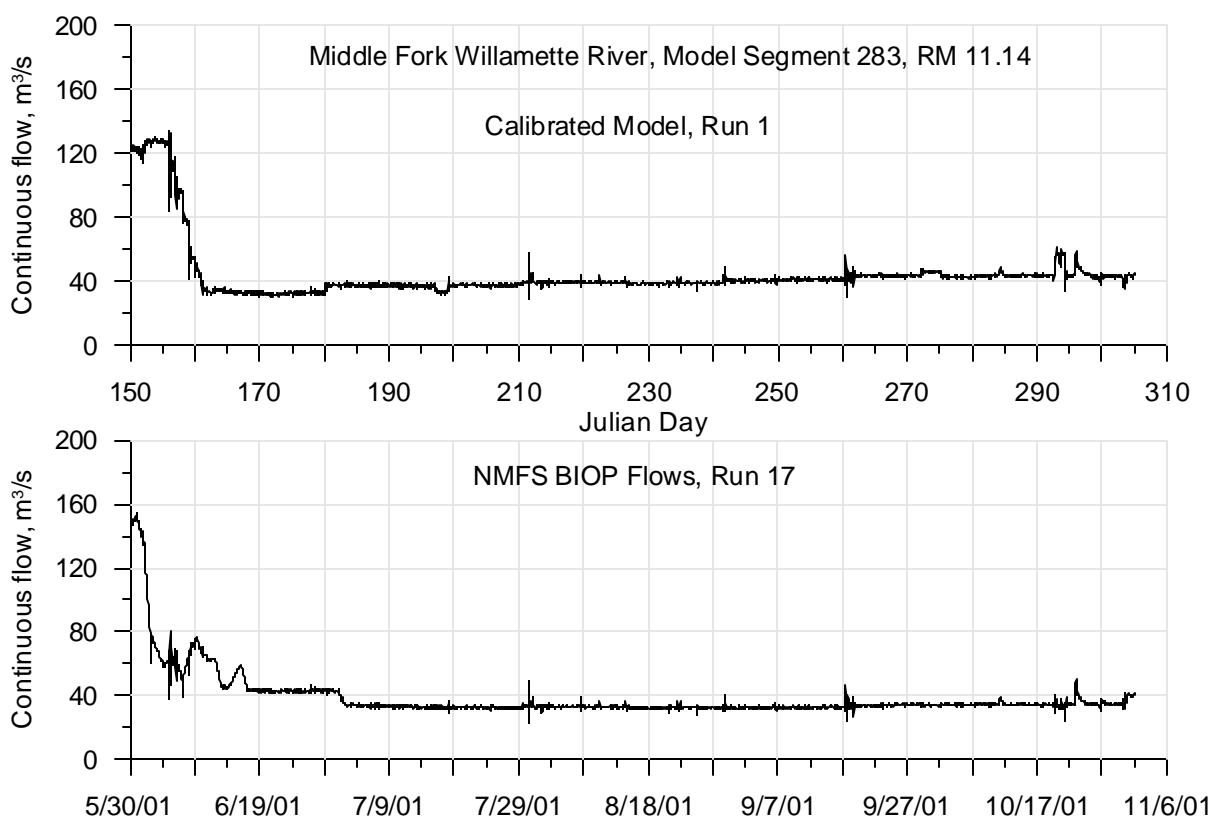
**Figure 759: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Coast Fork Willamette River at RM 20.18**



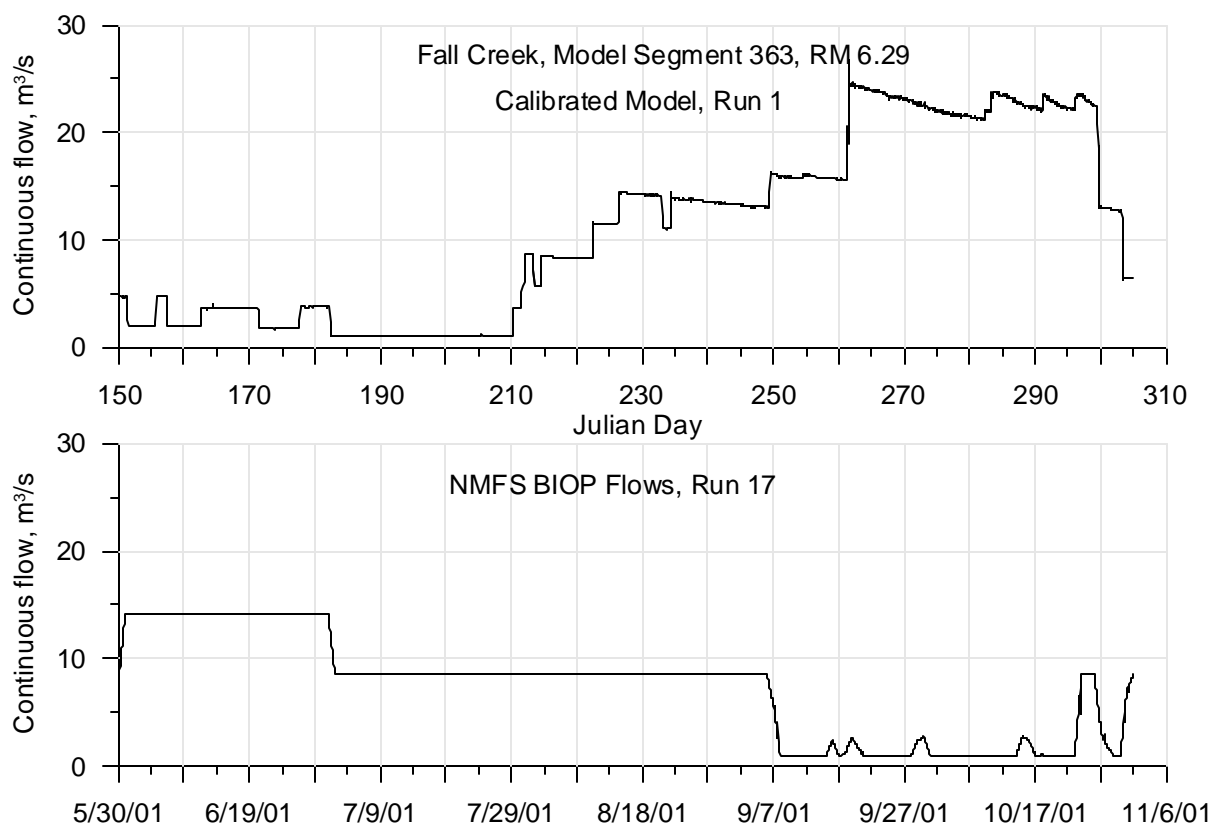
**Figure 760: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Row River at RM 5.51**



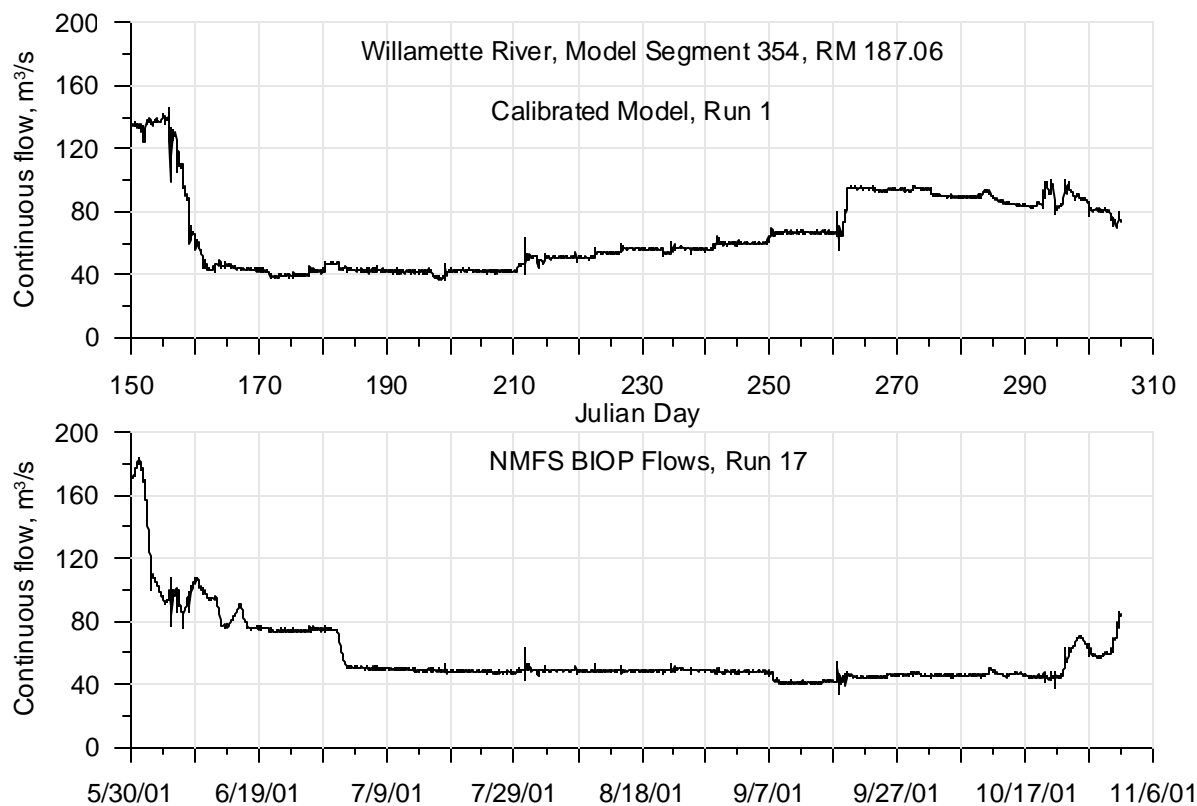
**Figure 761: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Middle Fork Willamette River at RM 13.95**



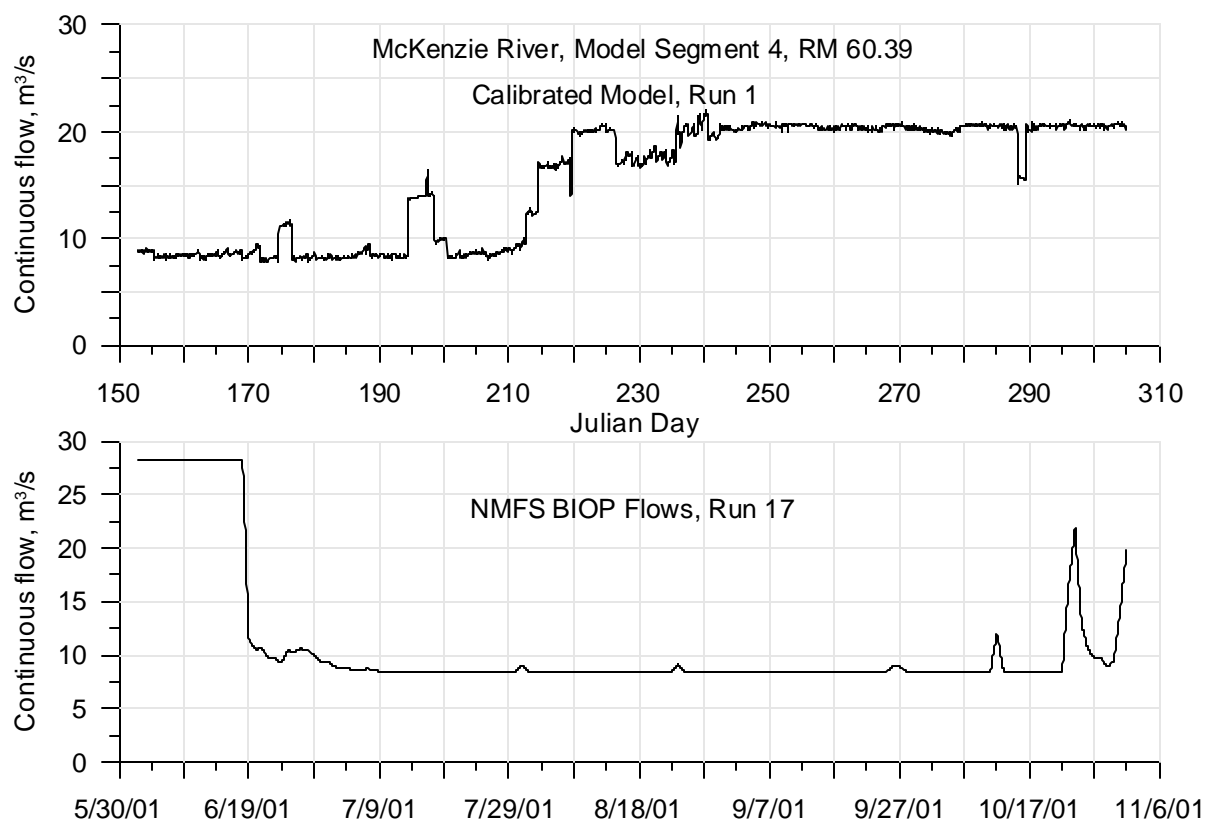
**Figure 762: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Middle Fork Willamette River at RM 11.14**



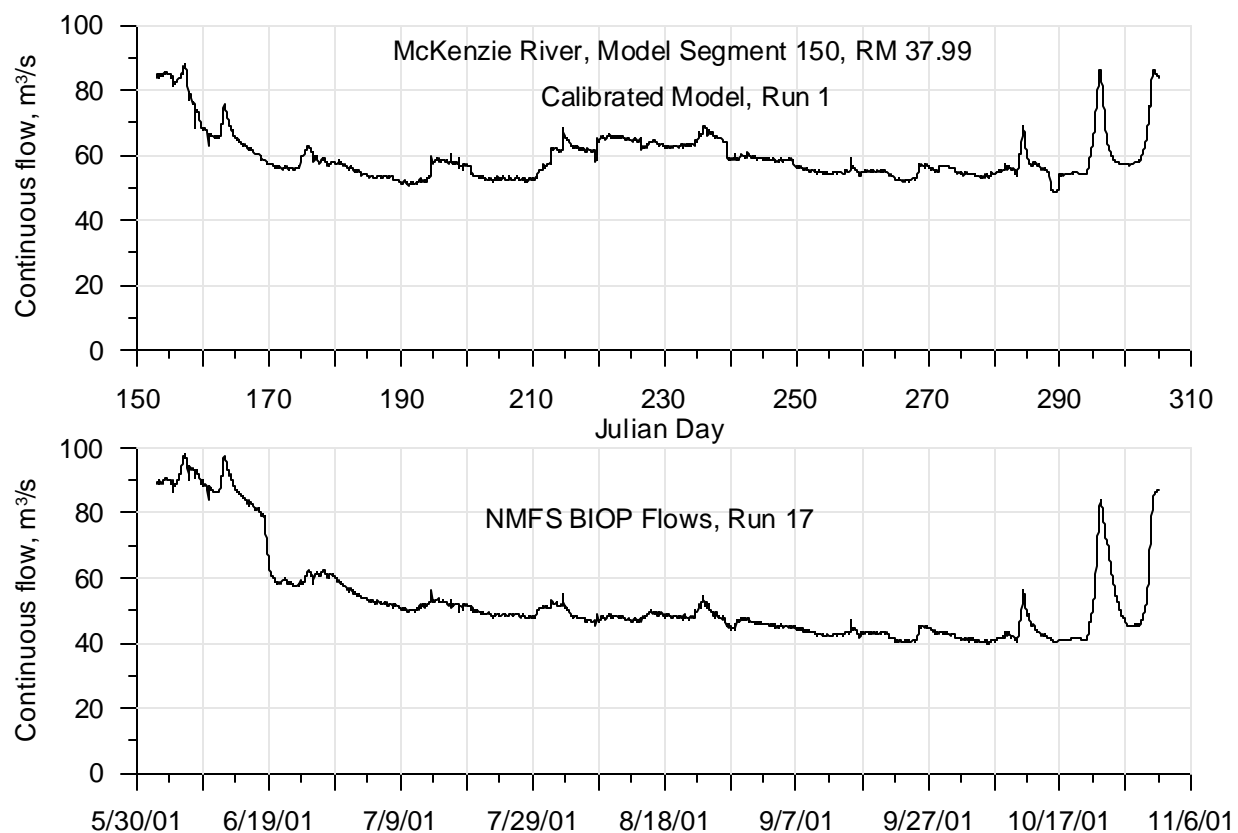
**Figure 763: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for Fall Creek at RM 6.29**



**Figure 764: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 187.06**

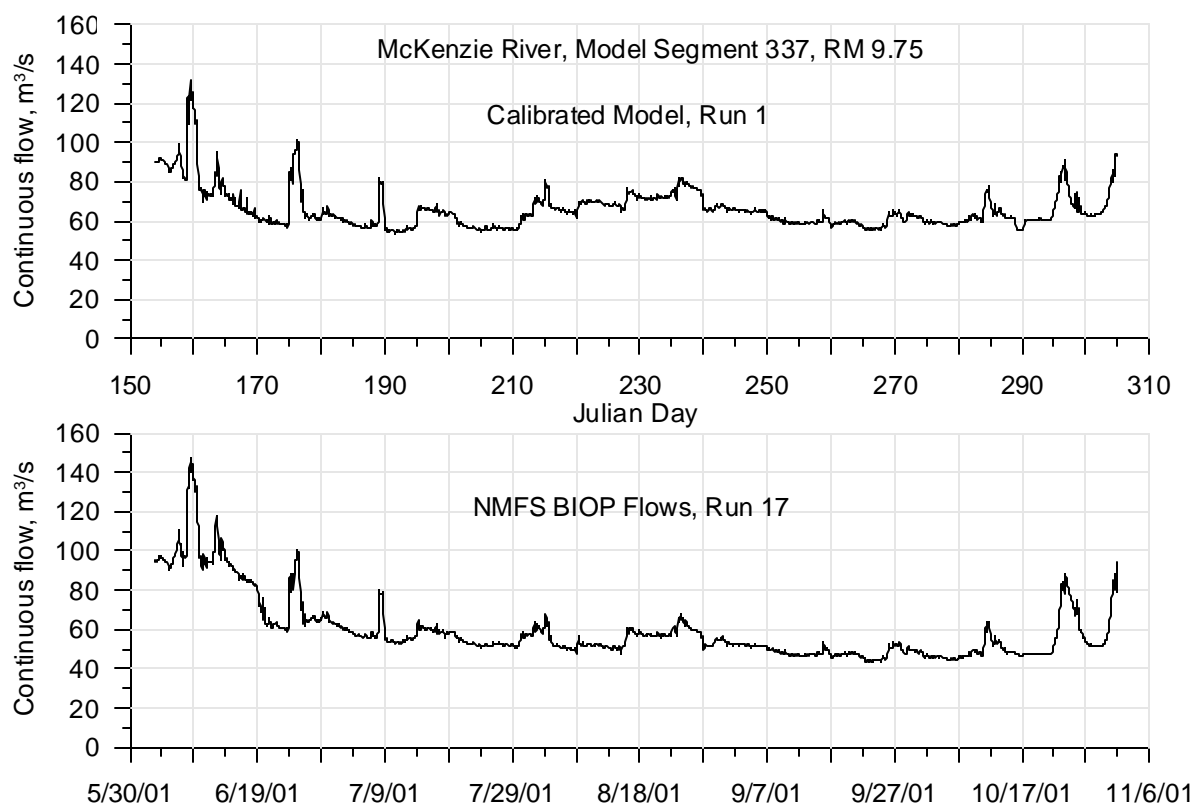


**Figure 765: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the McKenzie River at RM 60.39**

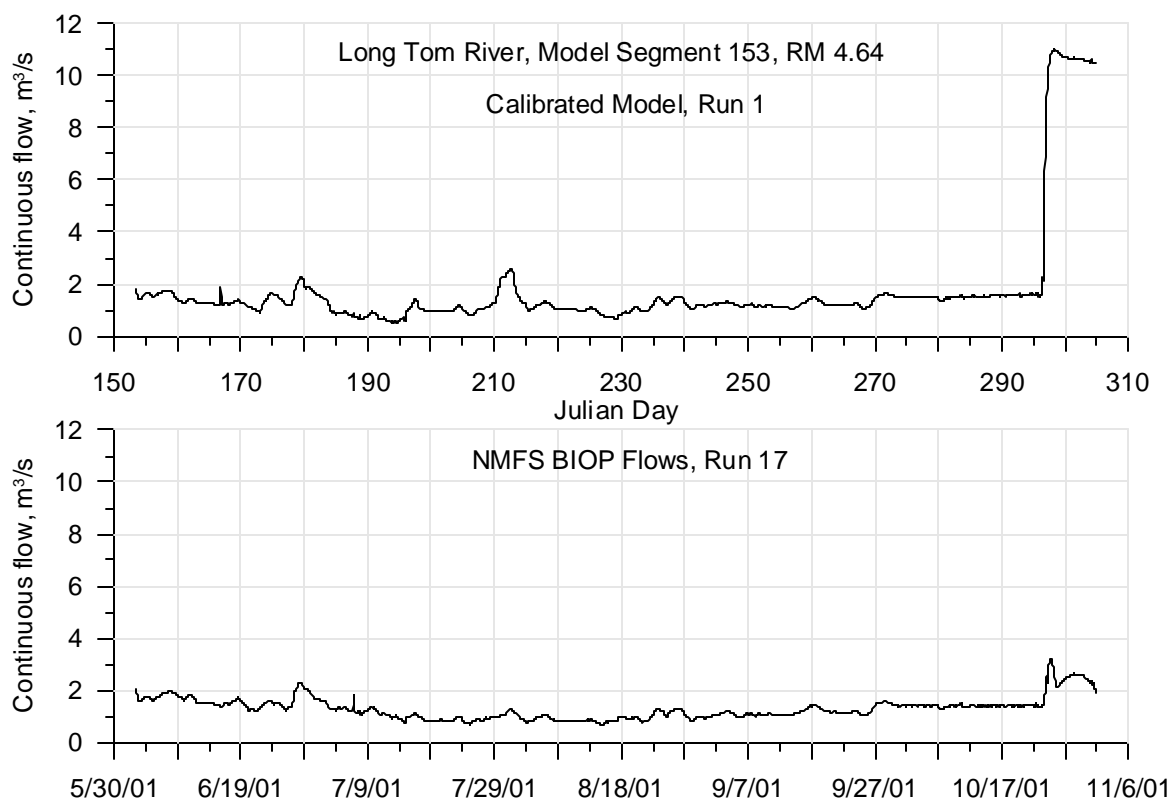


**Figure 766: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the McKenzie River at RM 37.99**

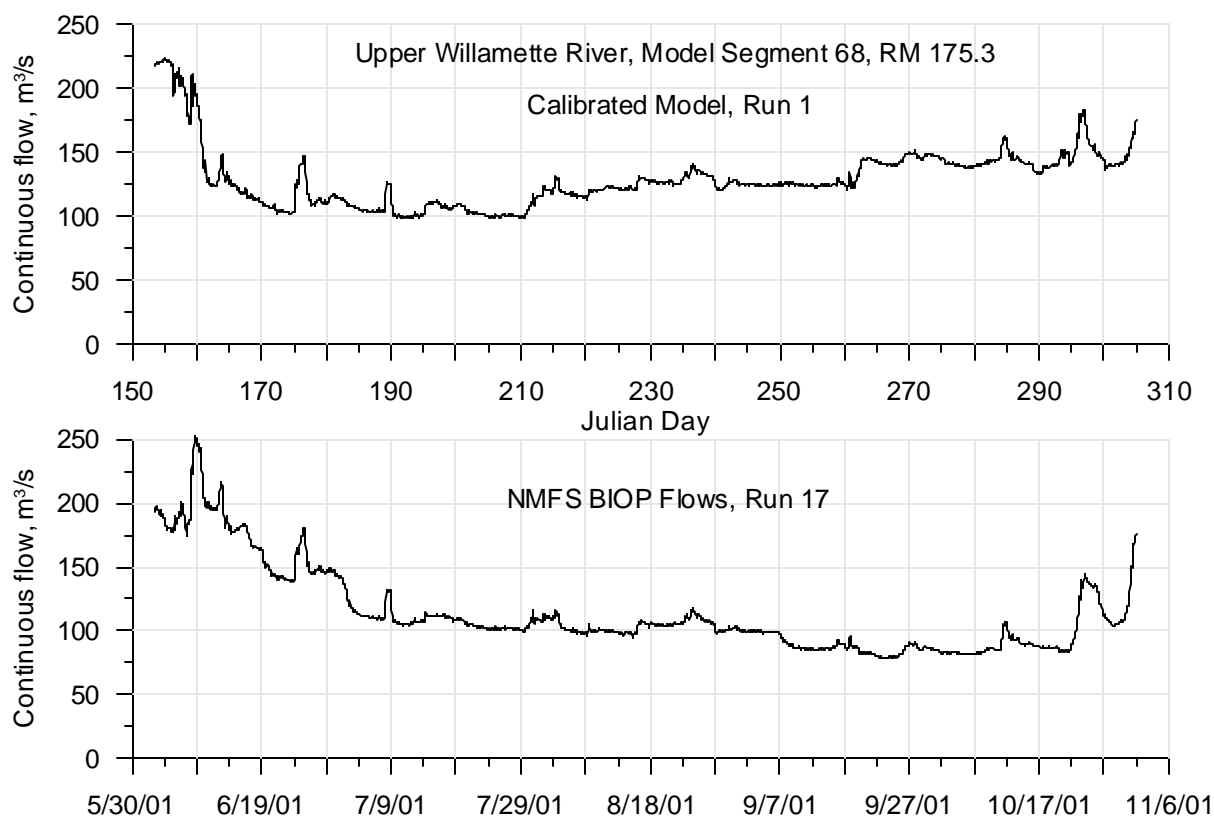




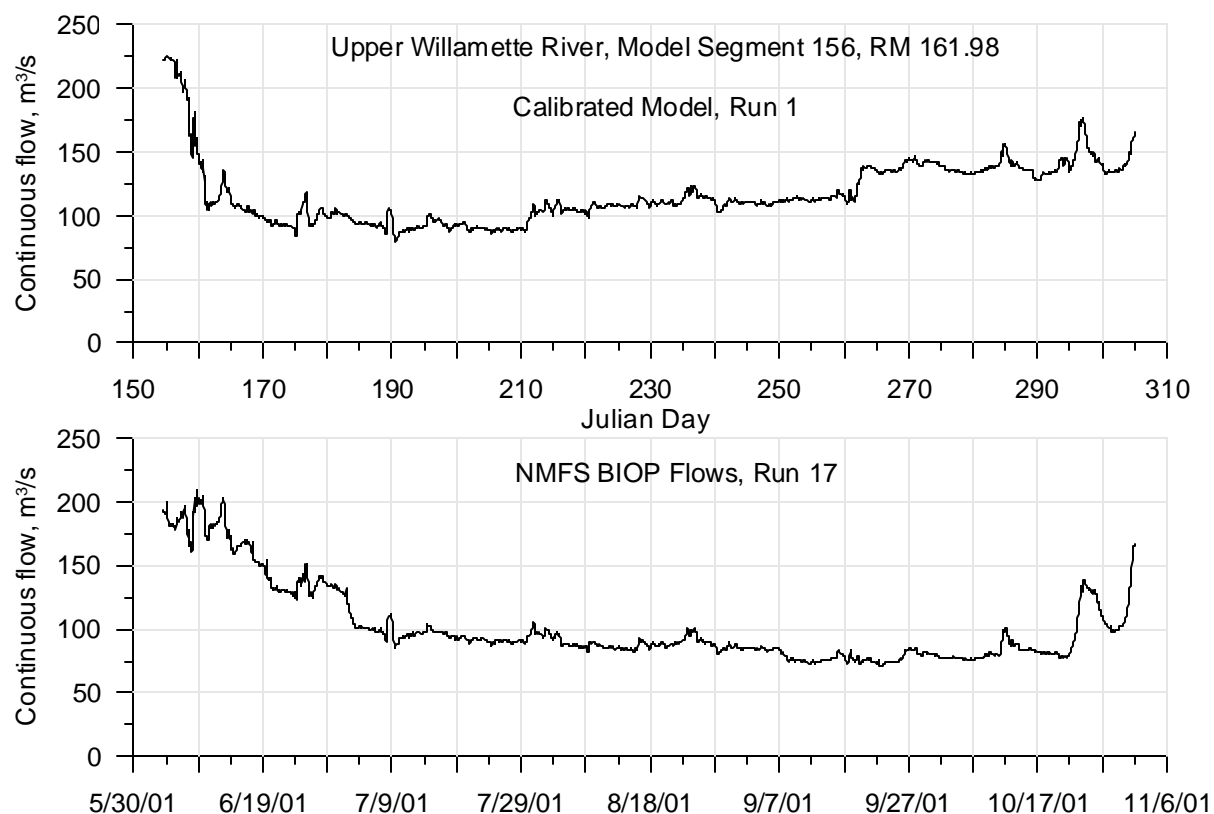
**Figure 767: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the McKenzie River at RM 9.75**



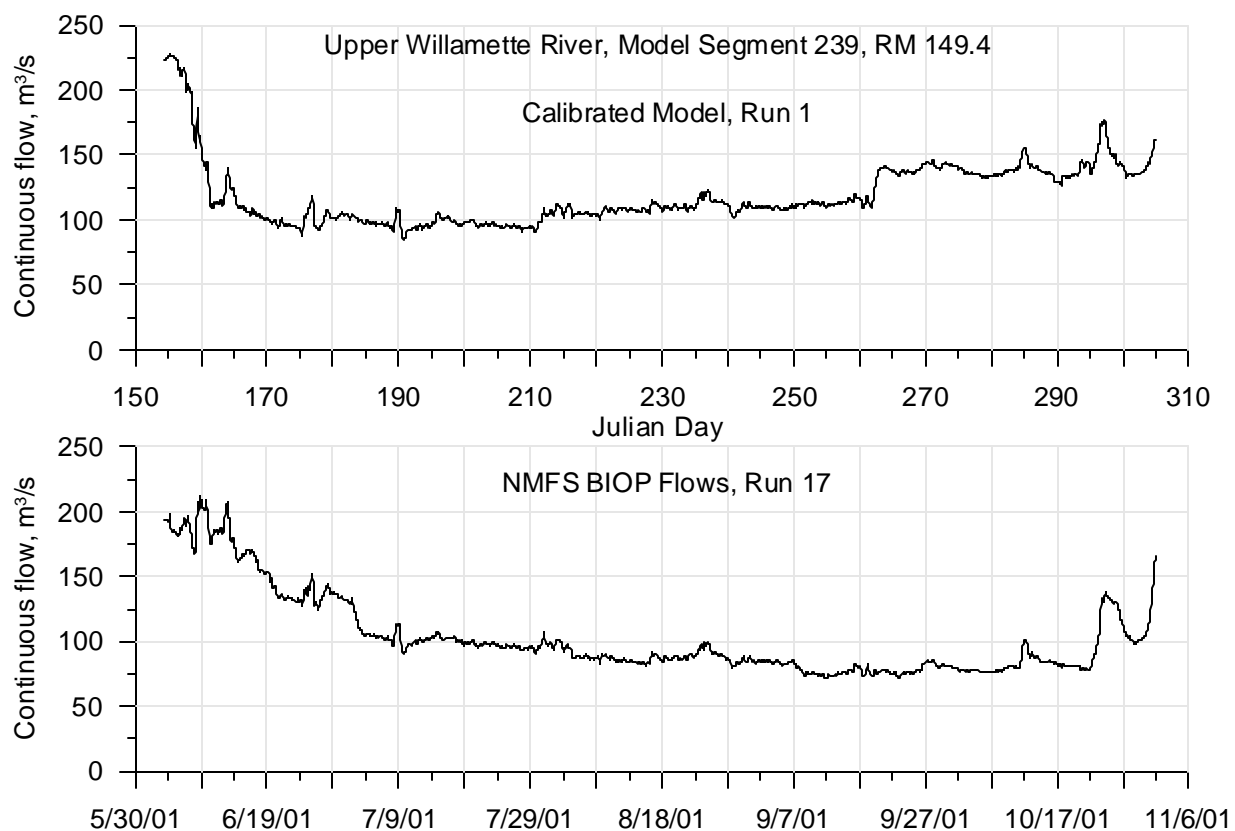
**Figure 768: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Long Tom River at RM 4.64**



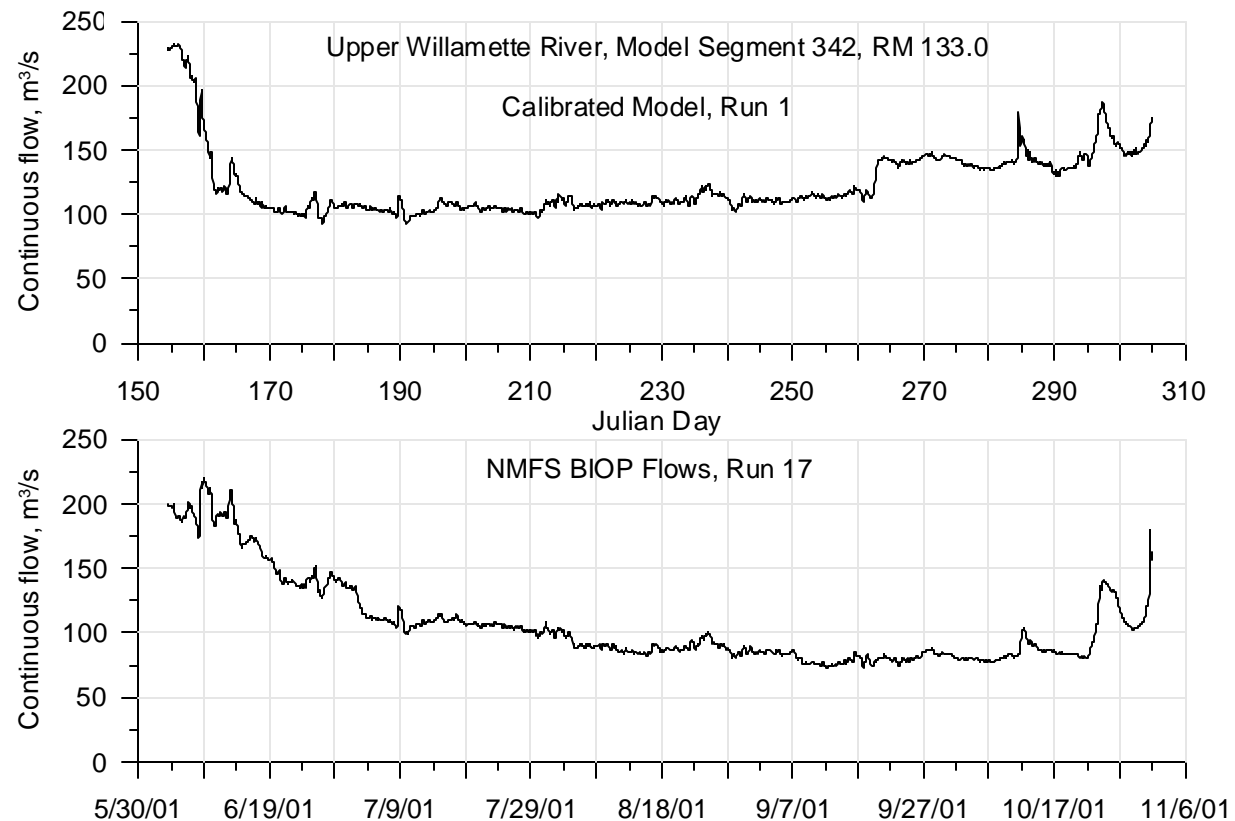
**Figure 769: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 175.3**



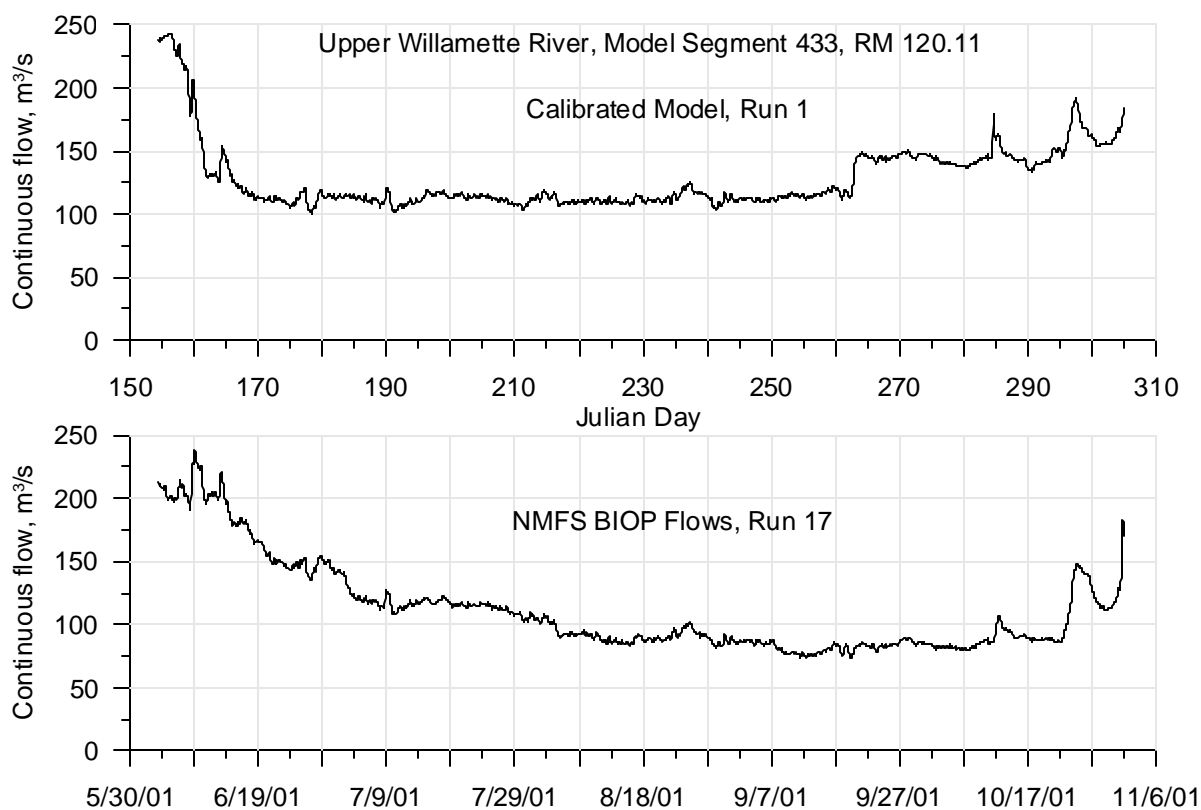
**Figure 770: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 161.98**



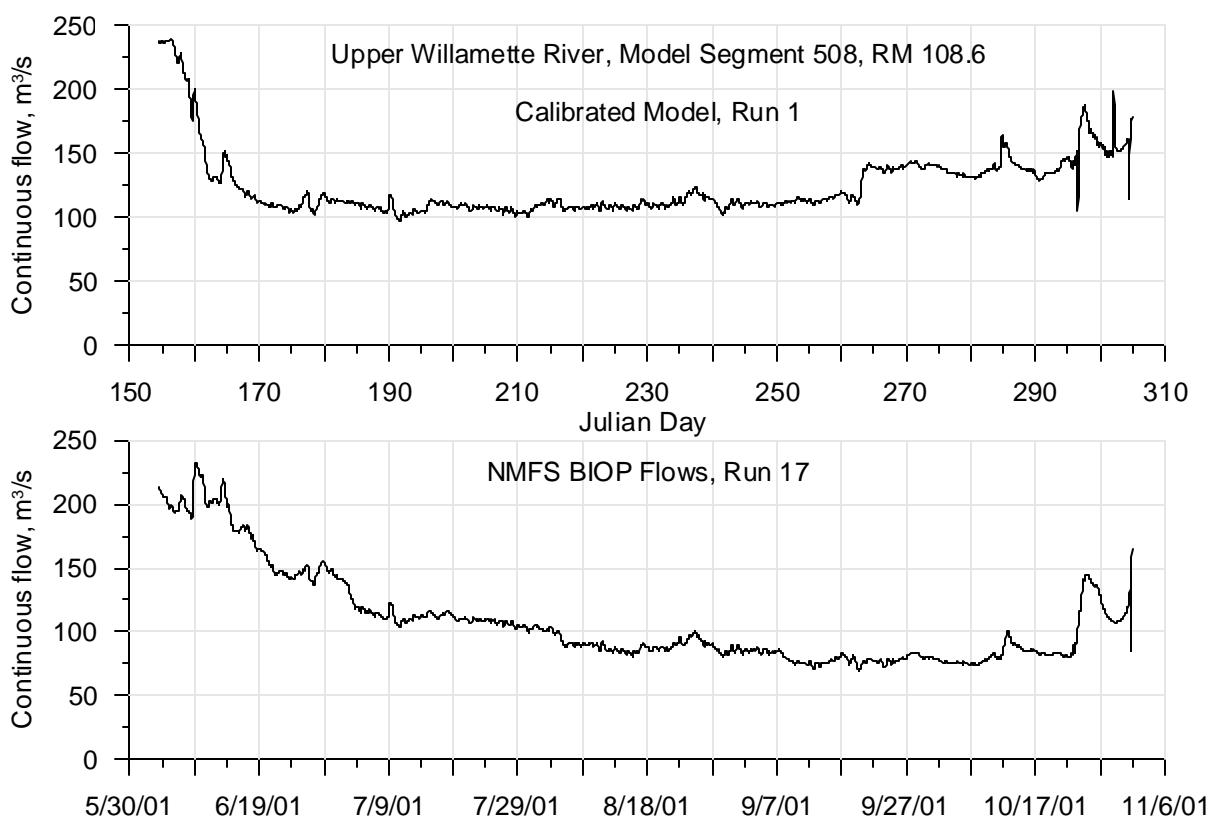
**Figure 771: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 149.4**



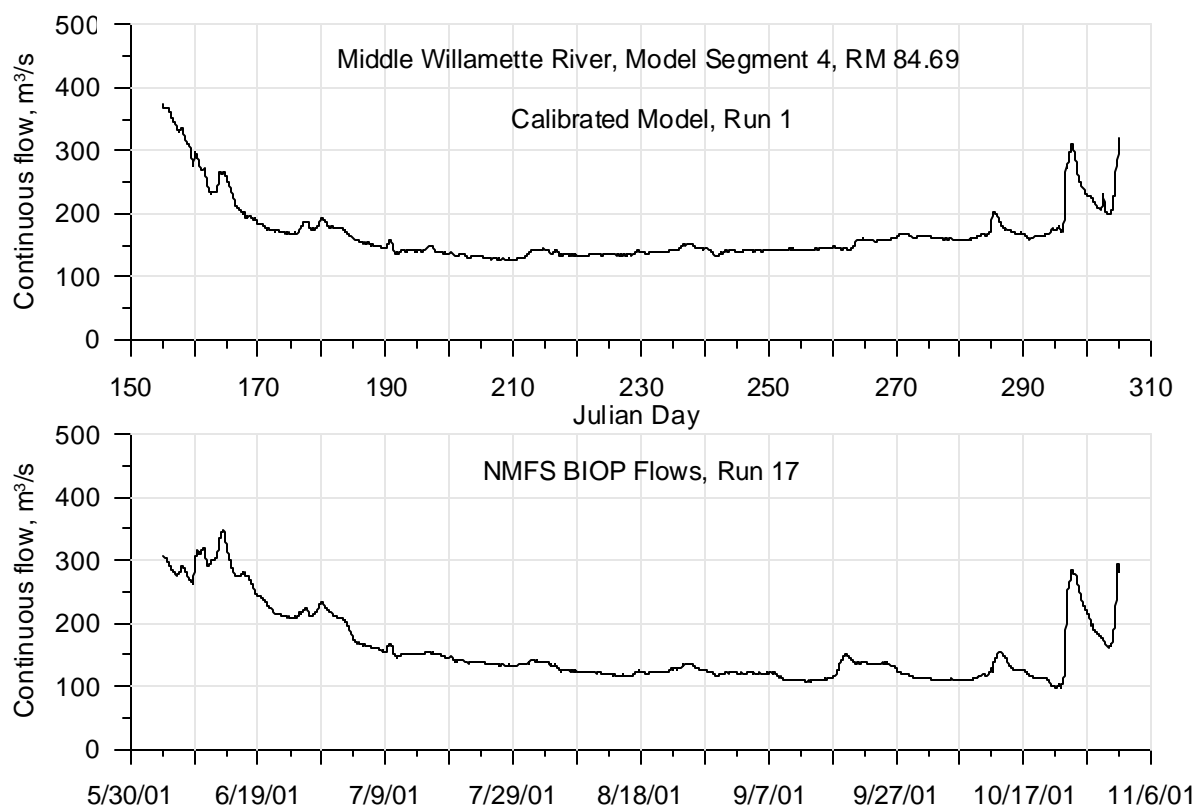
**Figure 772: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 133**



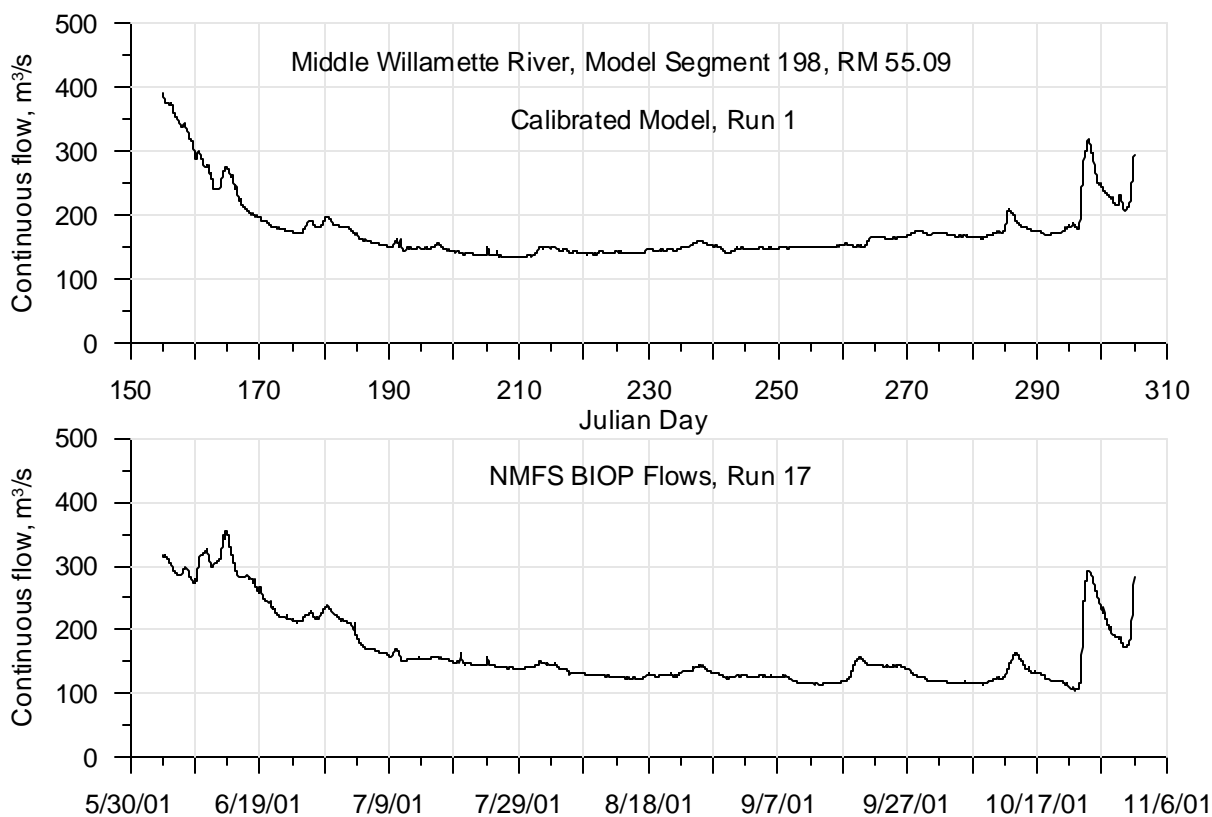
**Figure 773: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 120.11**



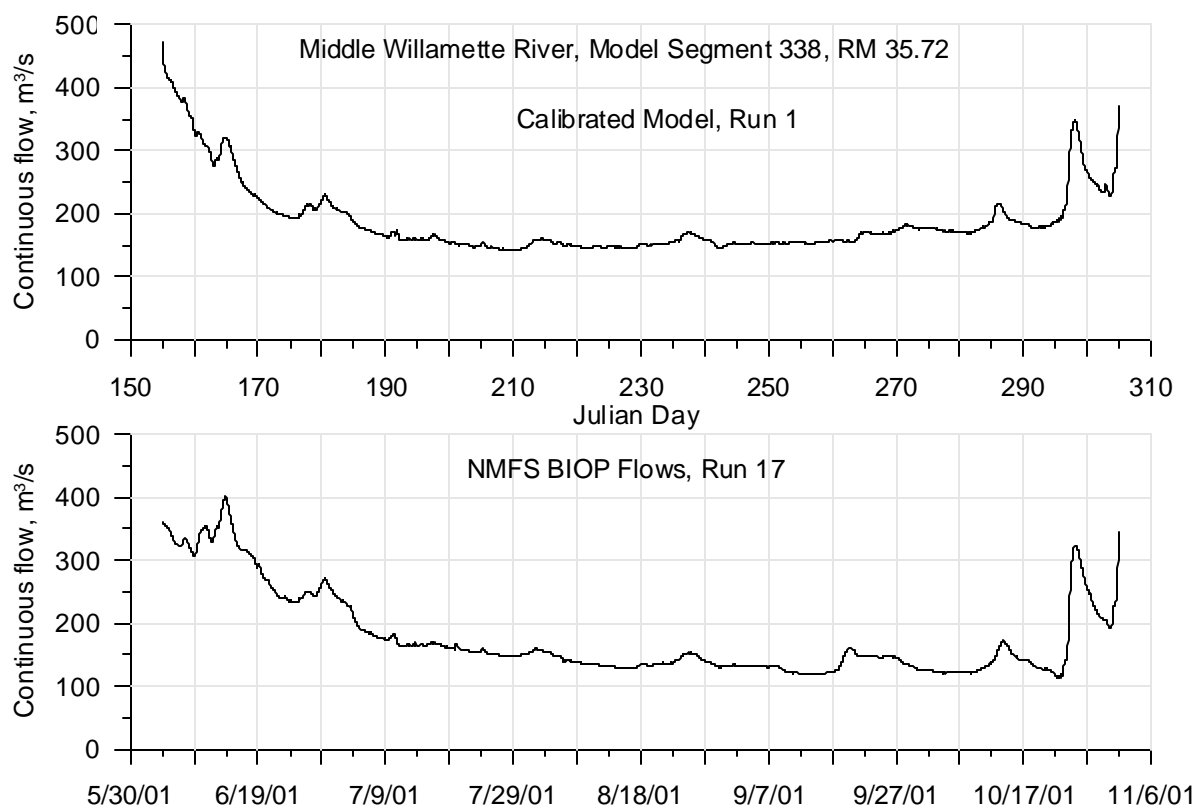
**Figure 774: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 108.6**



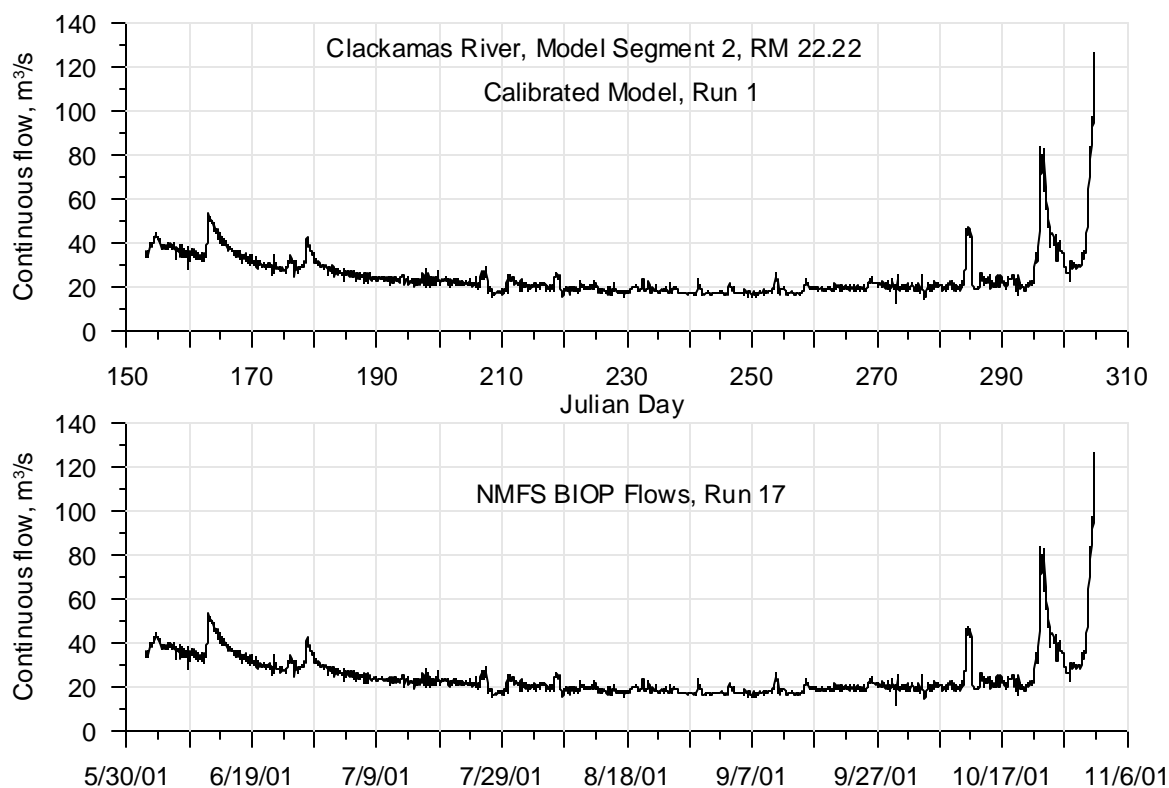
**Figure 775: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 84.69**



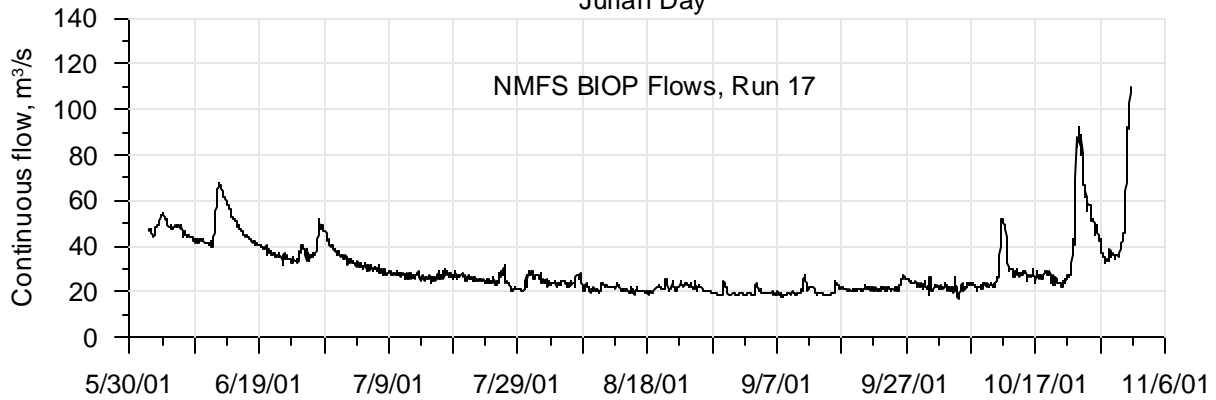
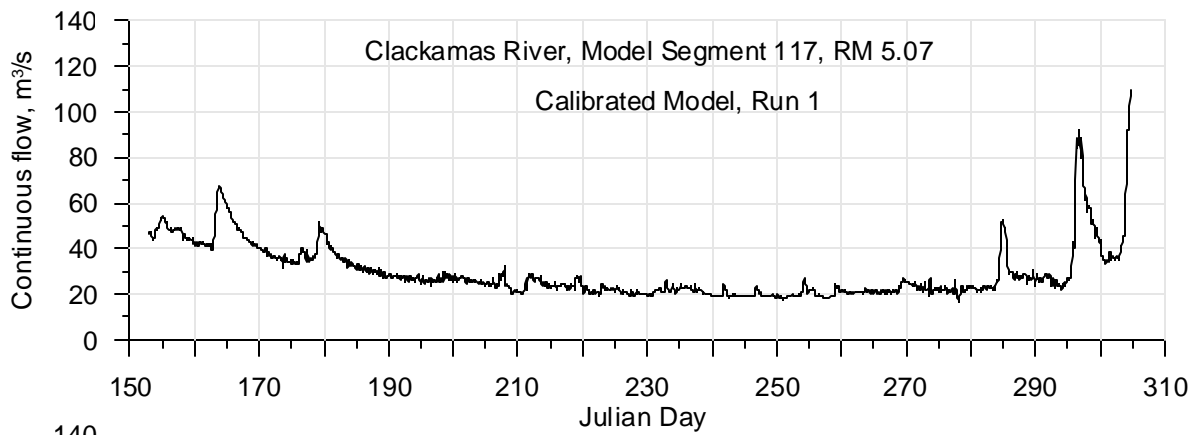
**Figure 776: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 55.09**



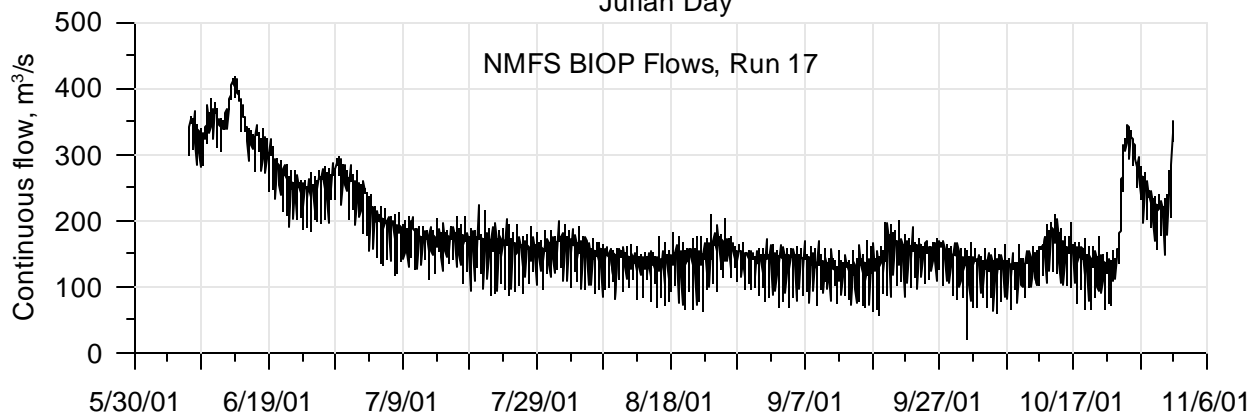
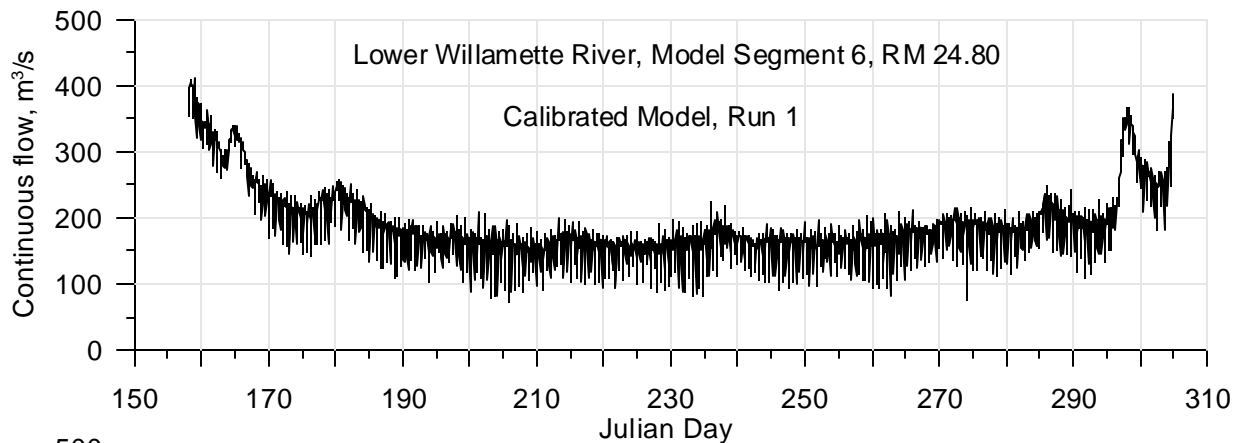
**Figure 777: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 35.72**



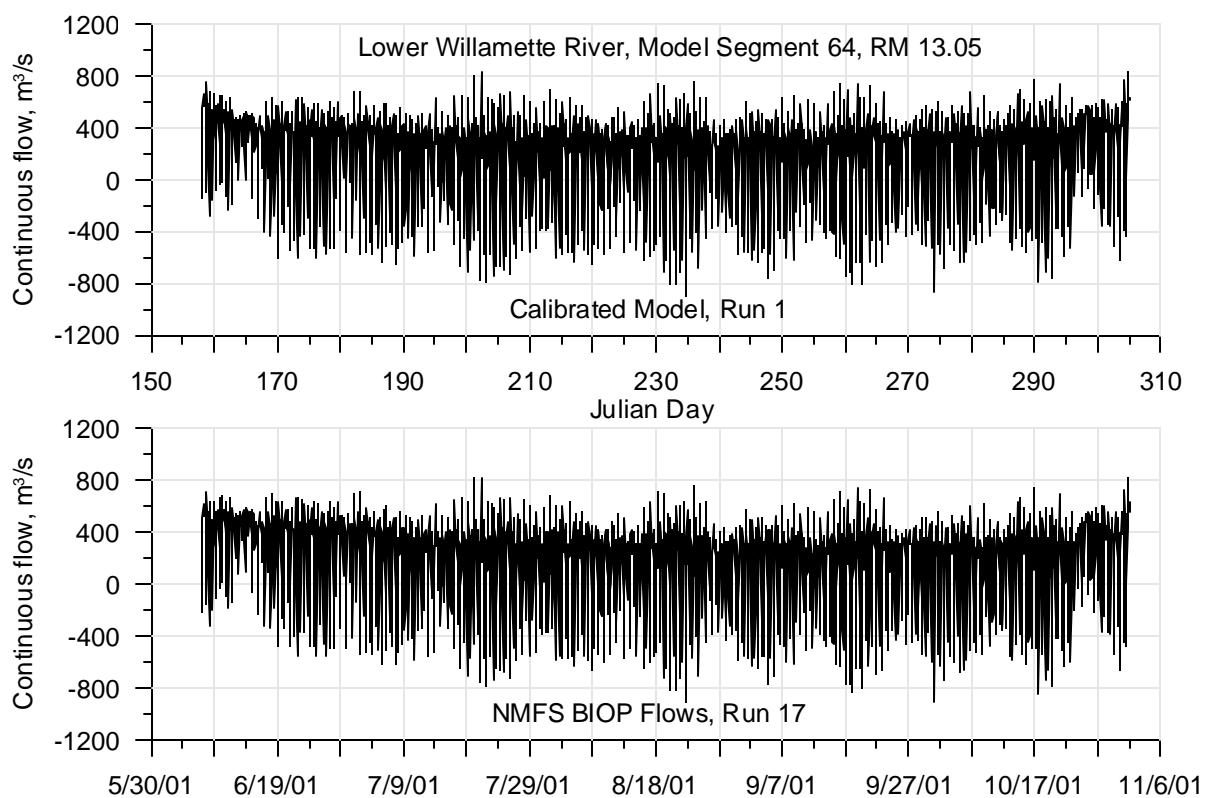
**Figure 778: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Clackamas River at RM 22.22**



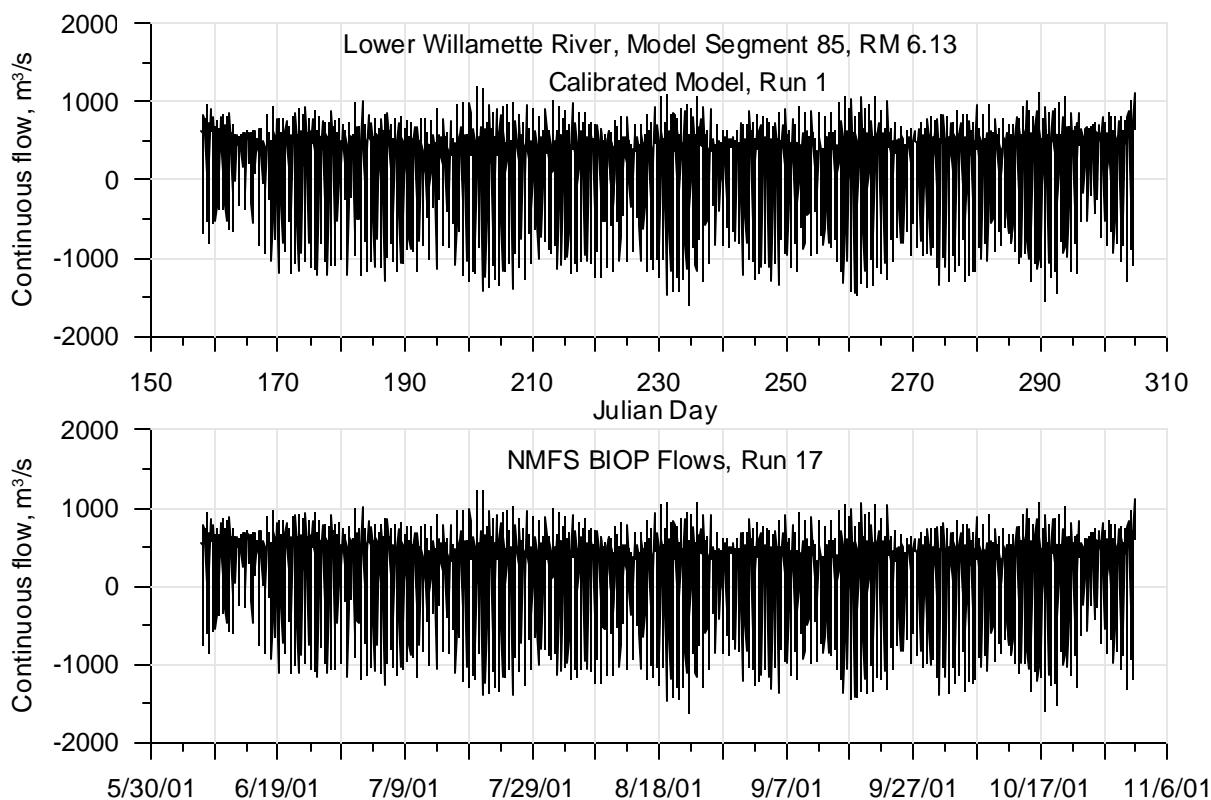
**Figure 779: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Clackamas River at RM 5.07**



**Figure 780: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 24.8**



**Figure 781: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 13.05**



**Figure 782: Calibrated model compared with NMFS Biological Opinion flows, continuous flow for 2001 for the Willamette River at RM 6.13**



## Daily seven day moving average of daily maximum temperature

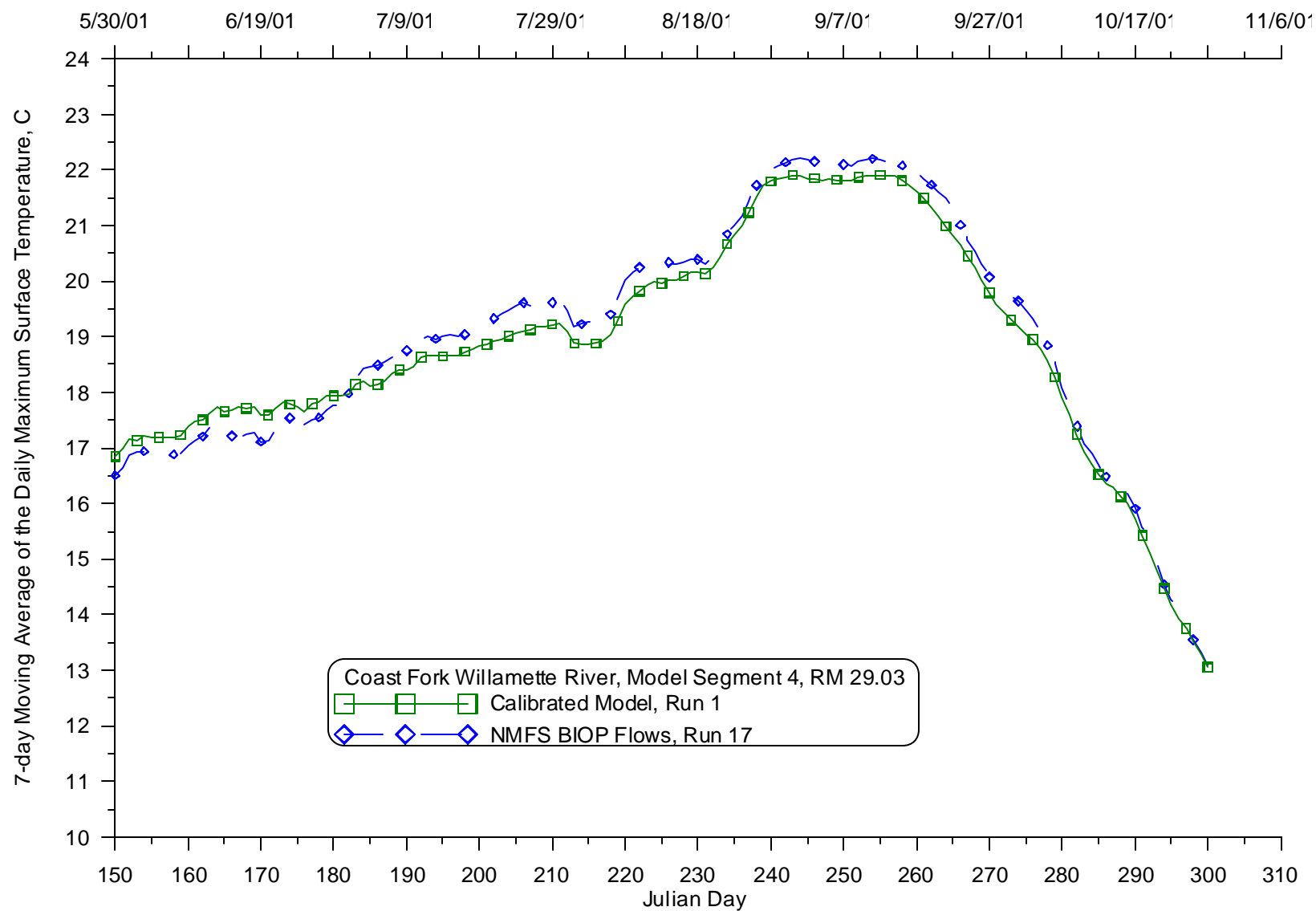
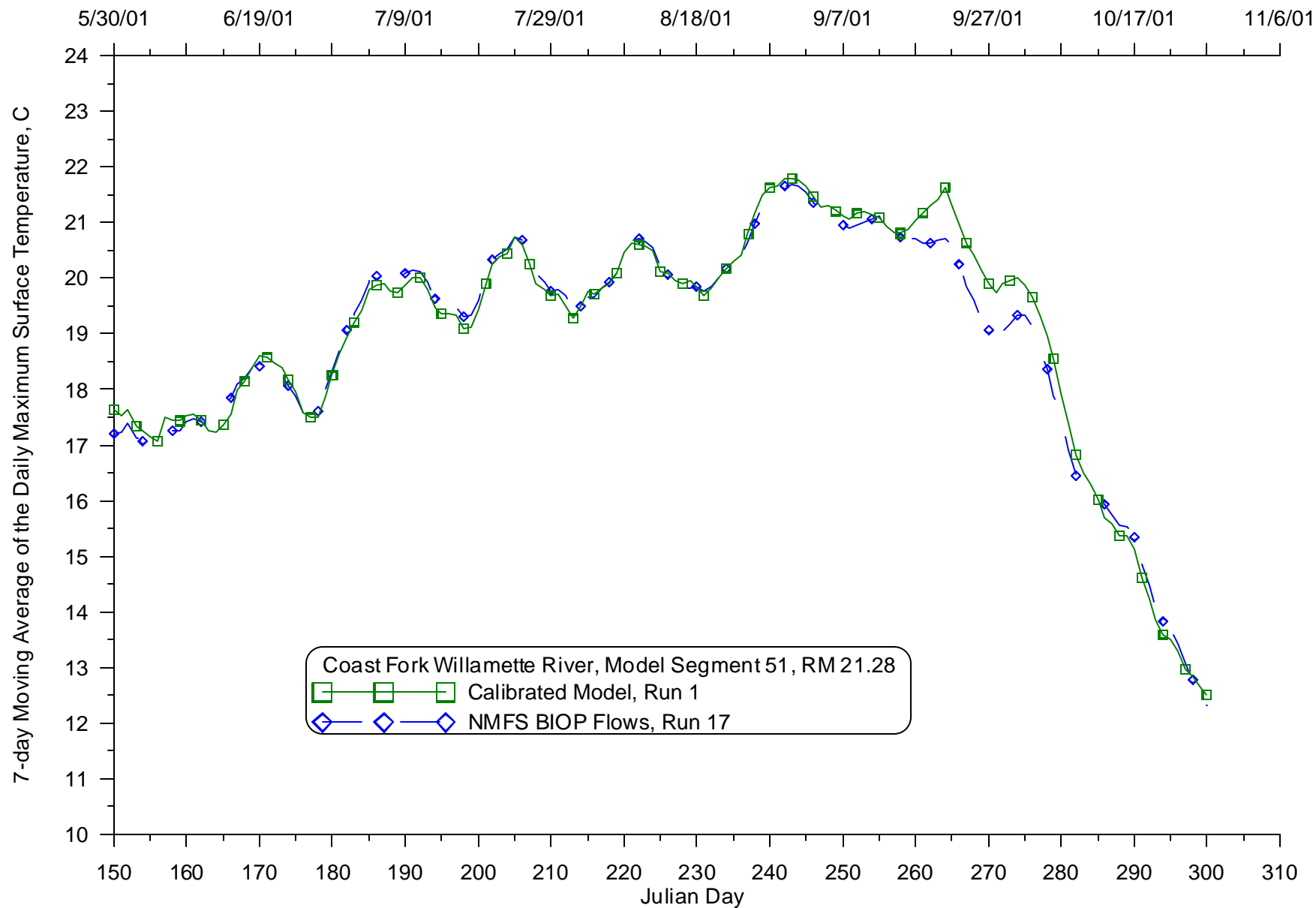


Figure 783: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 29.03



**Figure 784: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 21.28**

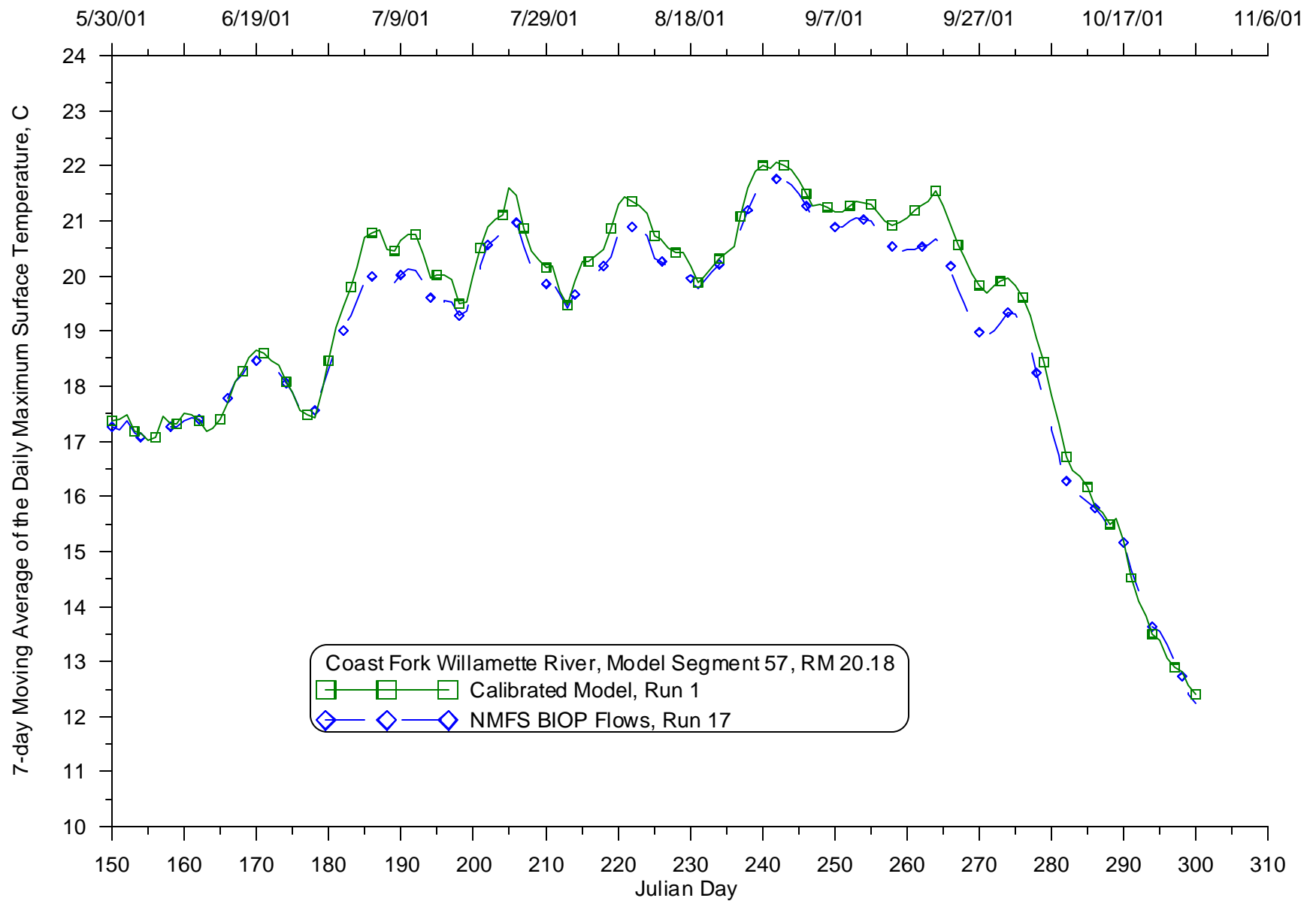
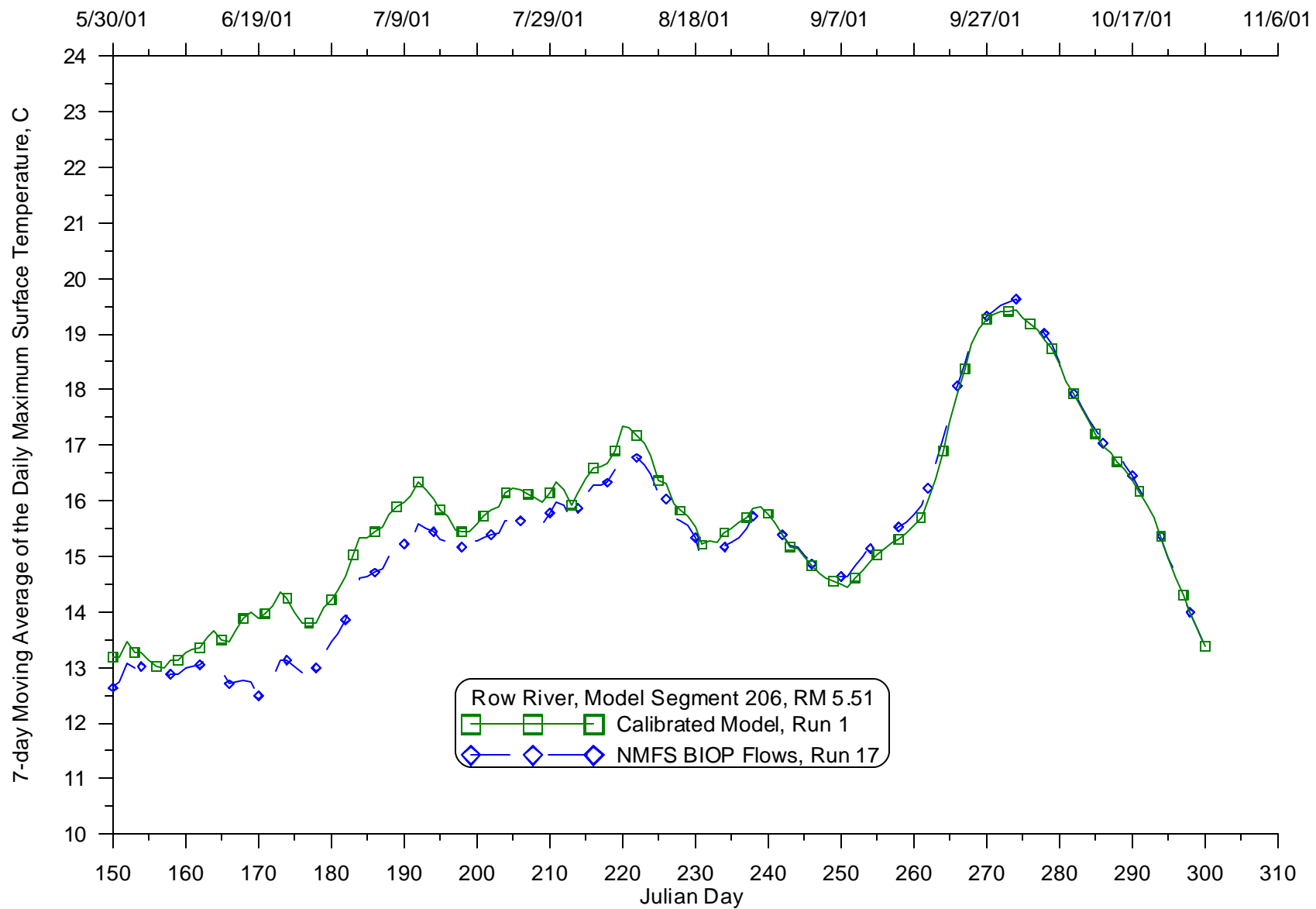
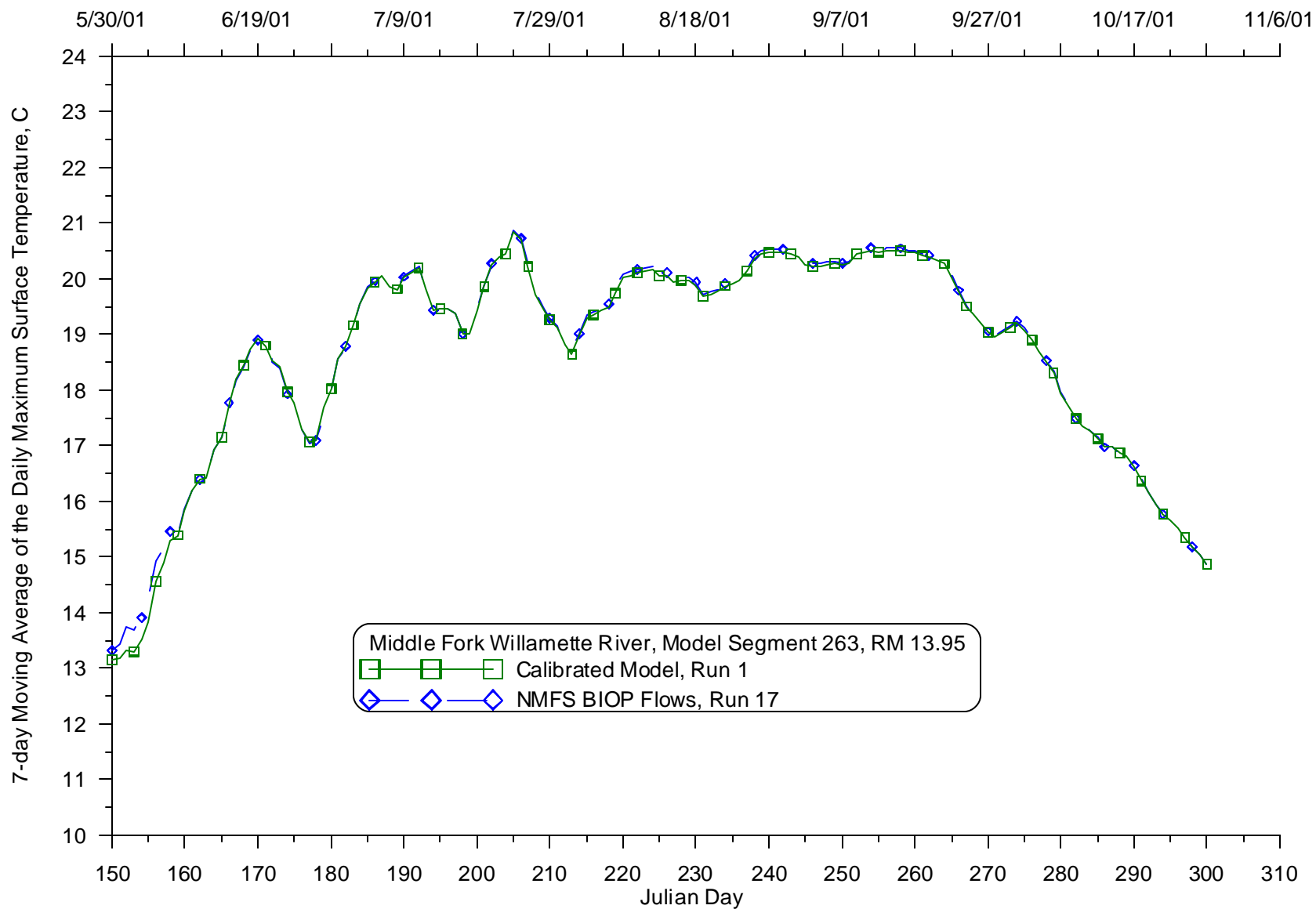


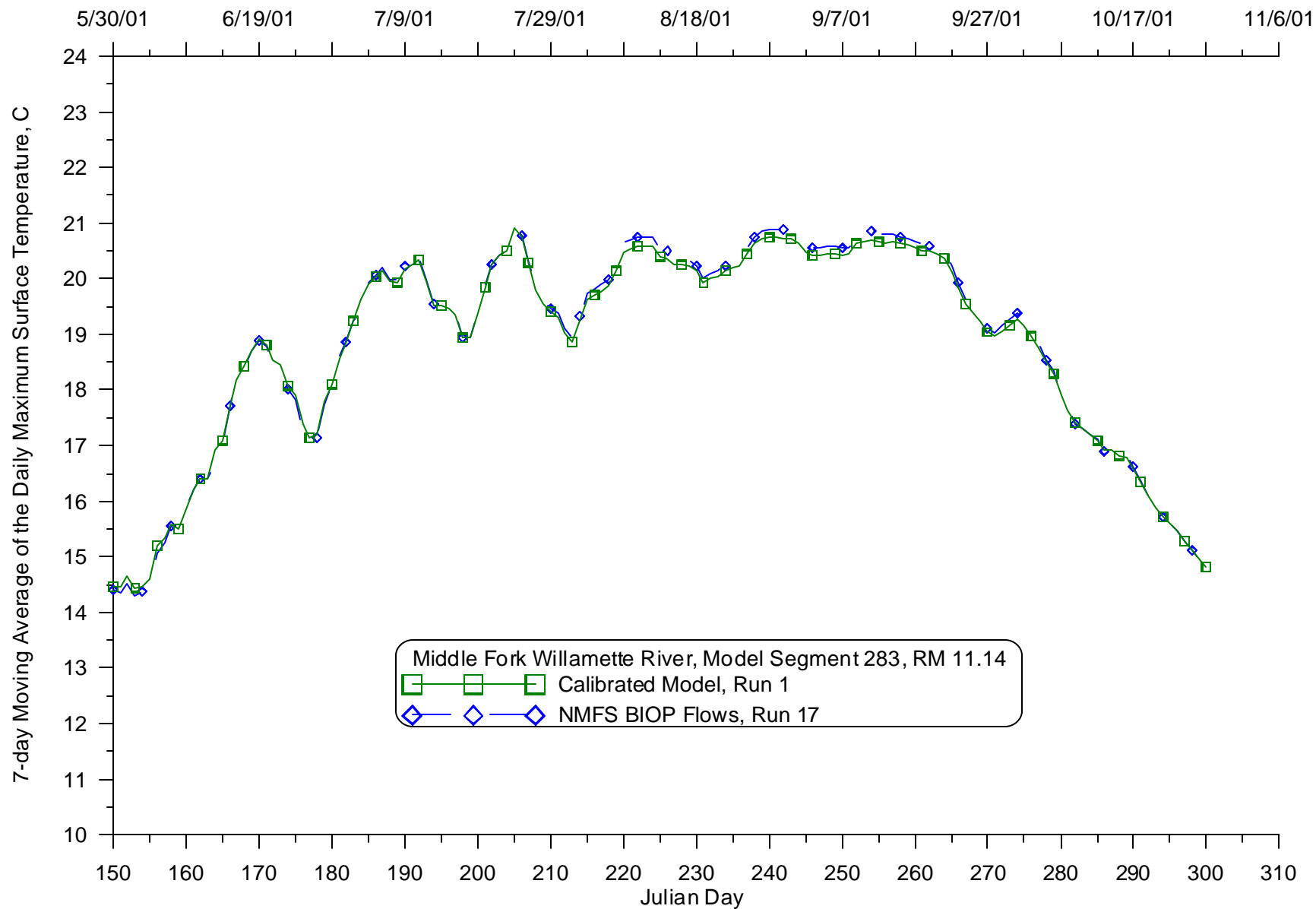
Figure 785: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Coast Fork Willamette River at RM 20.18



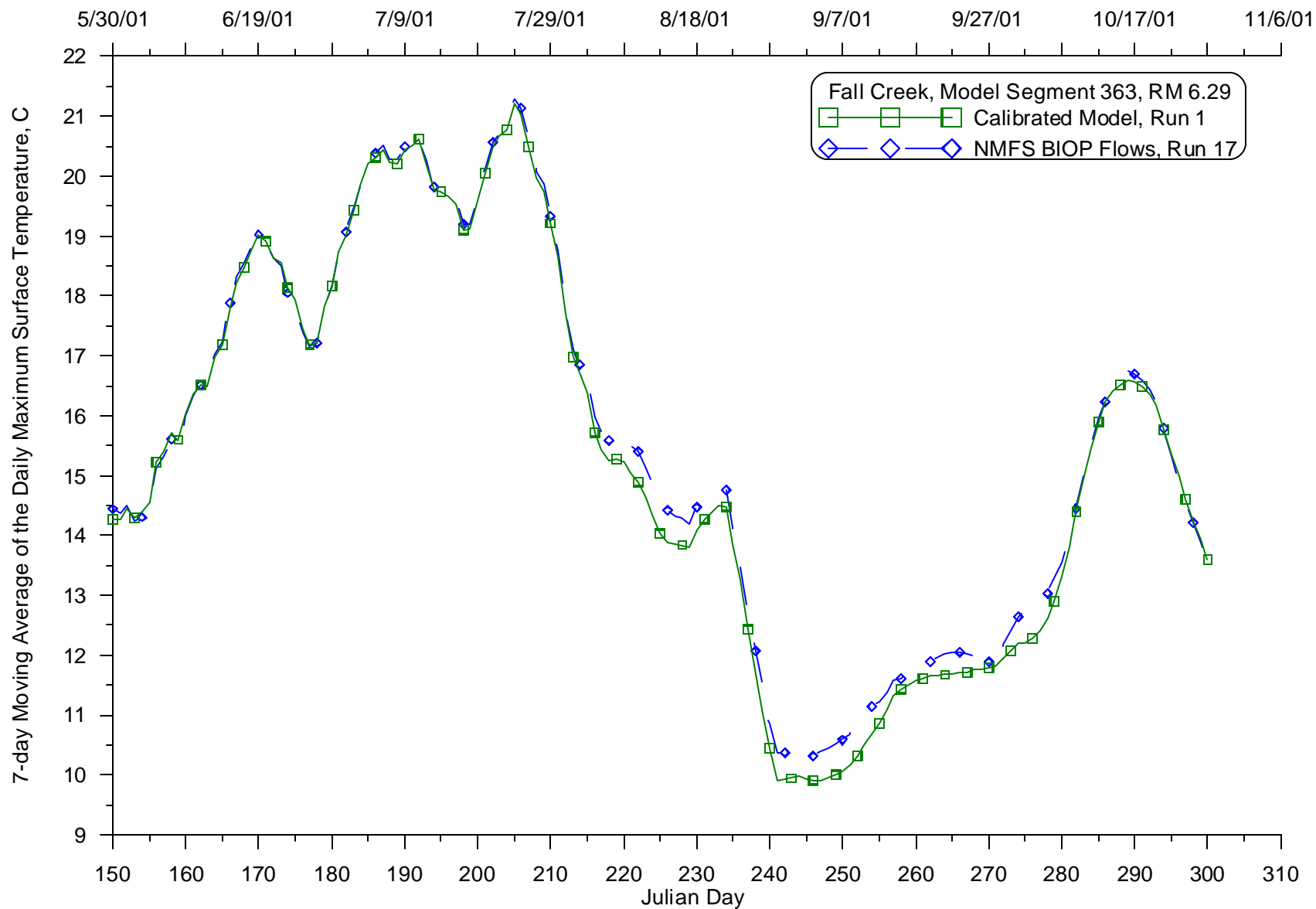
**Figure 786: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Row River at RM 5.51**



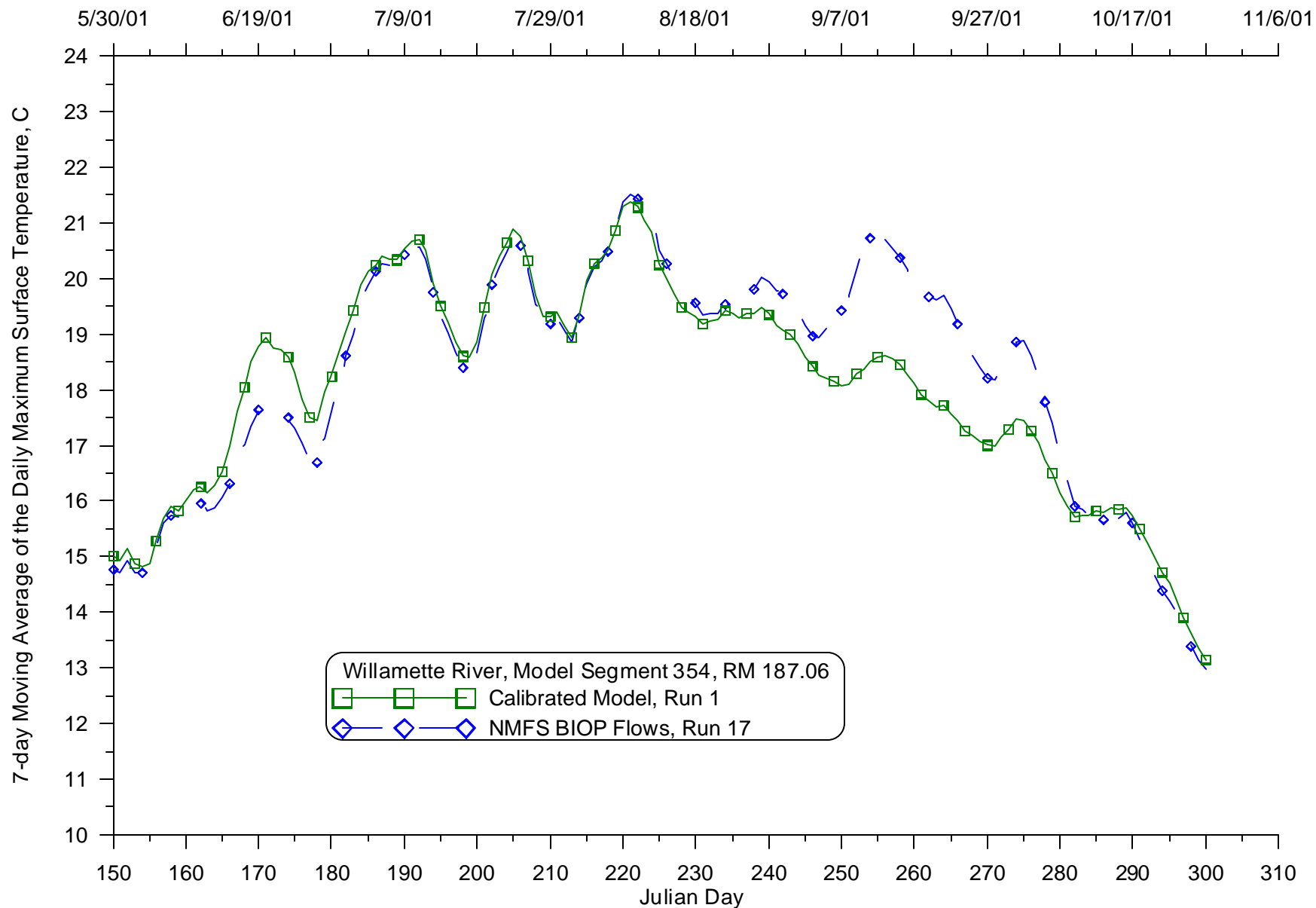
**Figure 787: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Middle Fork Willamette River at RM 13.95**



**Figure 788: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Middle Fork Willamette River at RM 11.14**

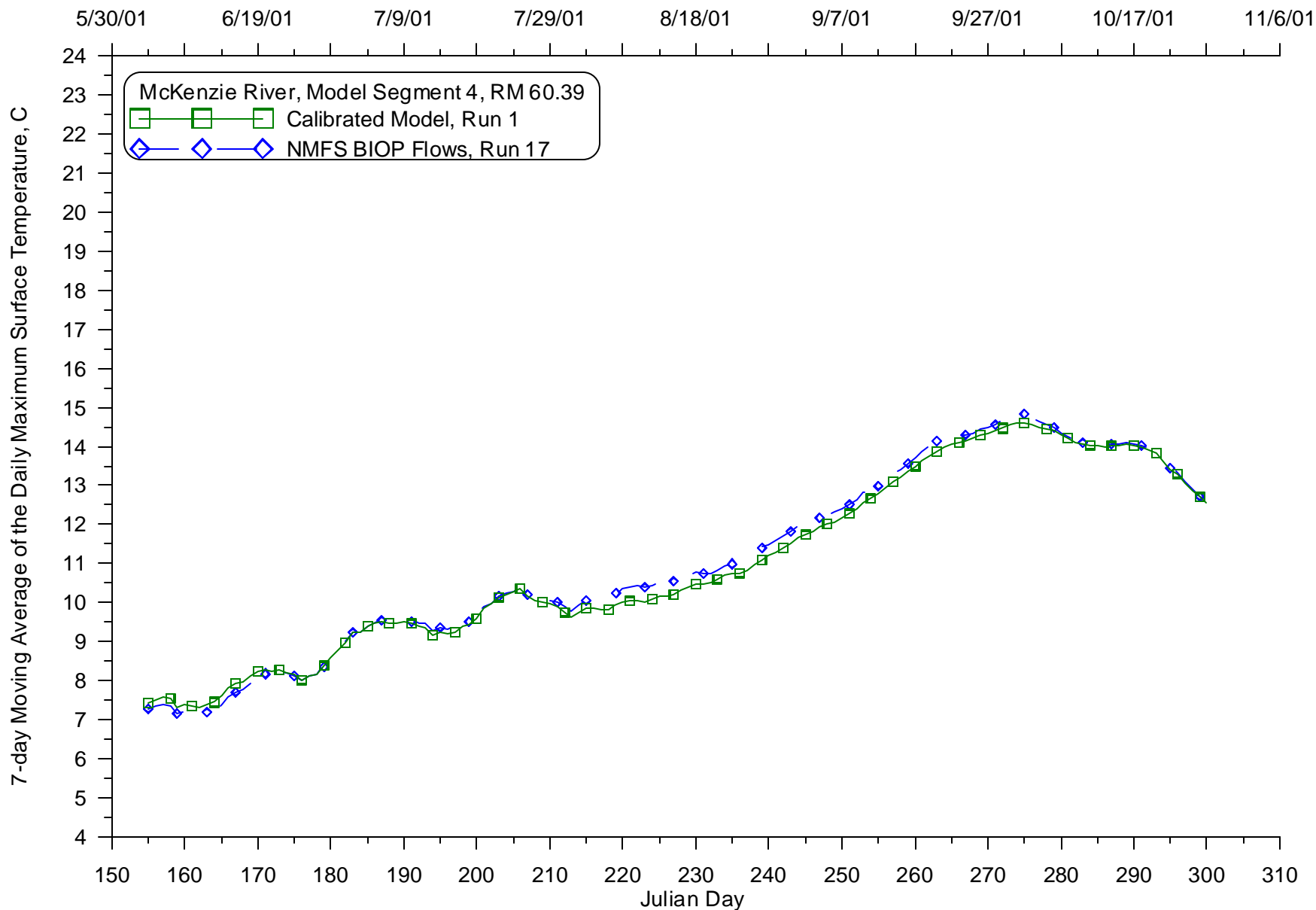


**Figure 789: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Fall Creek at RM 6.29**

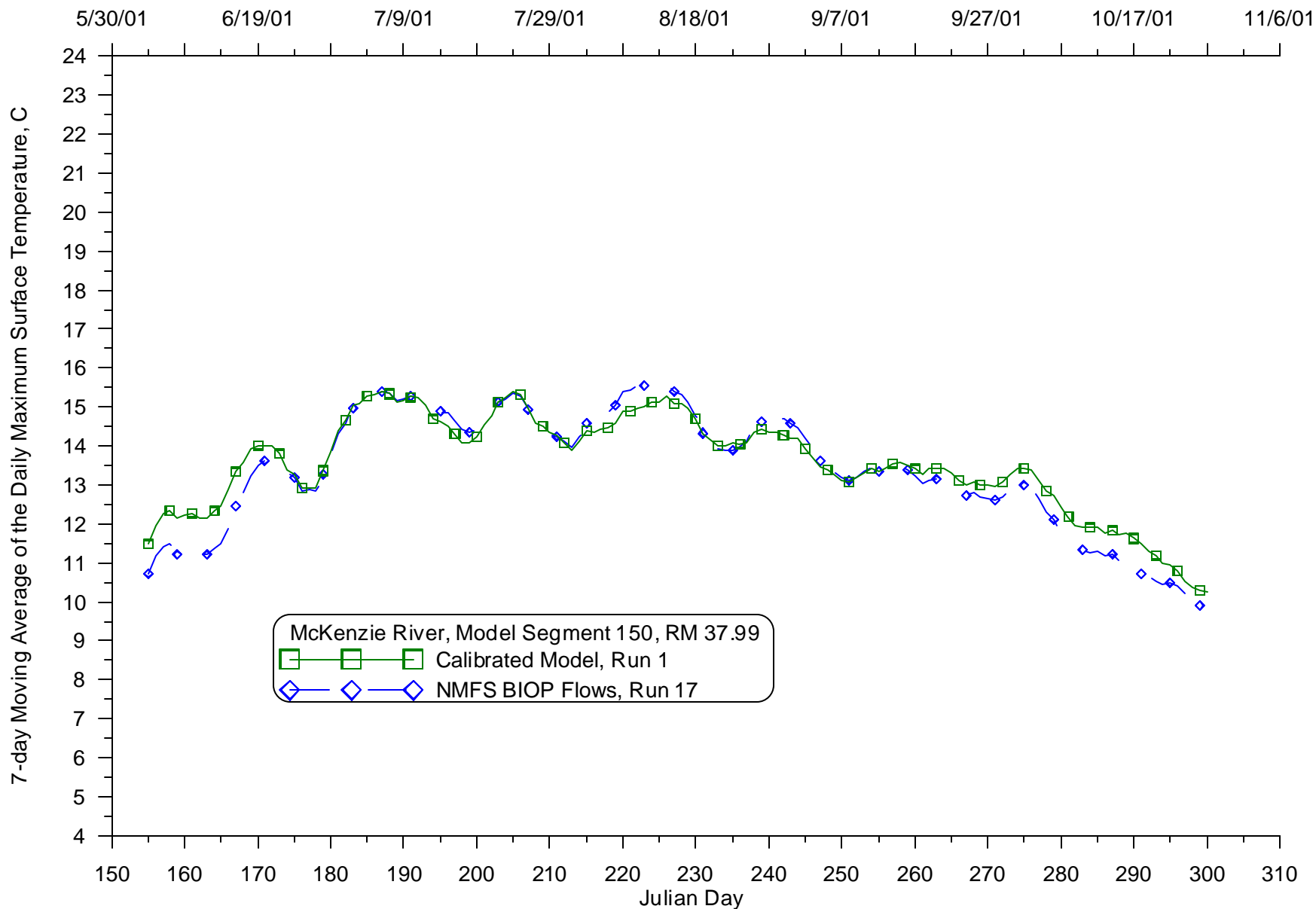


**Figure 790: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 187.06**

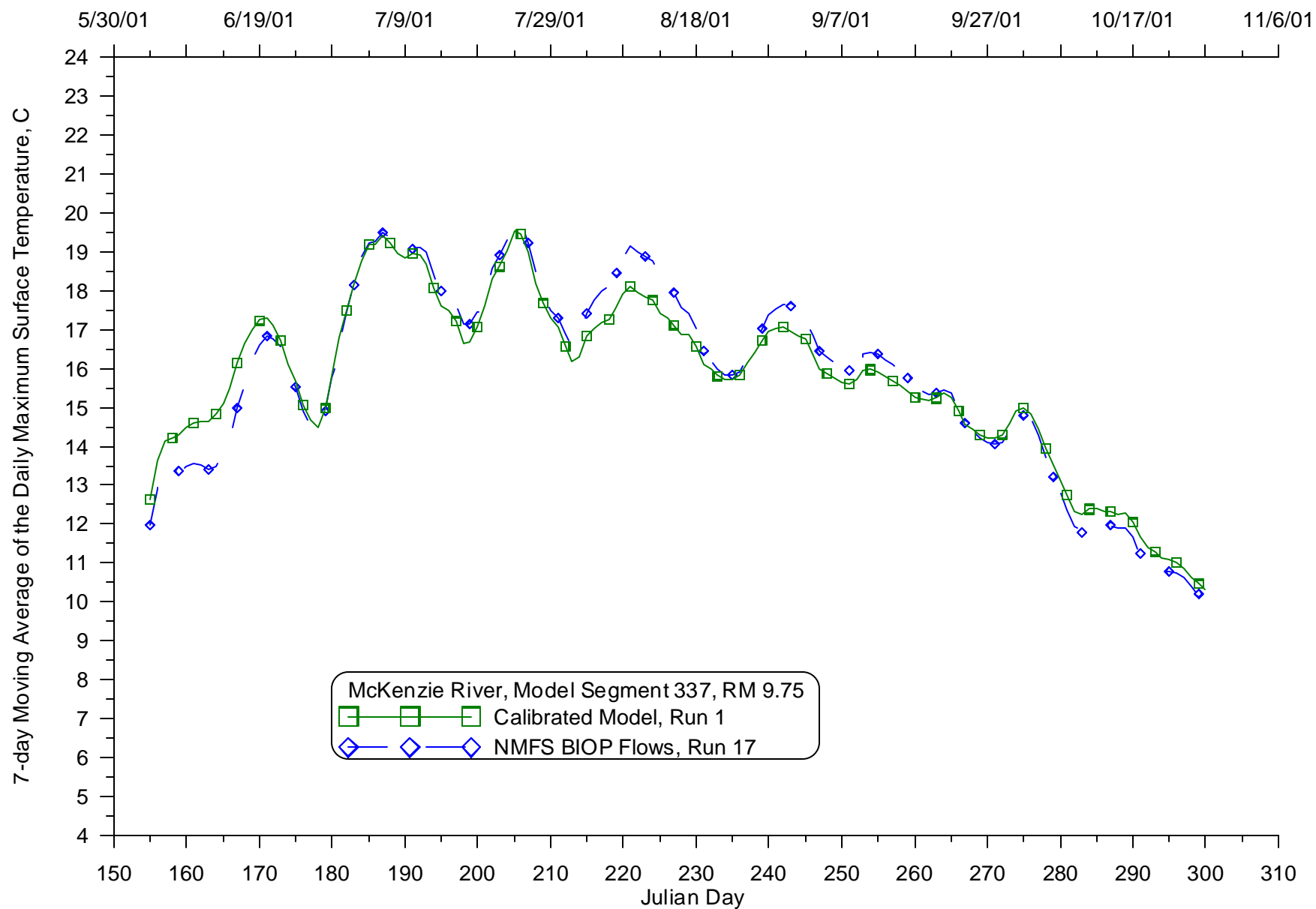




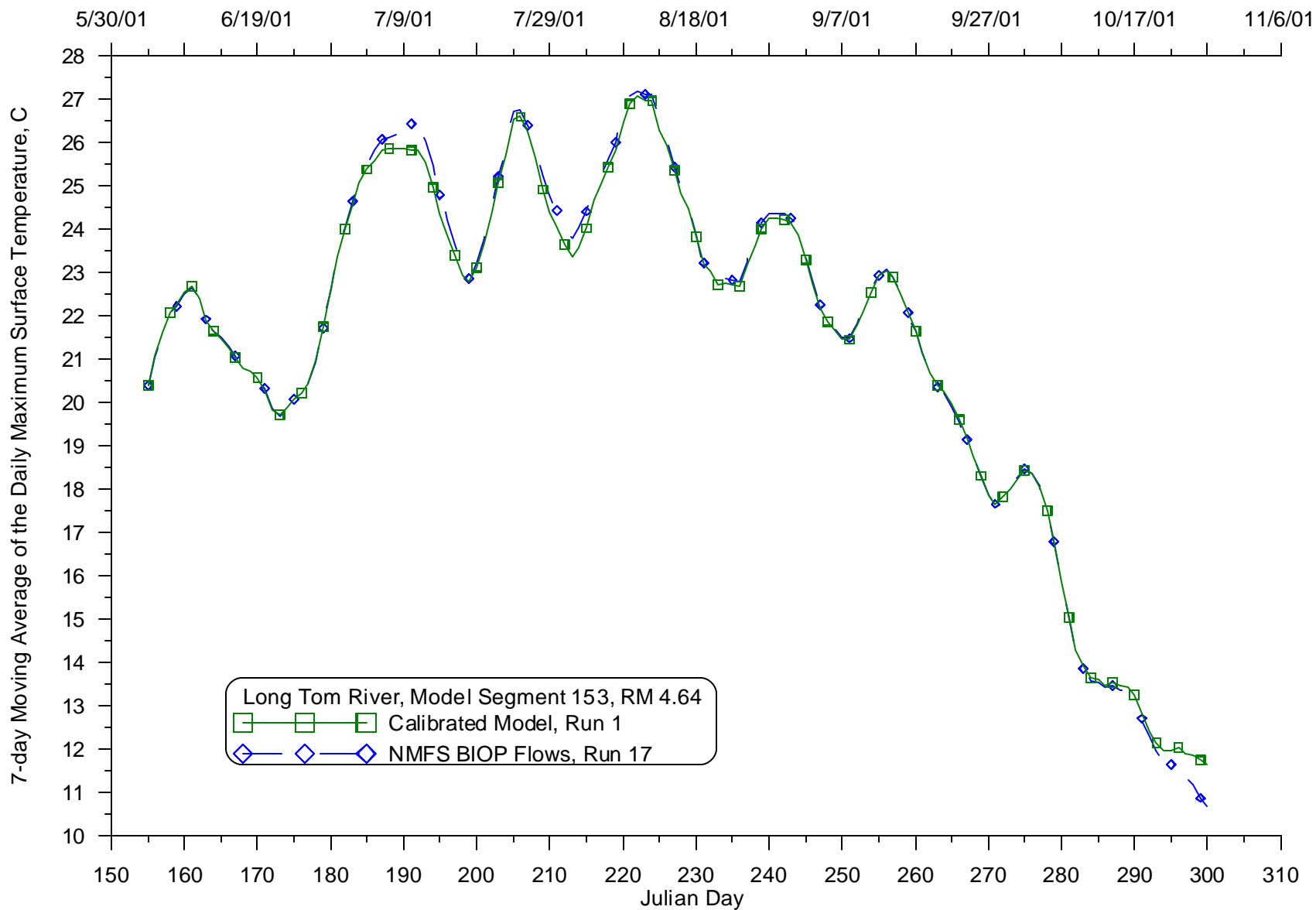
**Figure 791: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 60.39**



**Figure 792: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 37.99**



**Figure 793: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the McKenzie River at RM 9.75**



**Figure 794: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Long Tom River at RM 4.64**

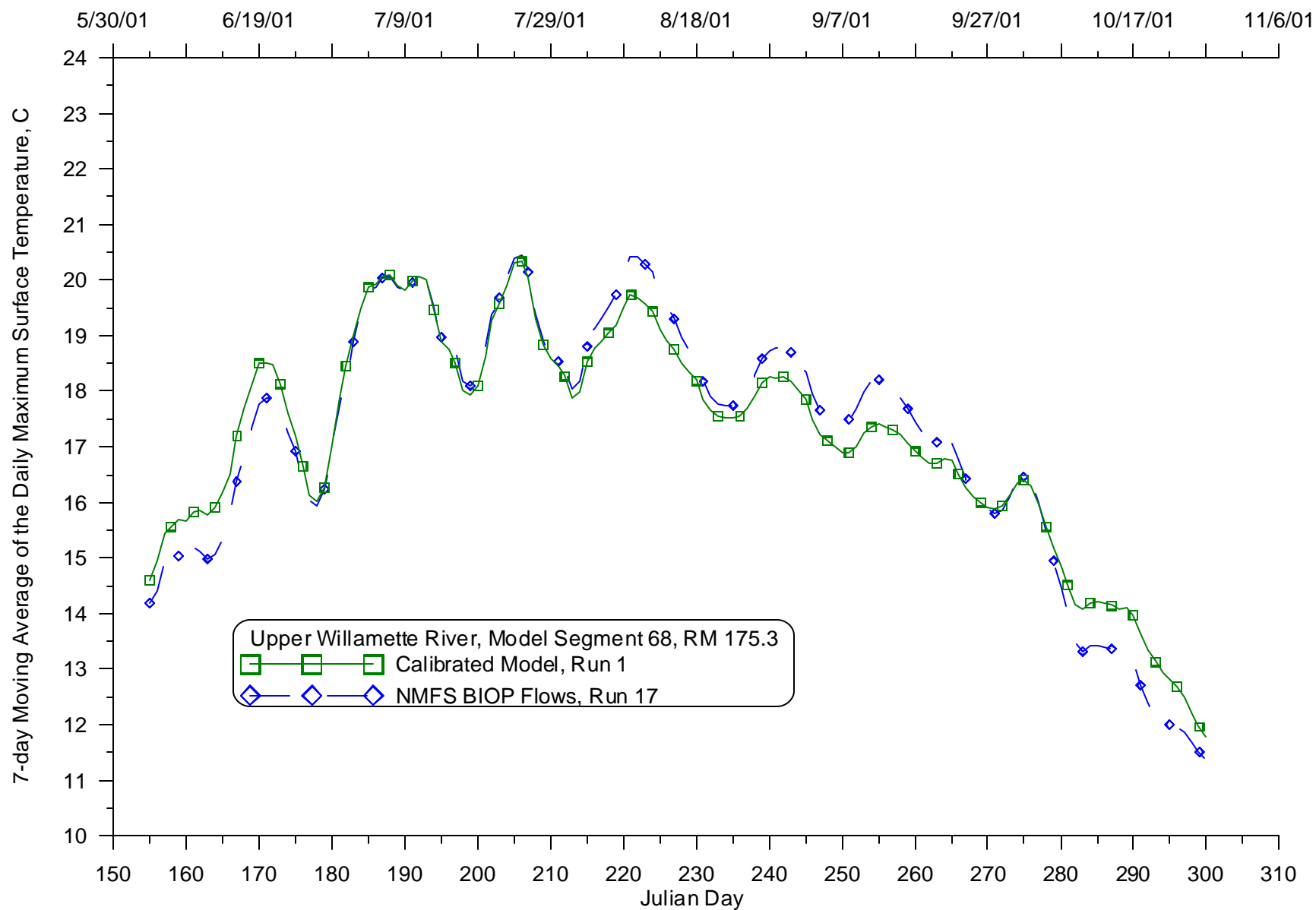
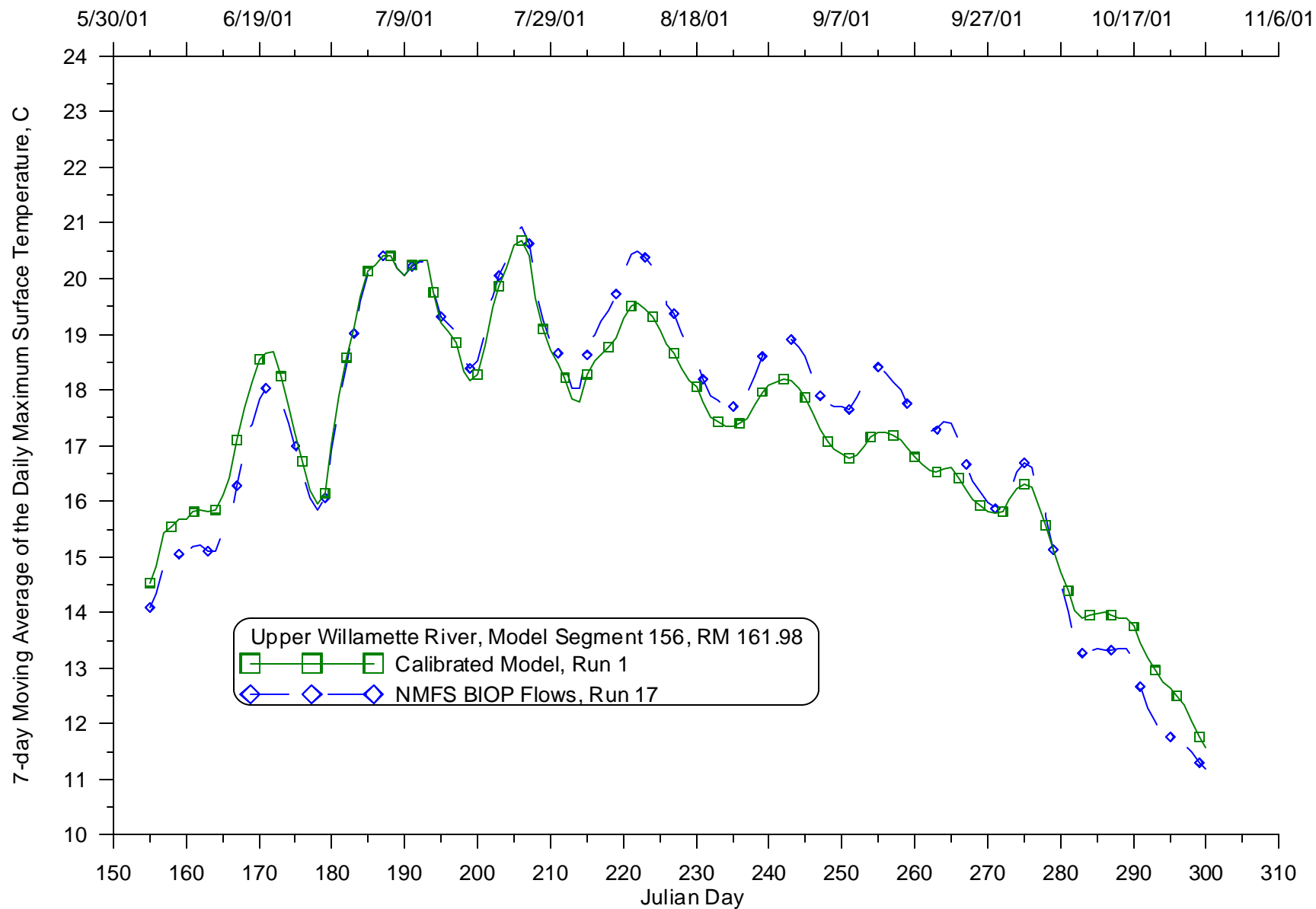
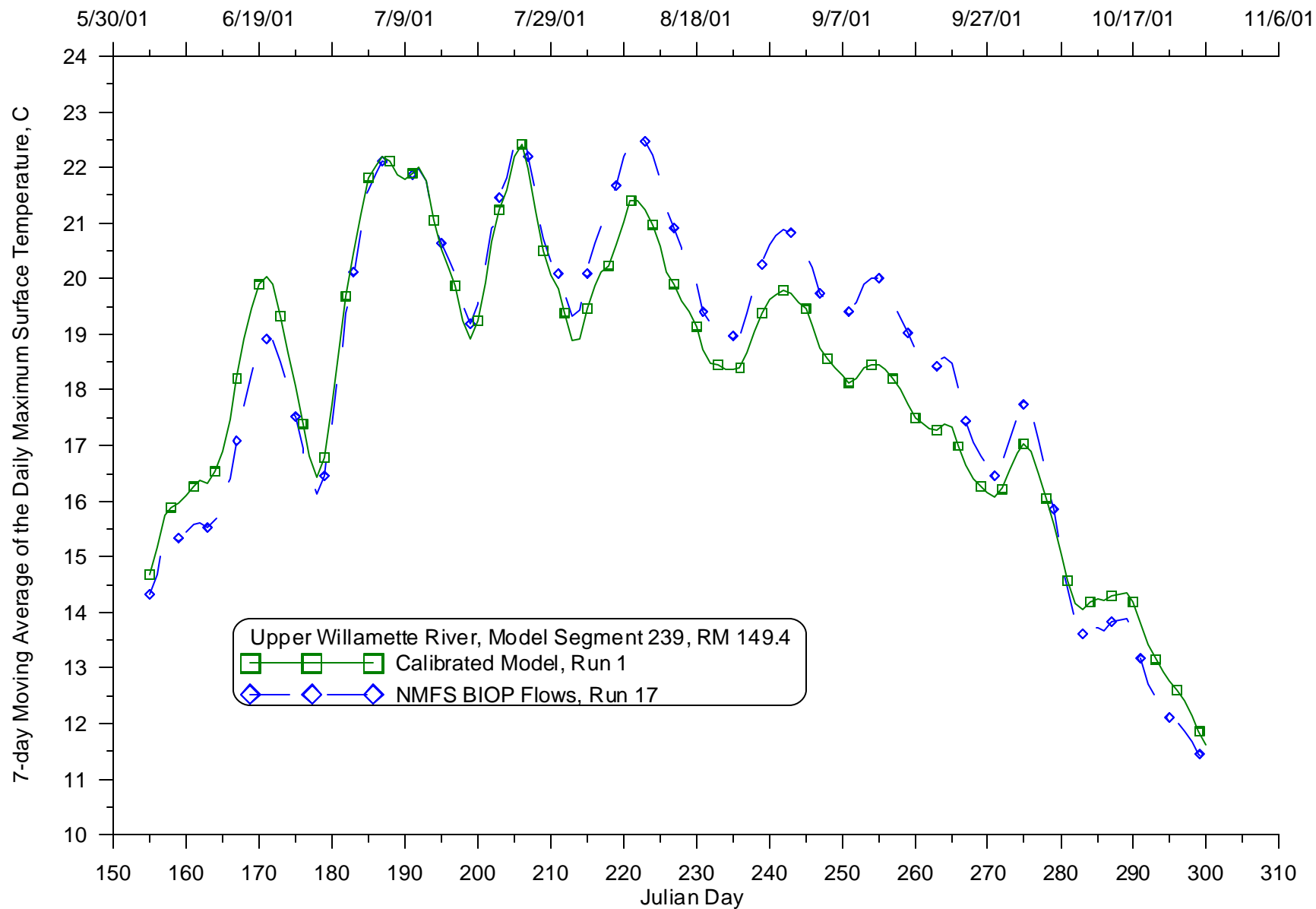


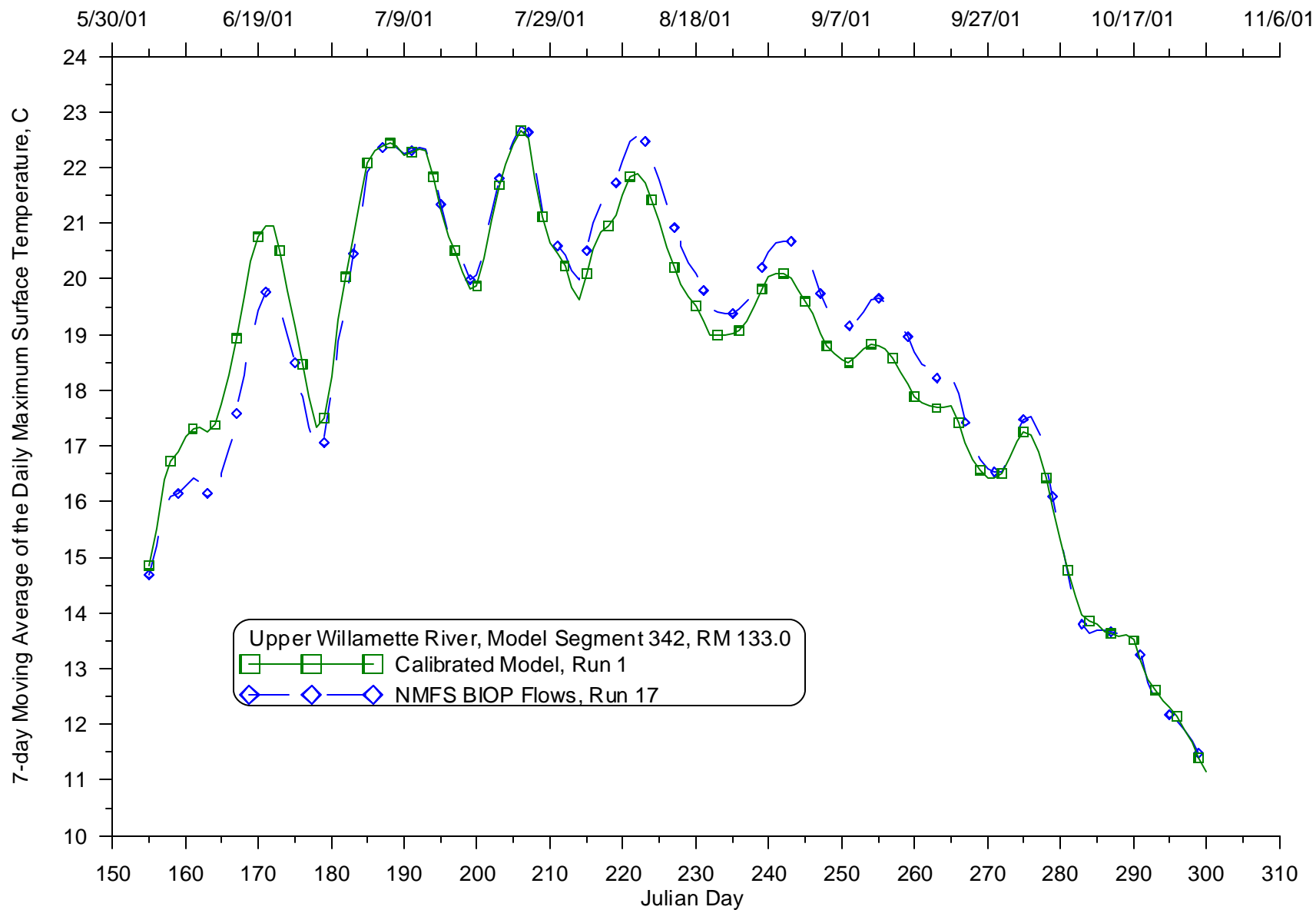
Figure 795: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 175.3



**Figure 796: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 161.98**

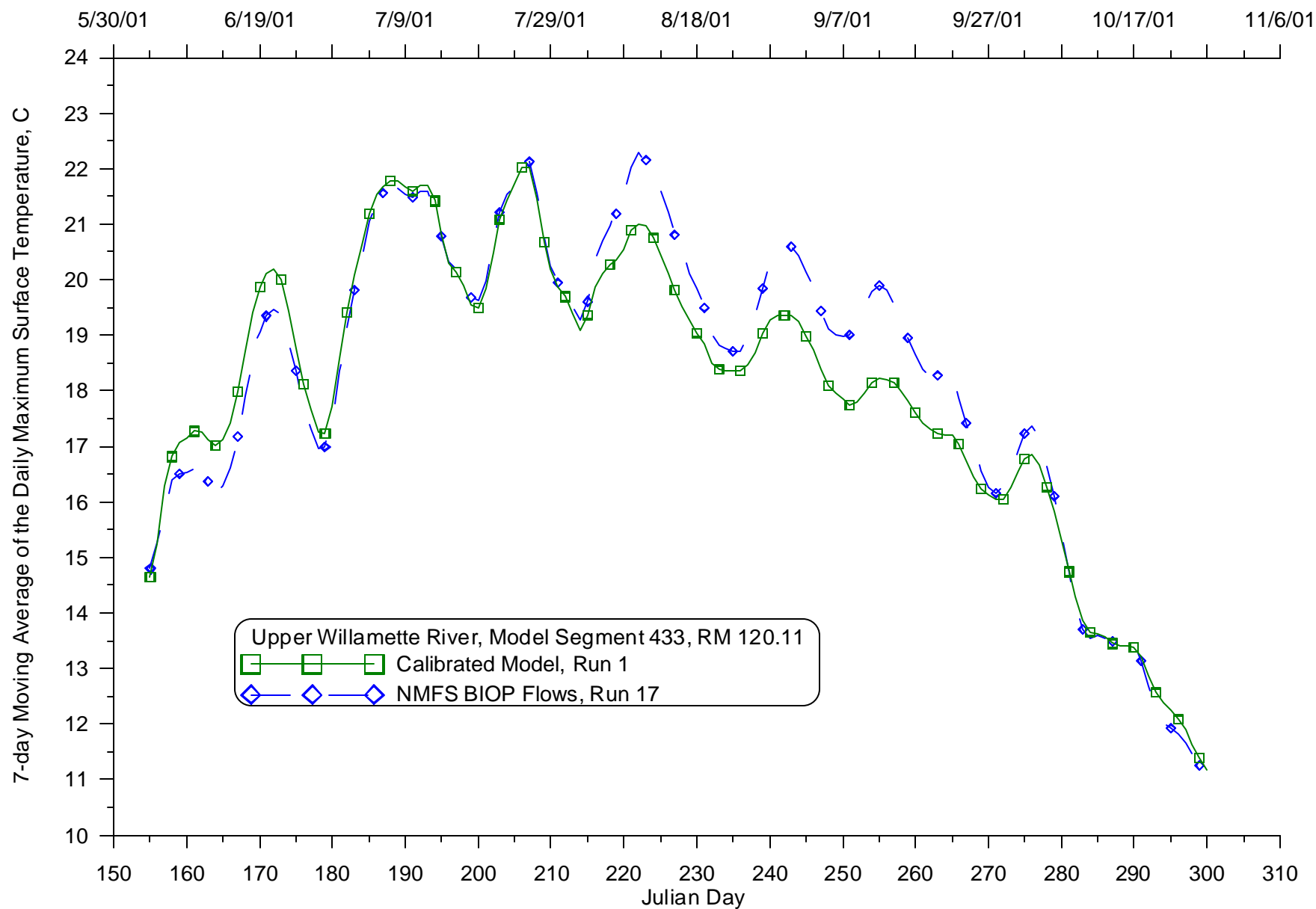


**Figure 797: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 149.4**

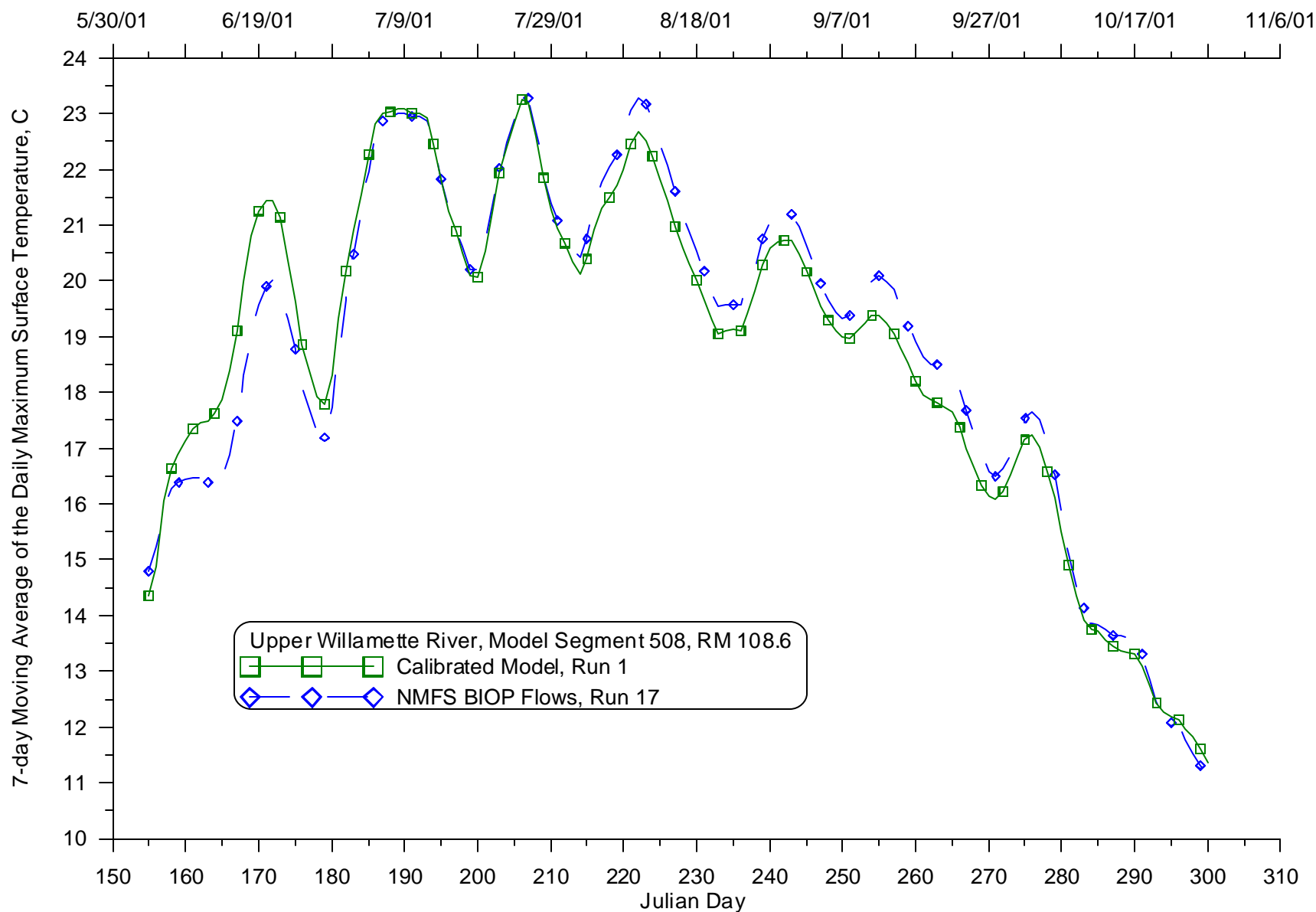


**Figure 798: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 133**

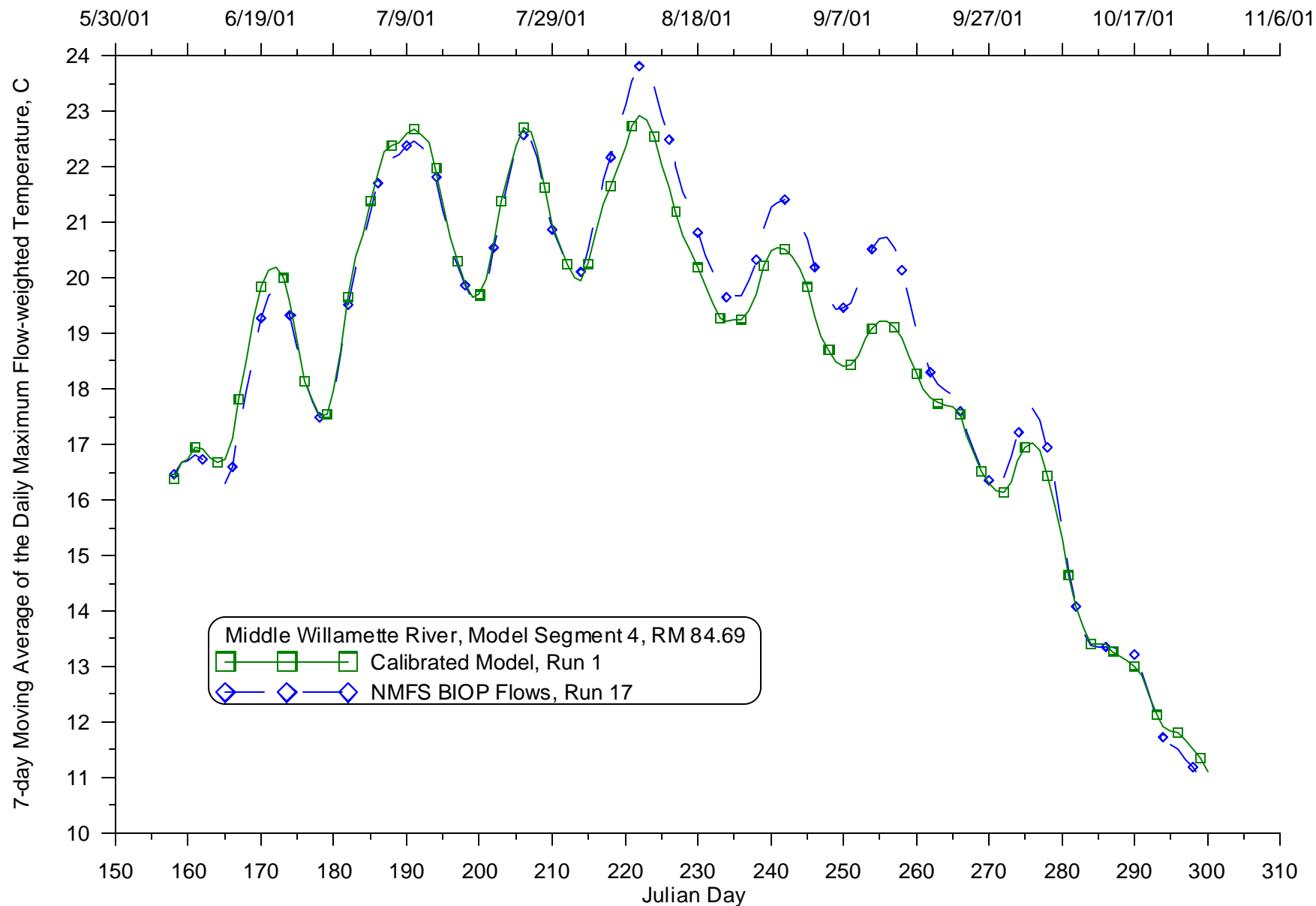




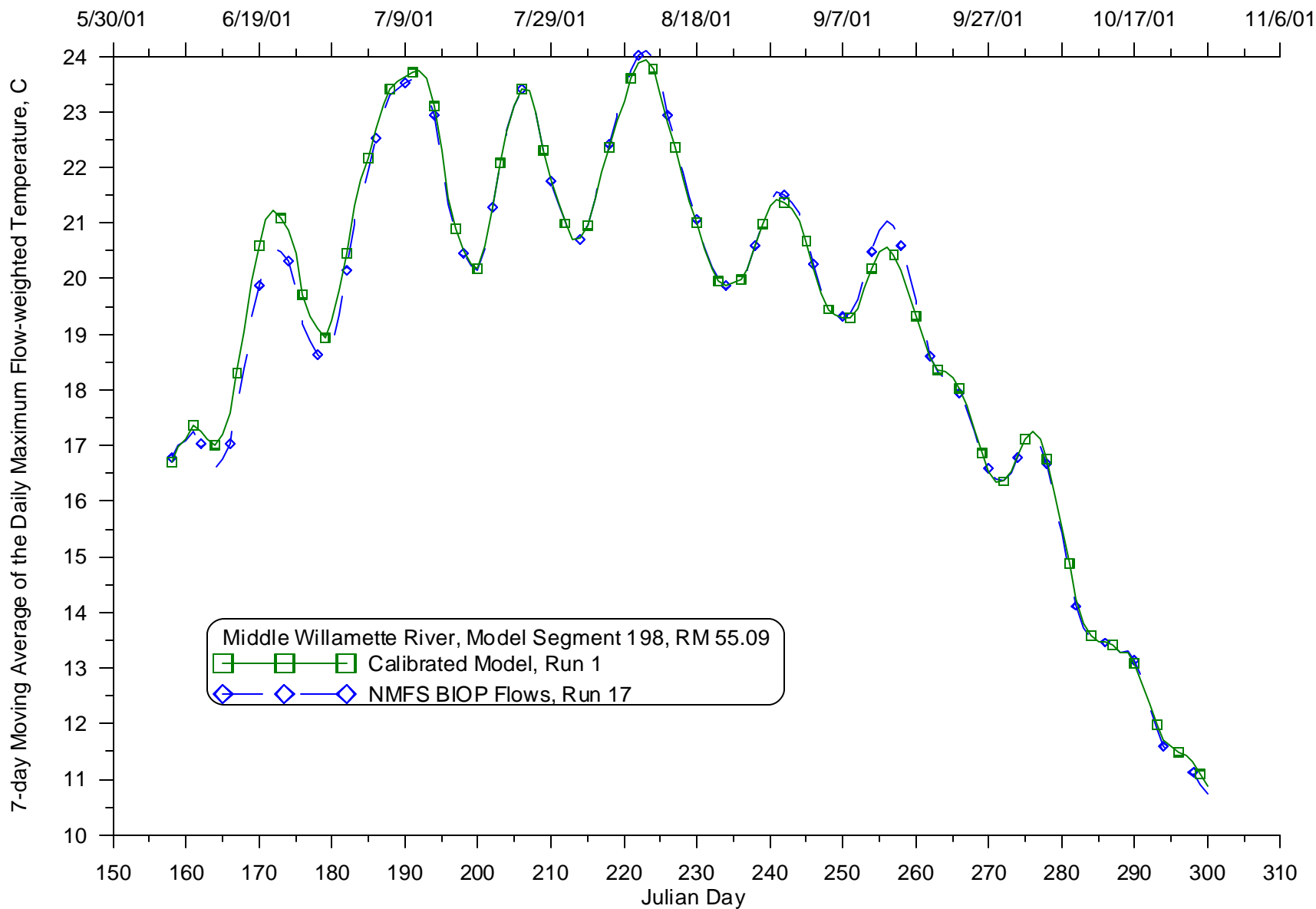
**Figure 799: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 120.11**



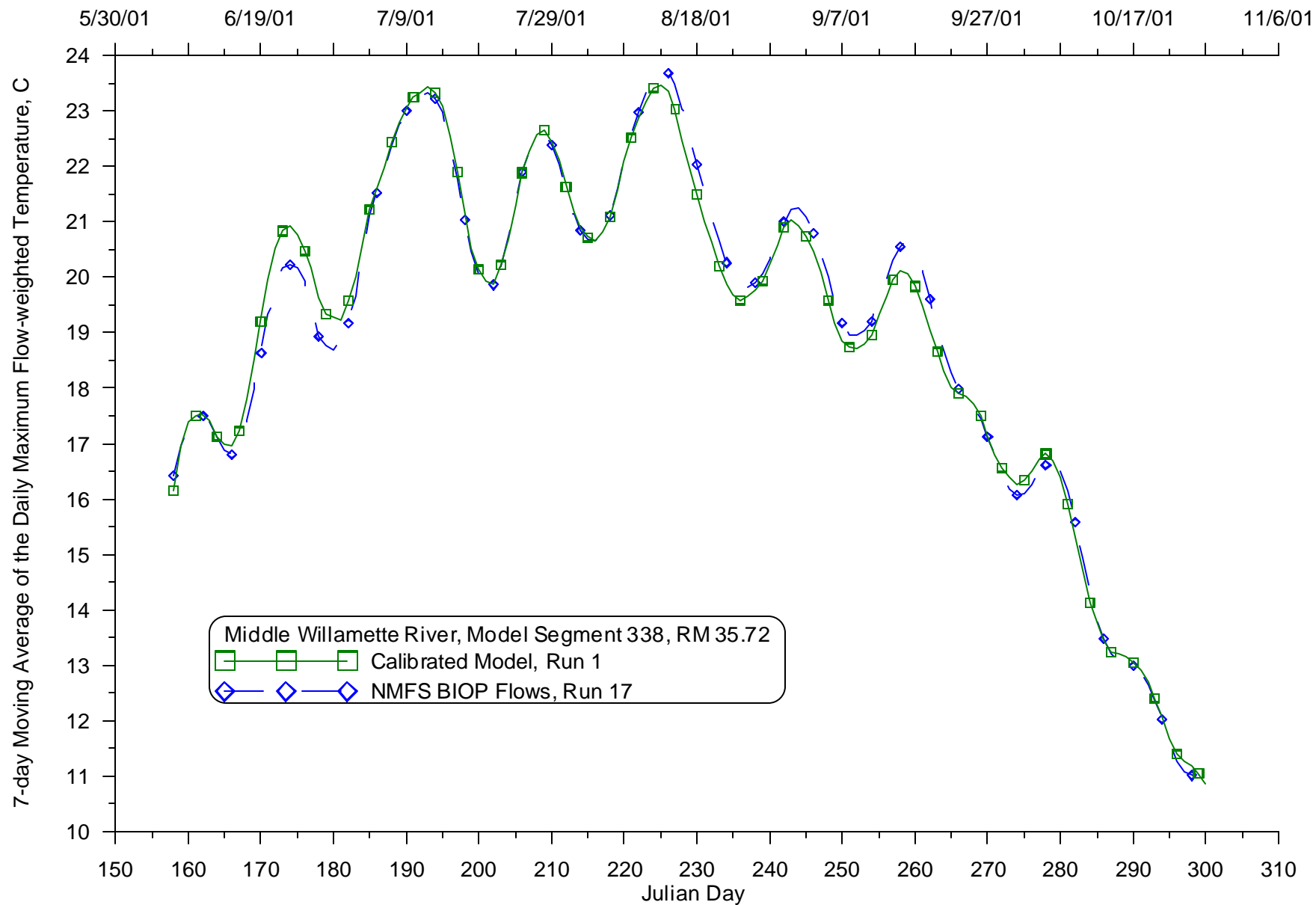
**Figure 800: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 108.6**



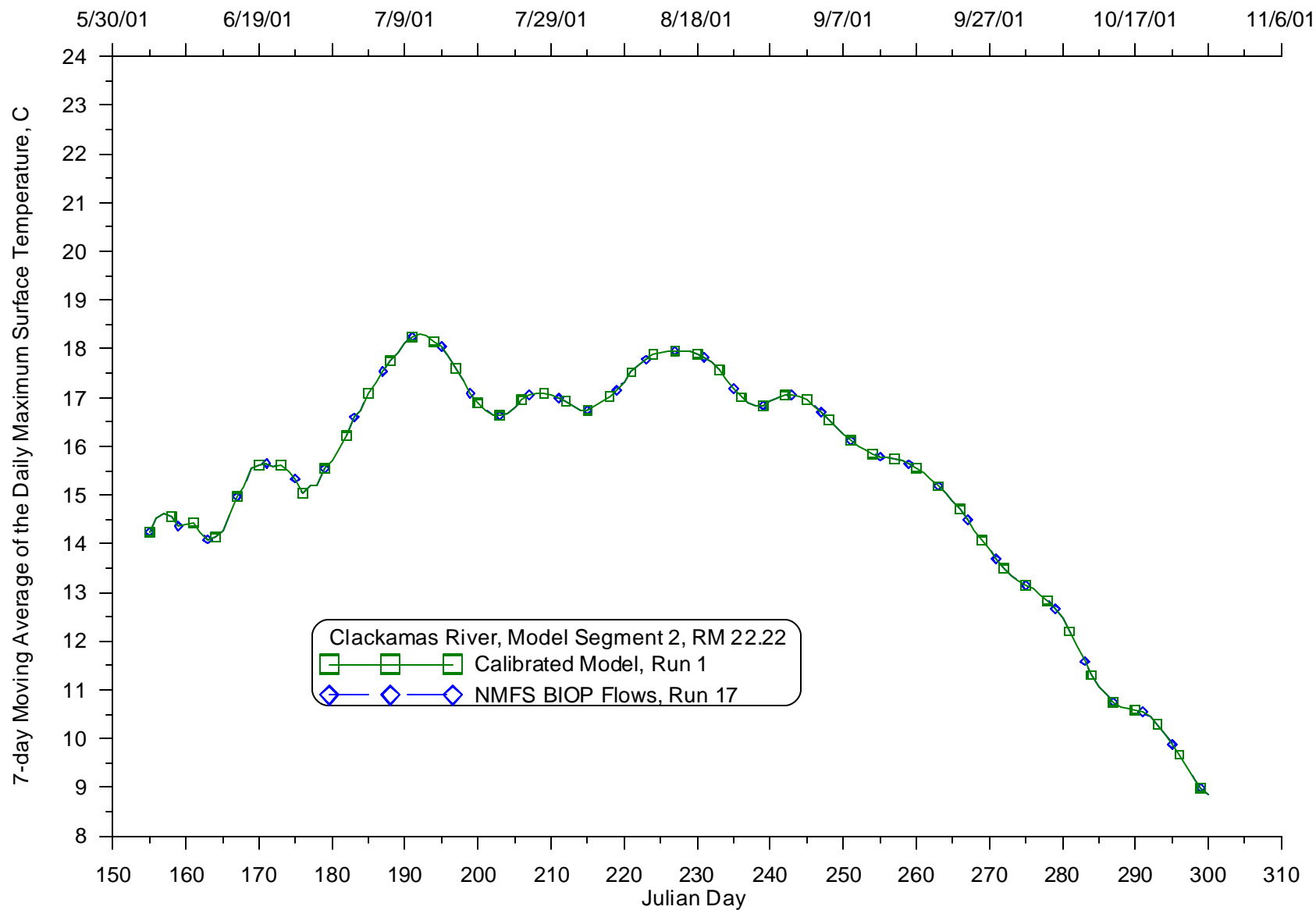
**Figure 801: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 84.69**



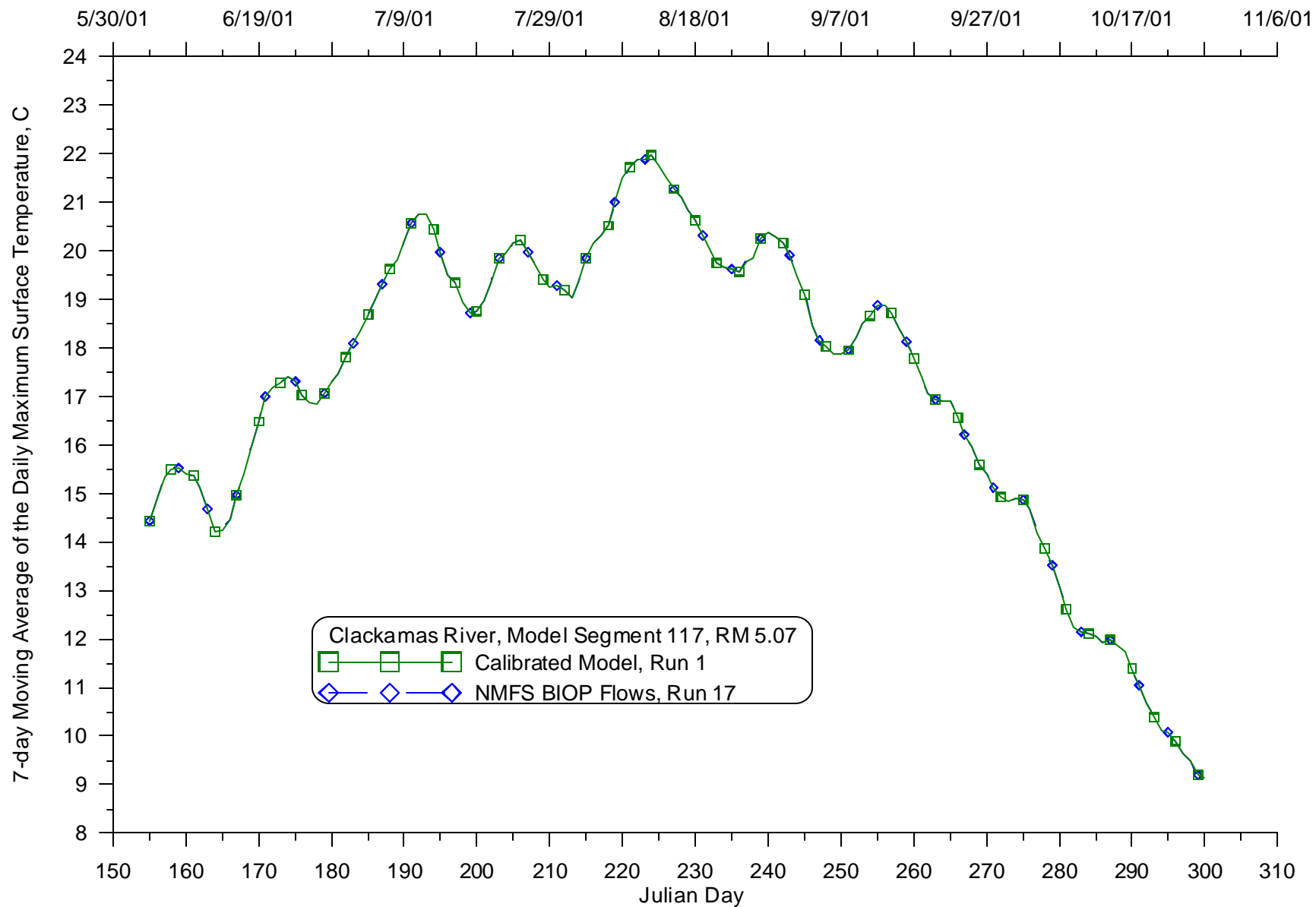
**Figure 802: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 55.09**



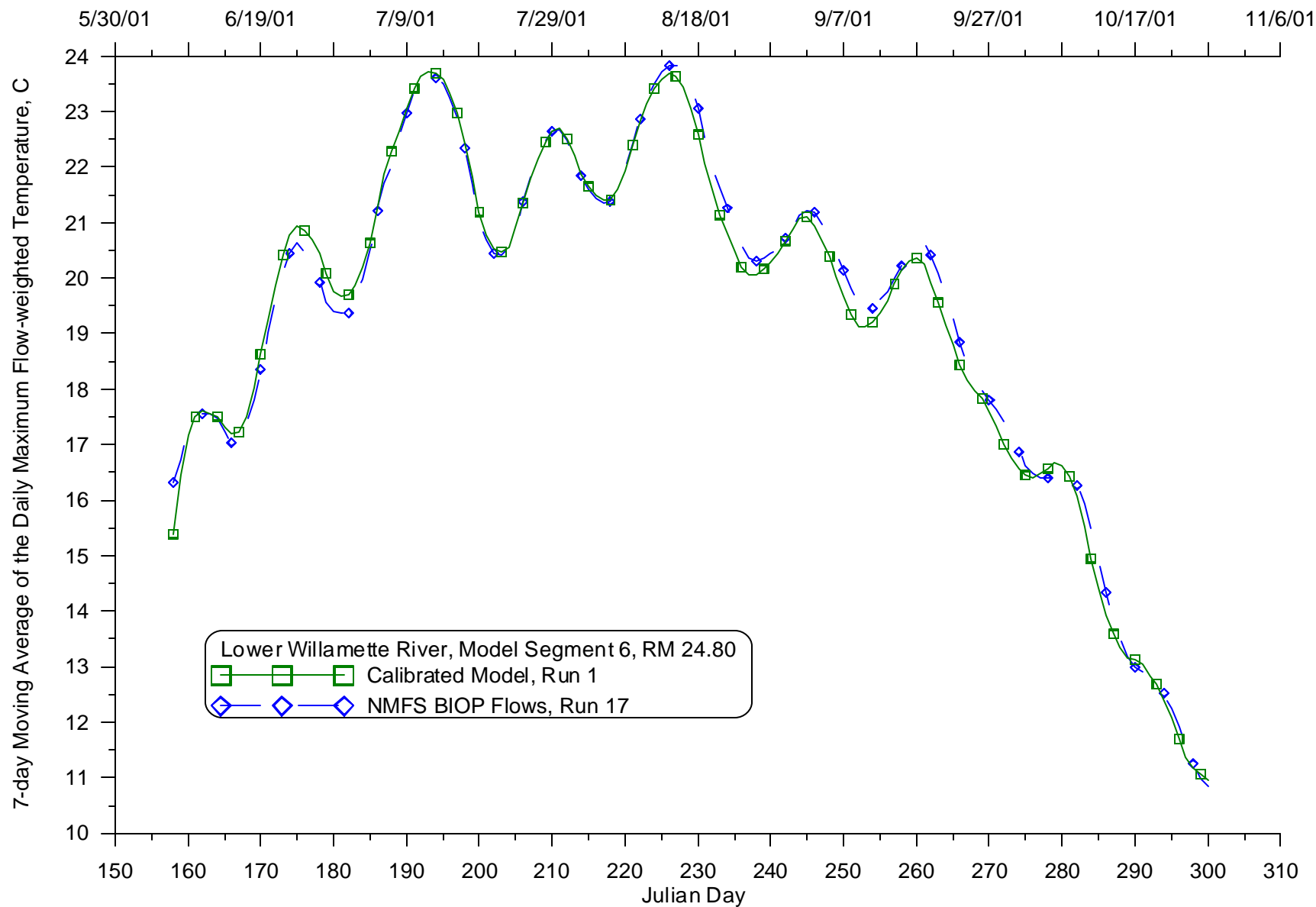
**Figure 803: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 35.72**



**Figure 804: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Clackamas River at RM 22.22**



**Figure 805: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Clackamas River at RM 5.07**



**Figure 806: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 24.8**



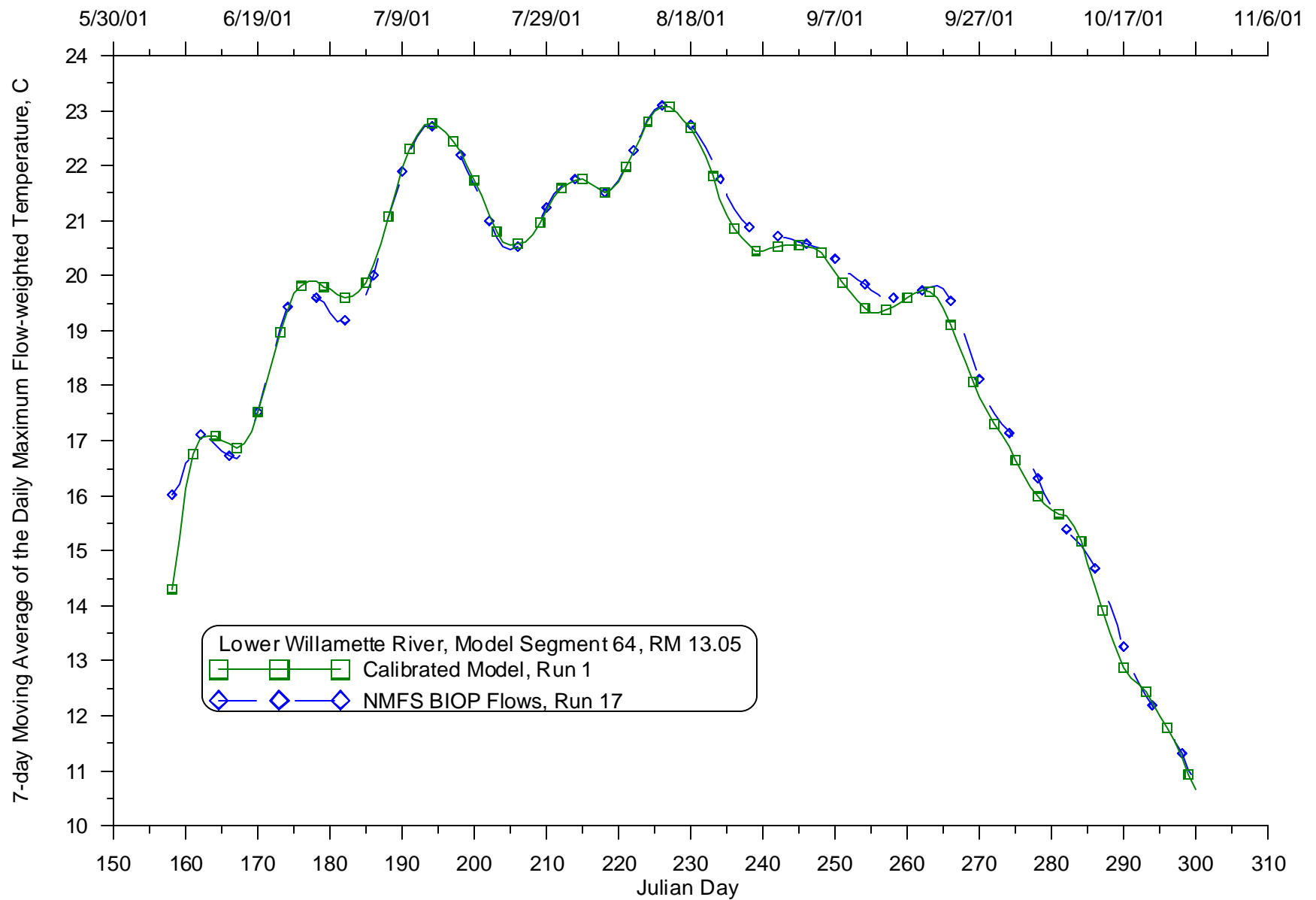
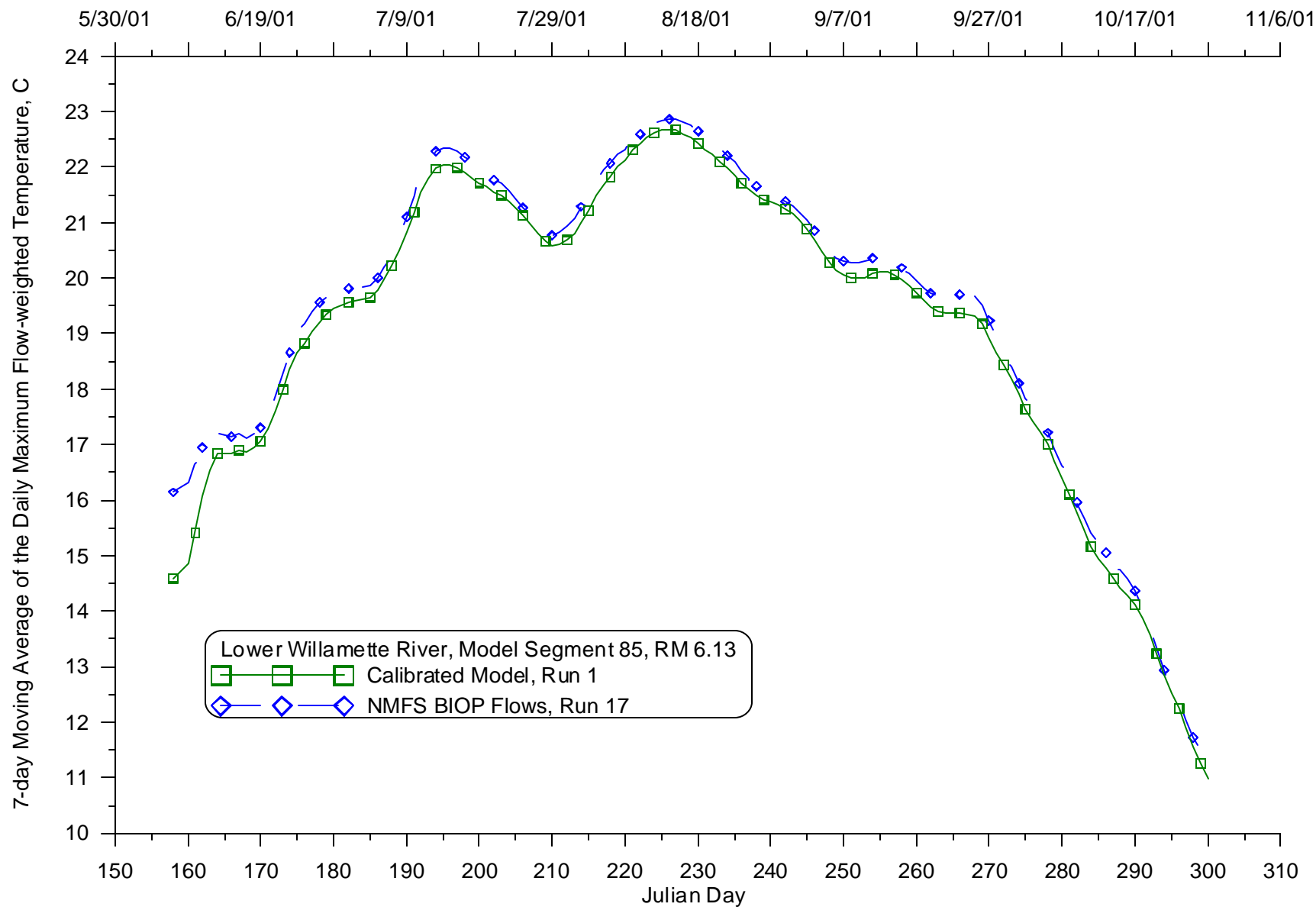
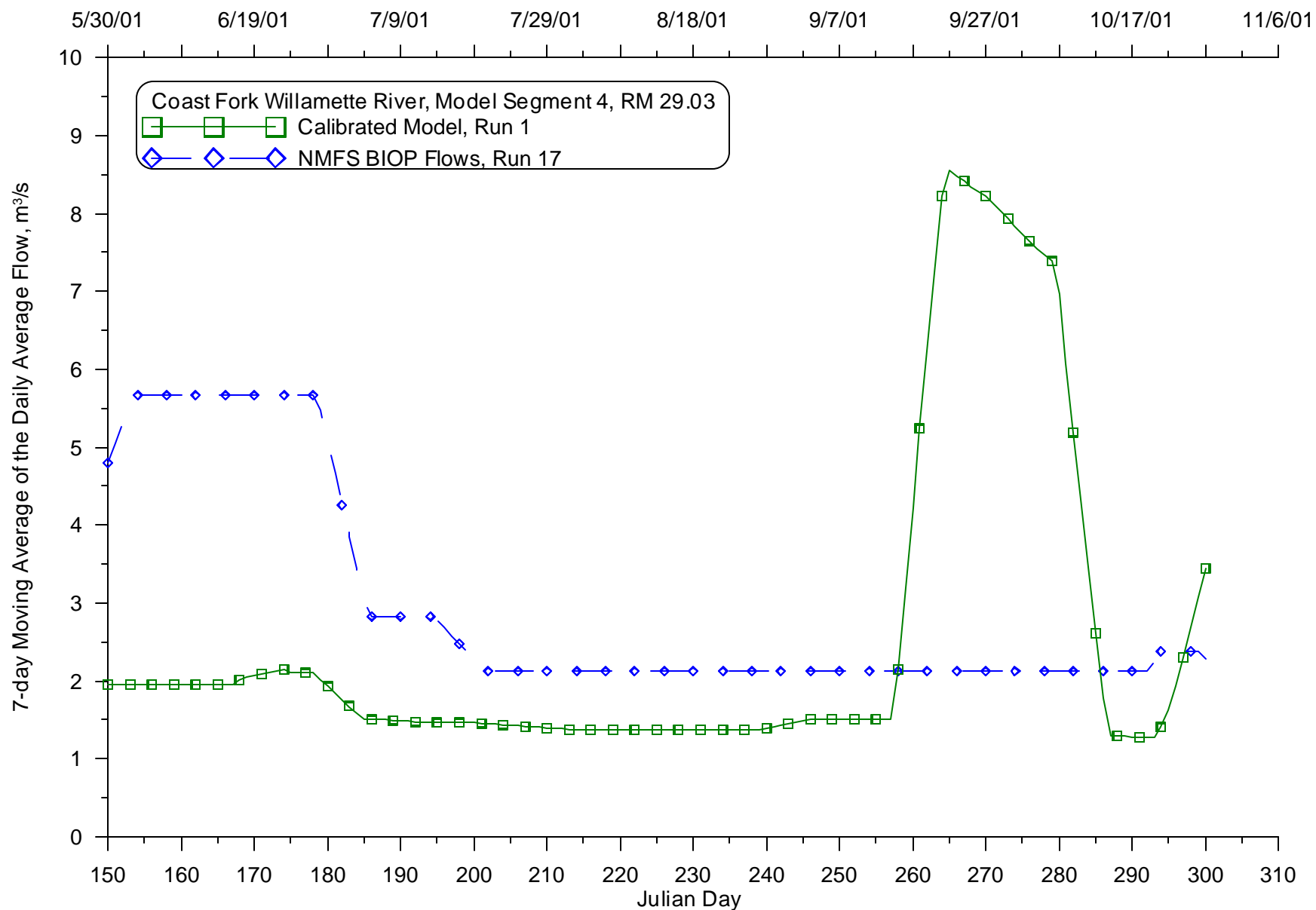


Figure 807: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 13.05

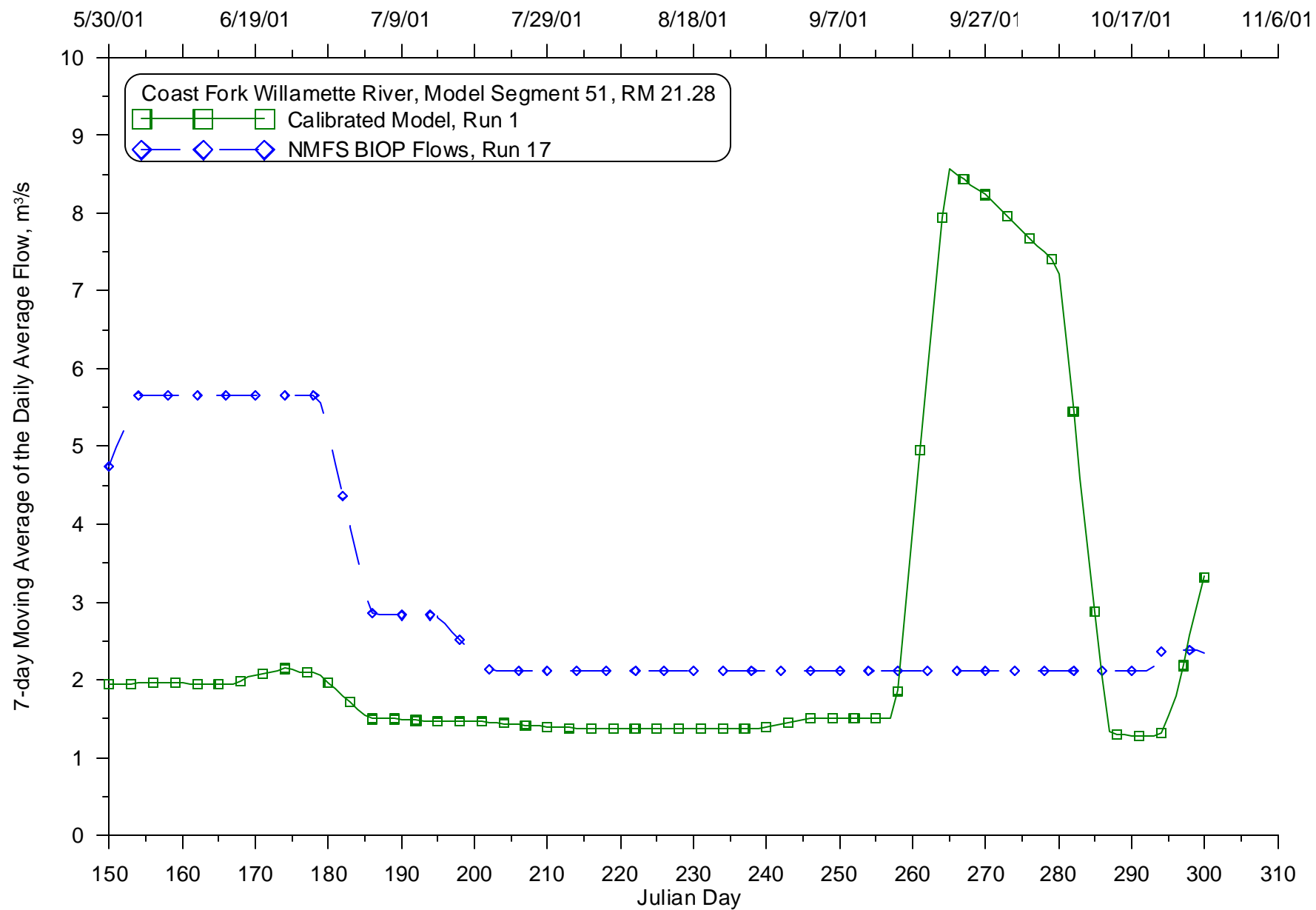


**Figure 808: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily maximum temperature for 2001 for the Willamette River at RM 6.13**

**Daily seven day average flow**



**Figure 809: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 29.03**



**Figure 810: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 21.28**

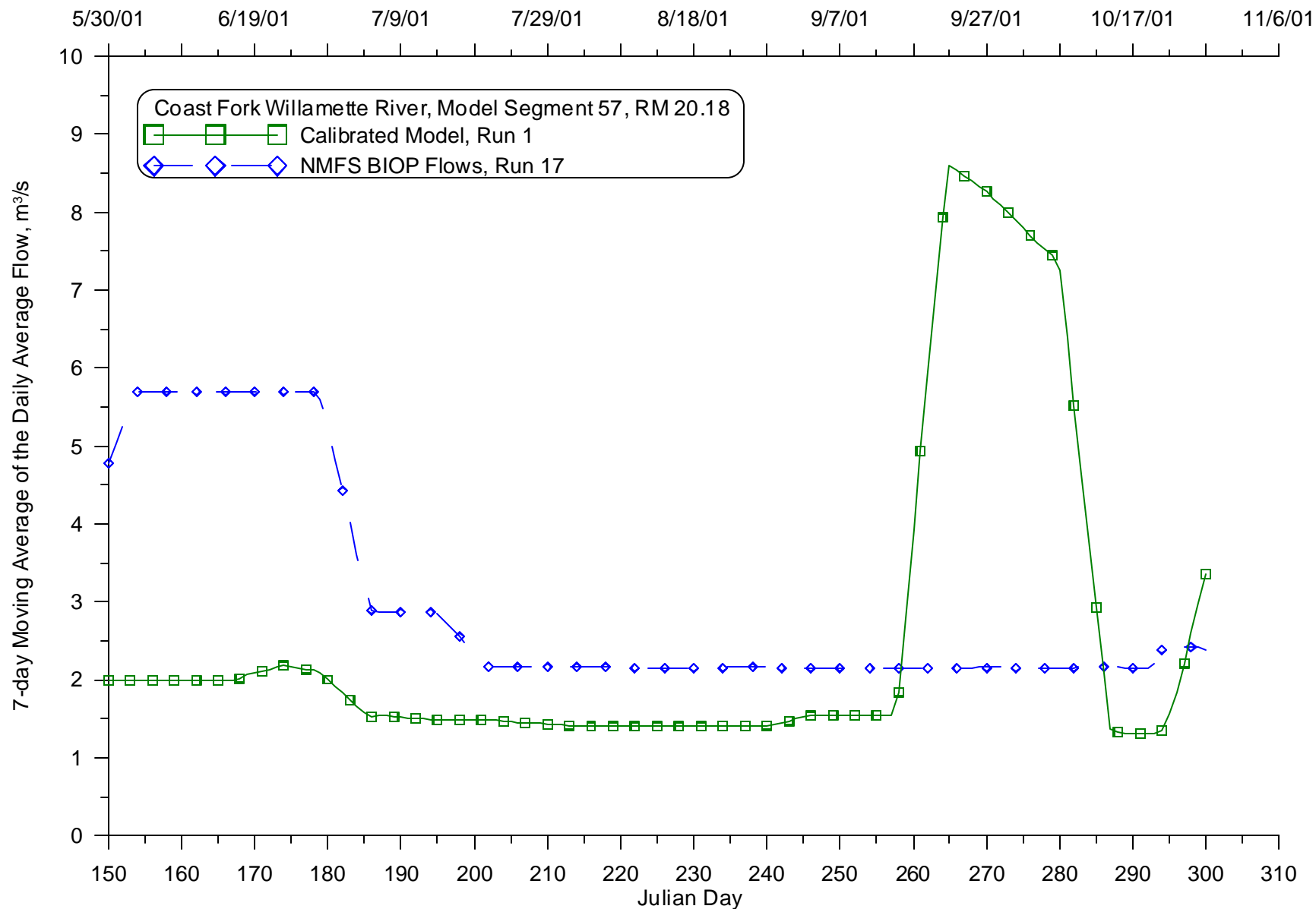


Figure 811: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Coast Fork Willamette River at RM 20.18

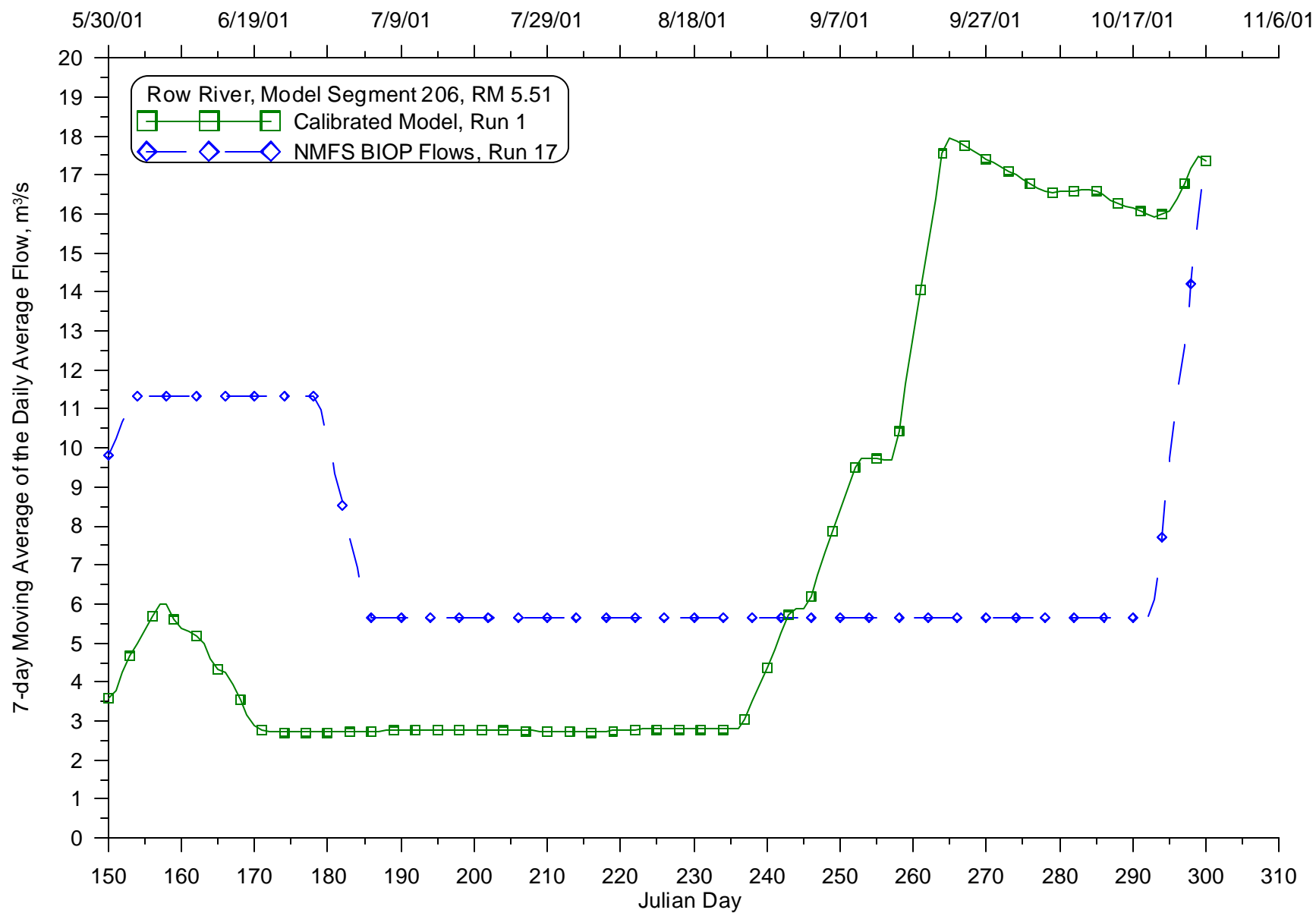
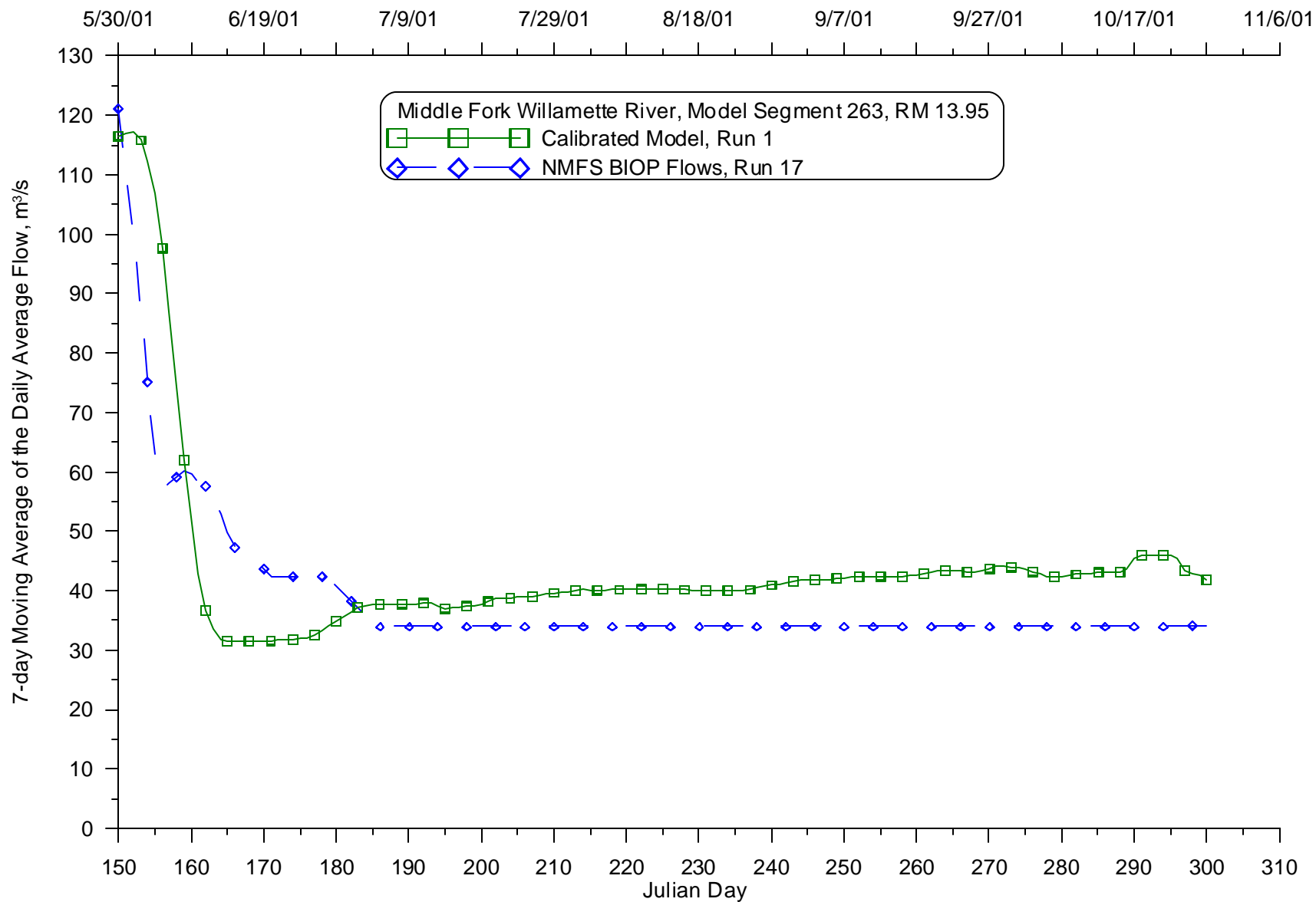


Figure 812: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Row River at RM 5.51



**Figure 813: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Middle Fork Willamette River at RM 13.95**



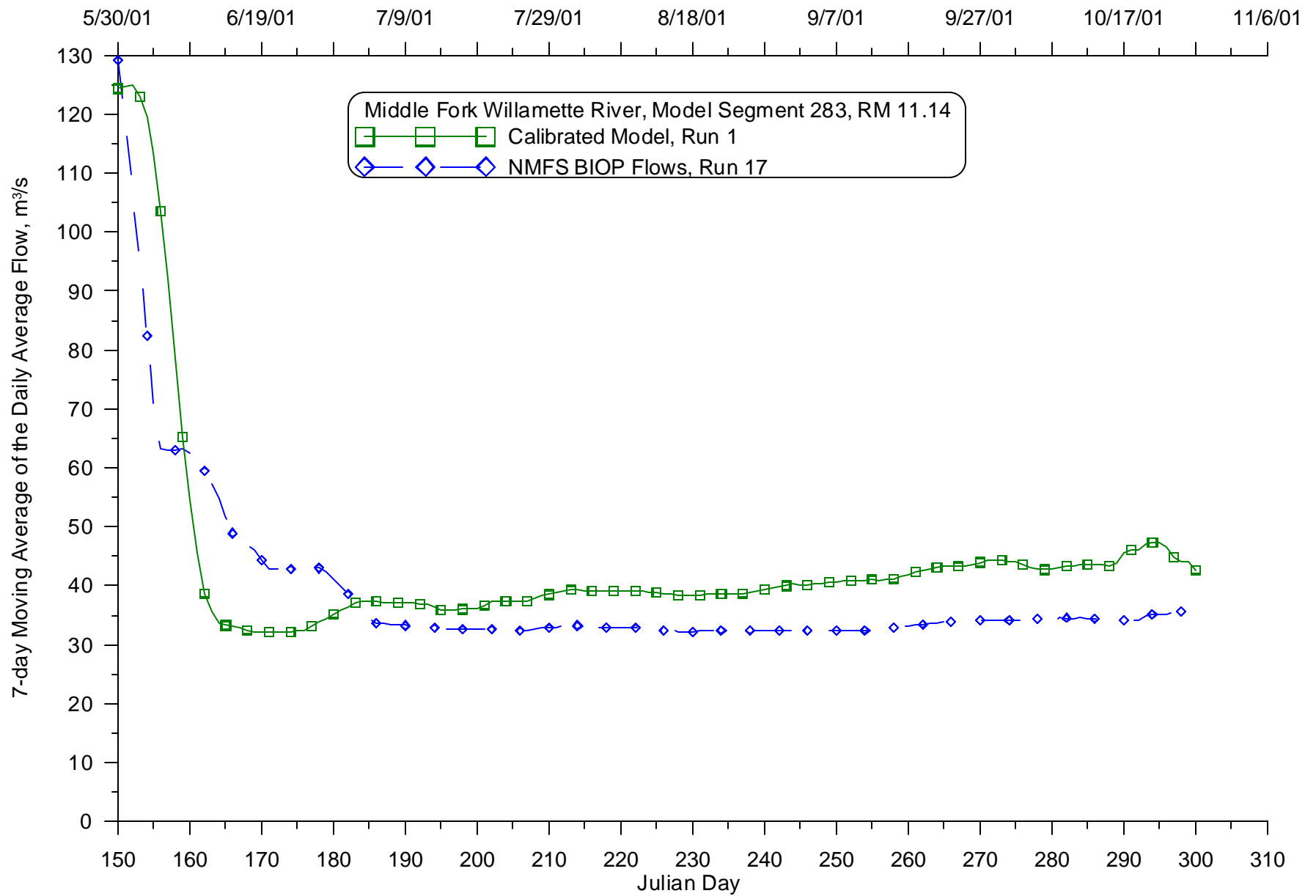


Figure 814: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Middle Fork Willamette River at RM 11.14

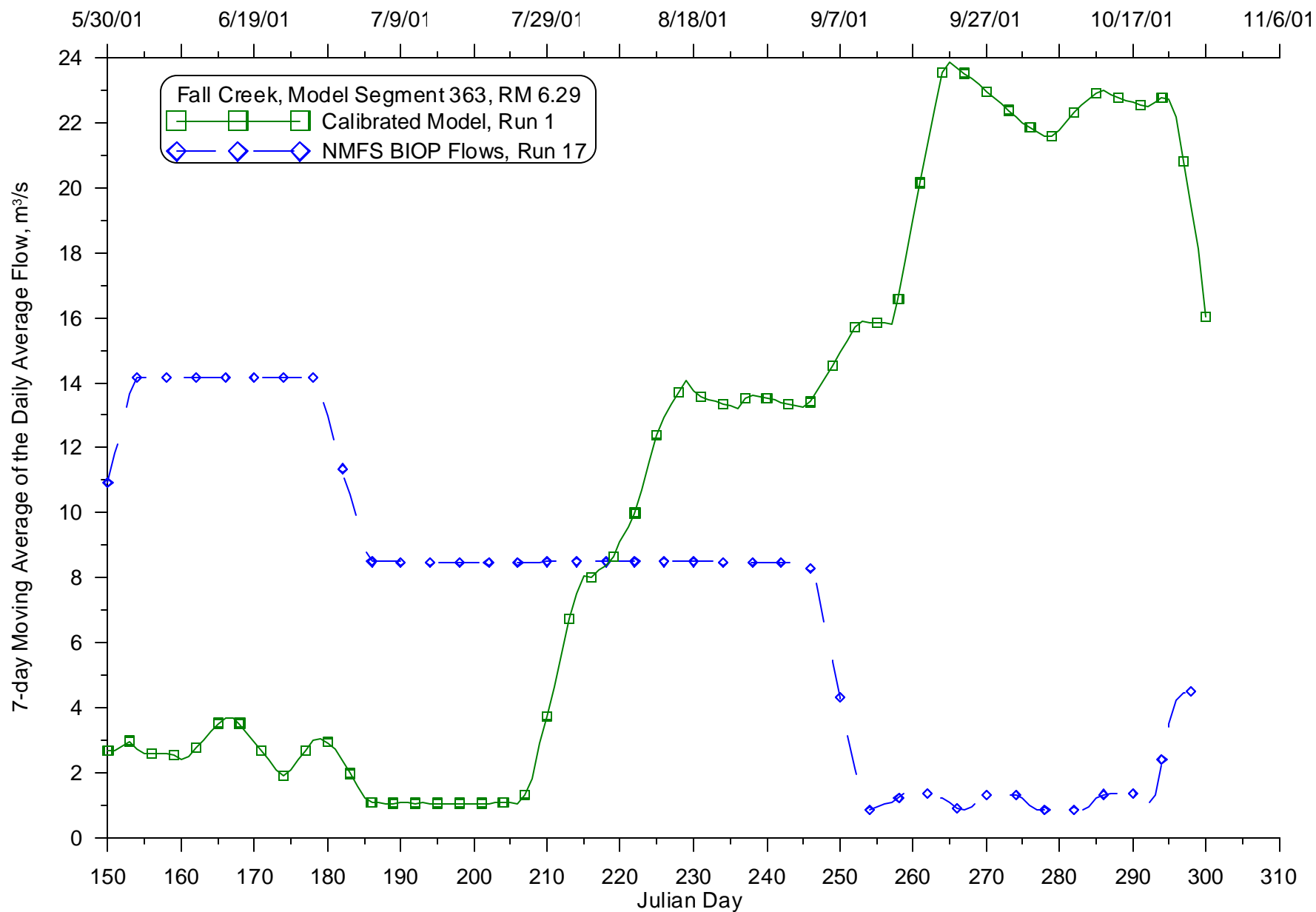


Figure 815: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for Fall Creek at RM 6.29

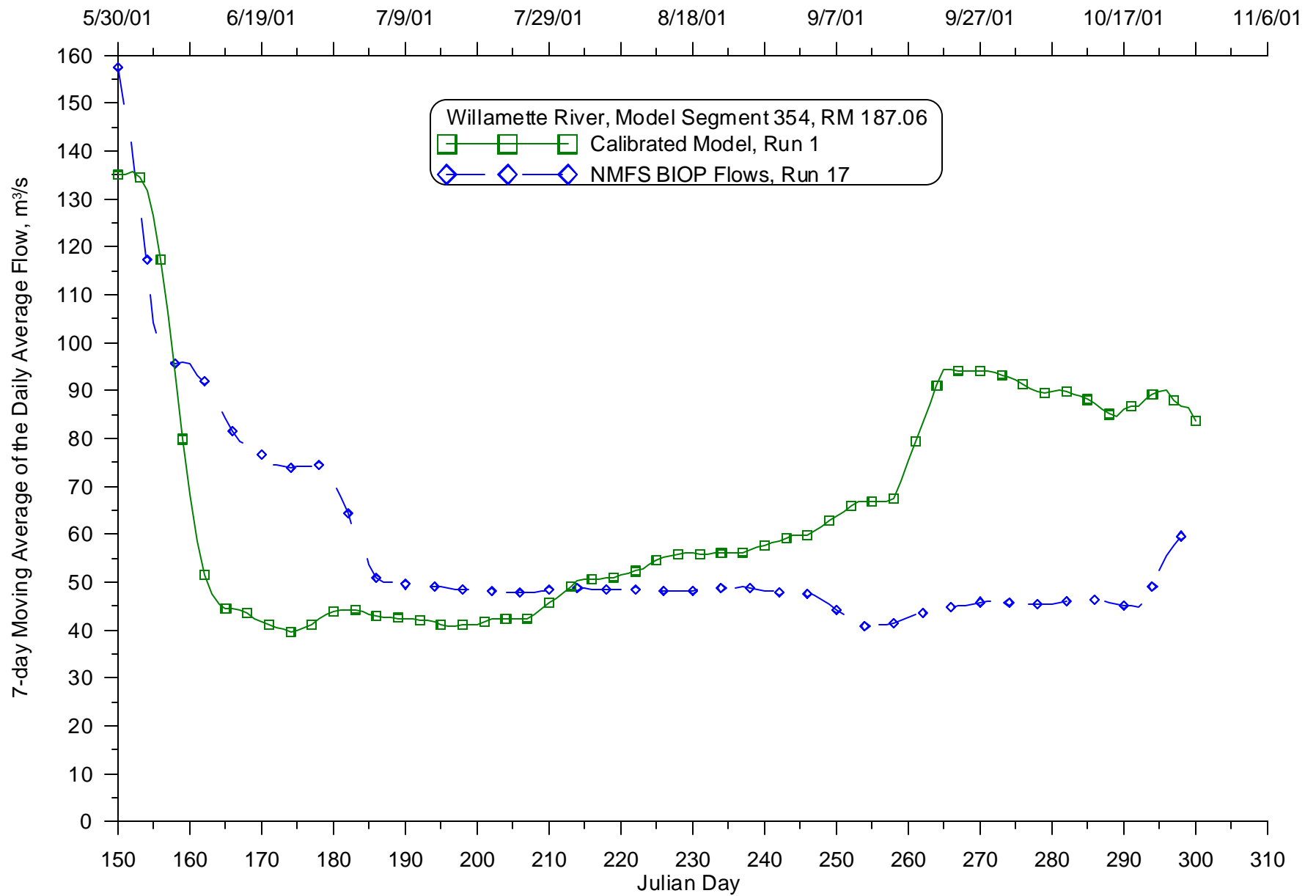


Figure 816: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 187.06

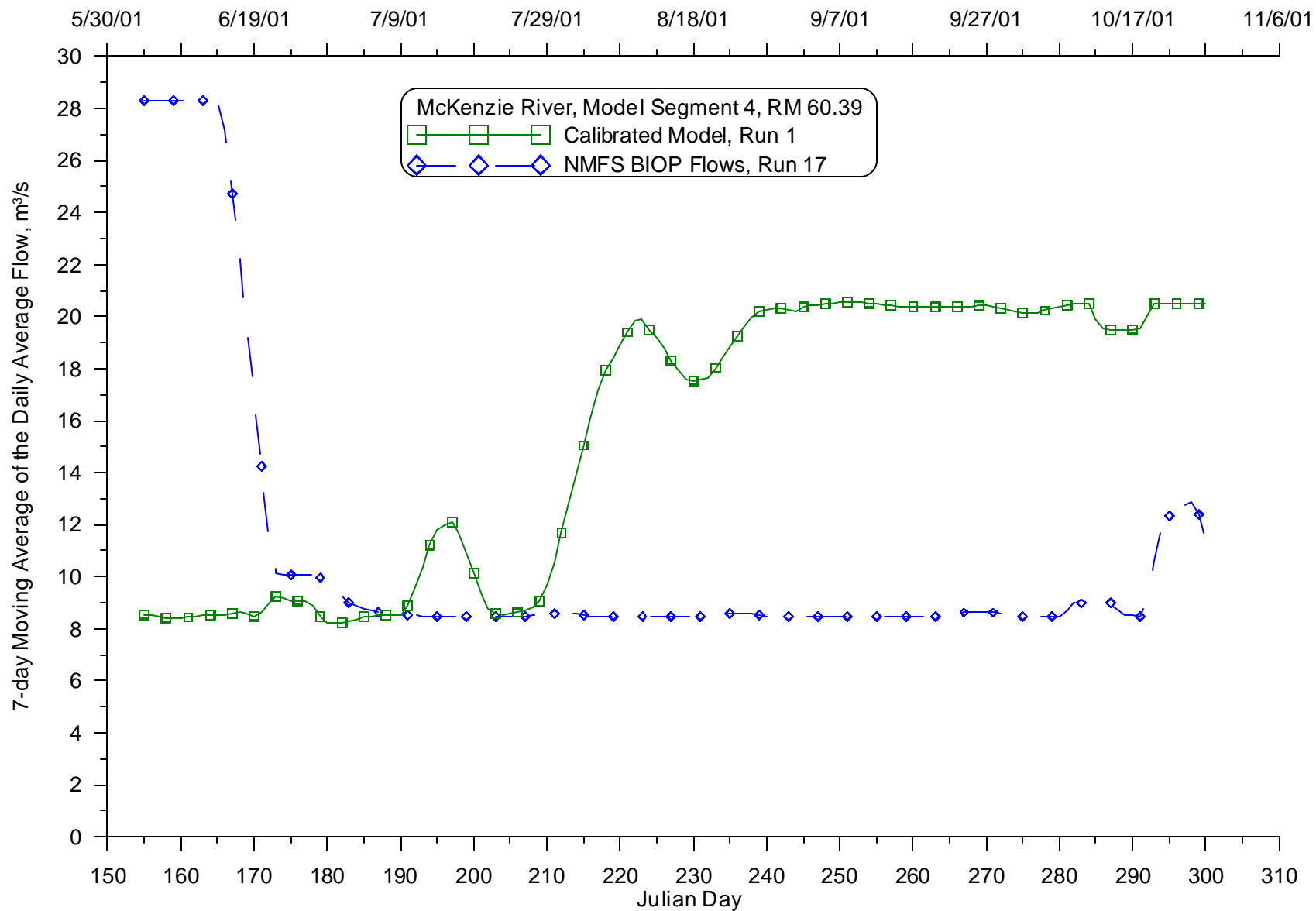


Figure 817: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the McKenzie River at RM 60.39

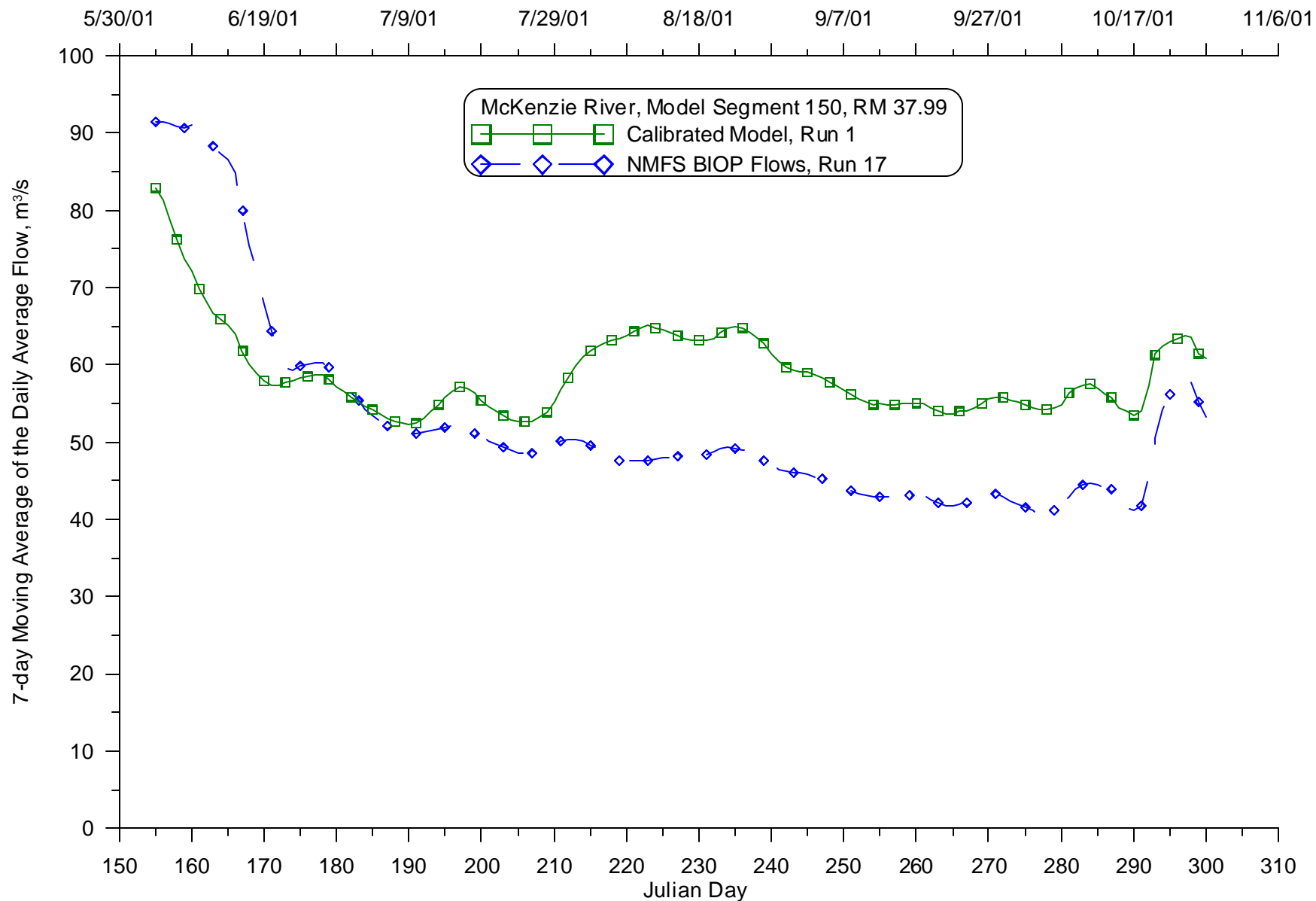
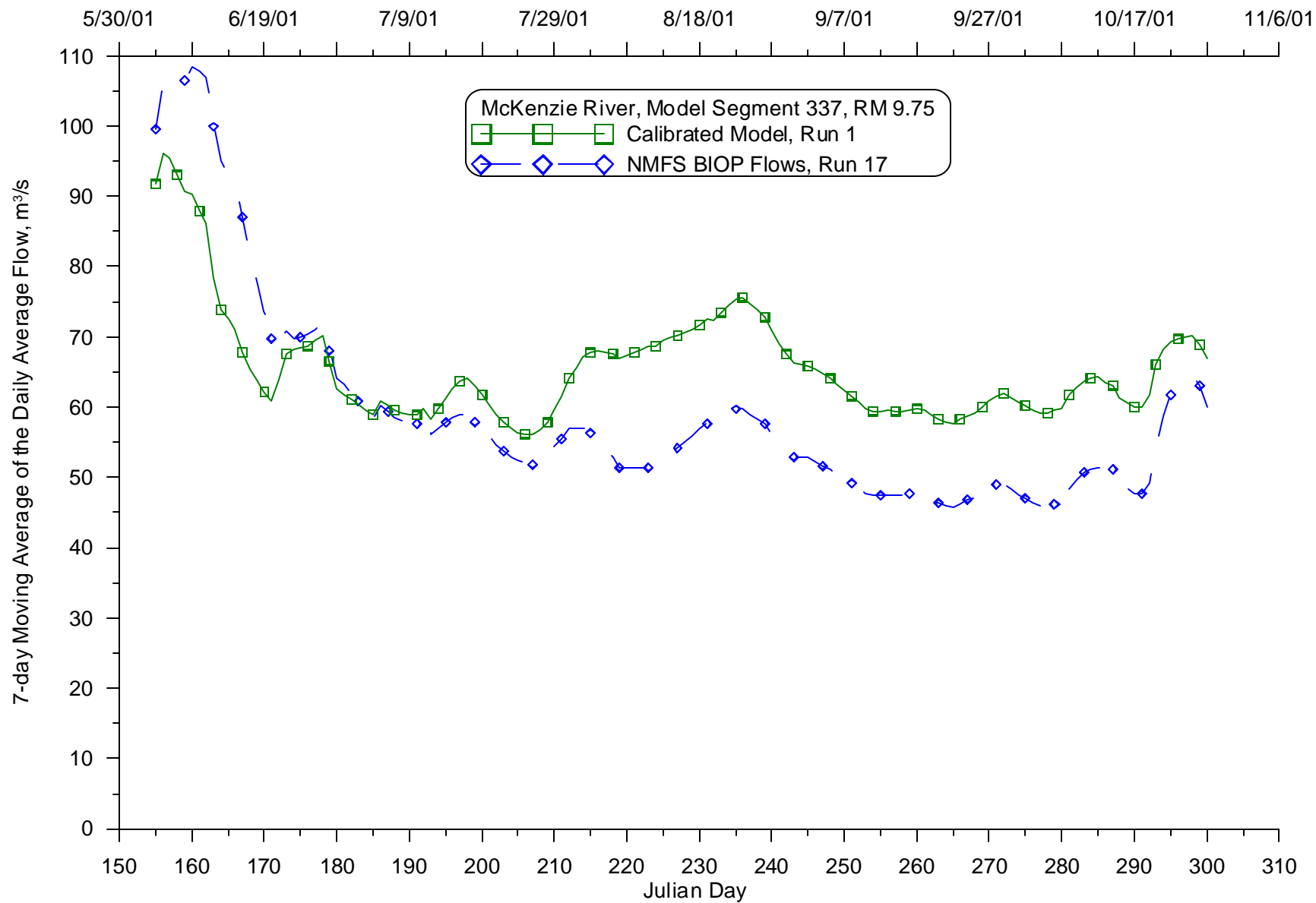
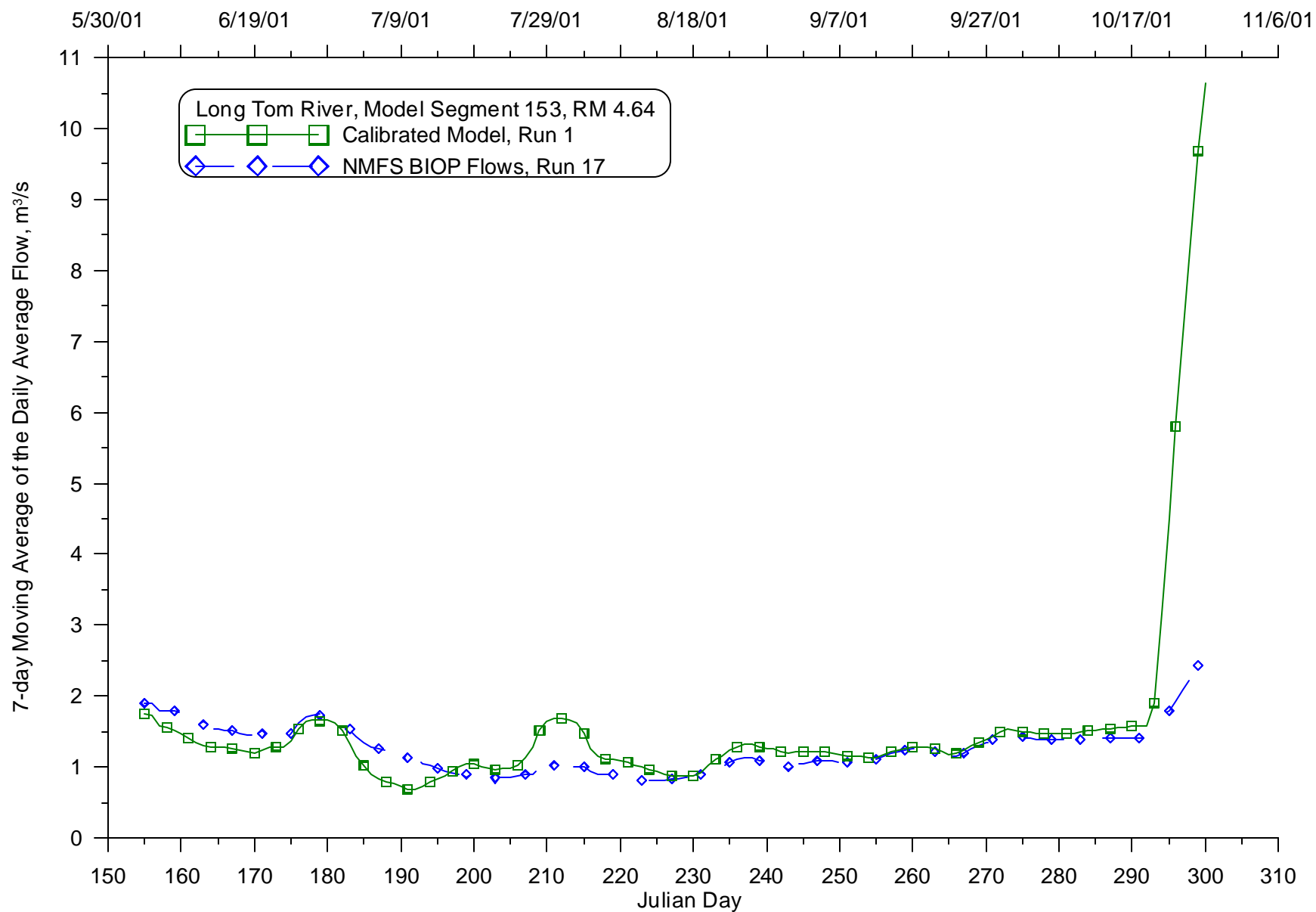


Figure 818: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the McKenzie River at RM 37.99



**Figure 819: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the McKenzie River at RM 9.75**



**Figure 820: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Long Tom River at RM 4.64**

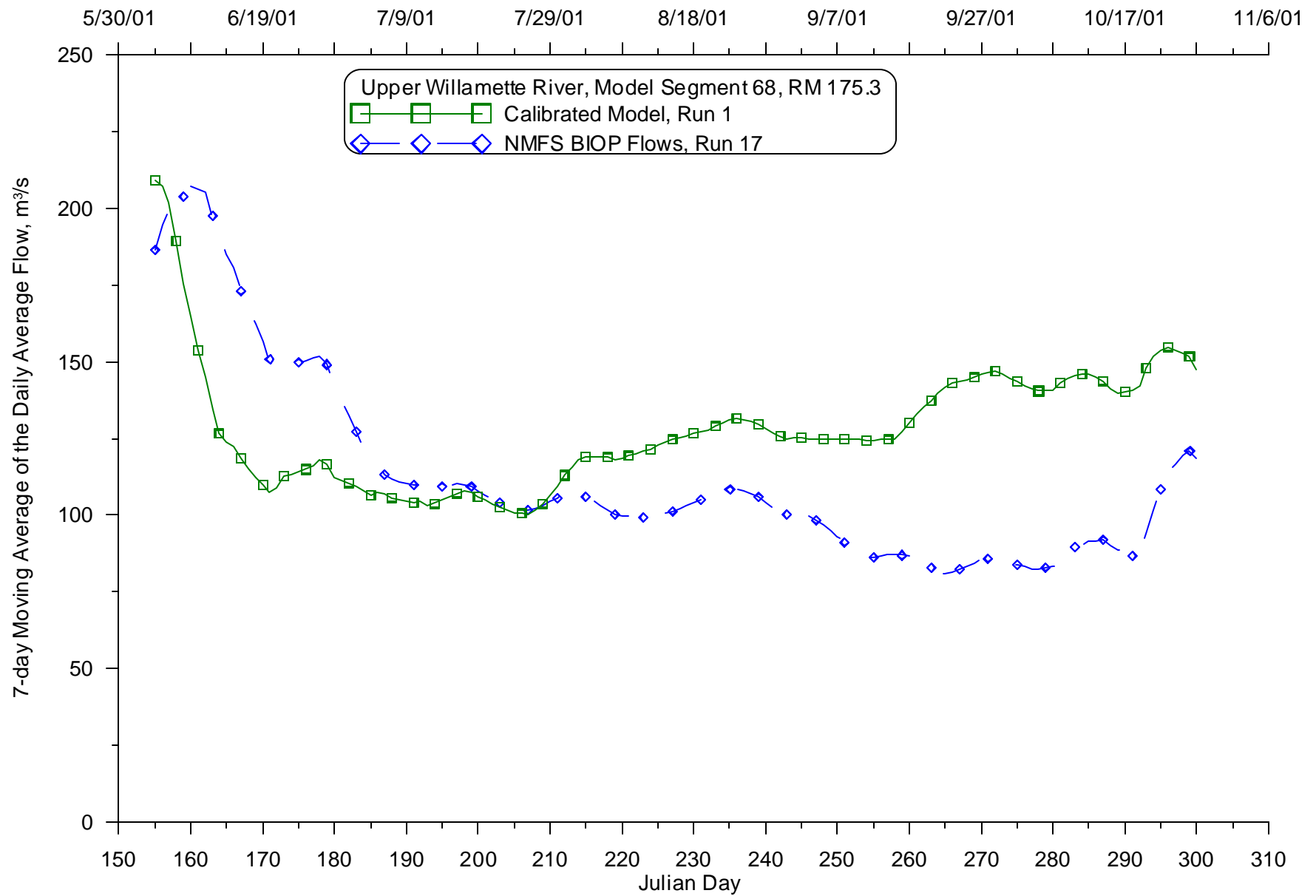


Figure 821: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 175.3



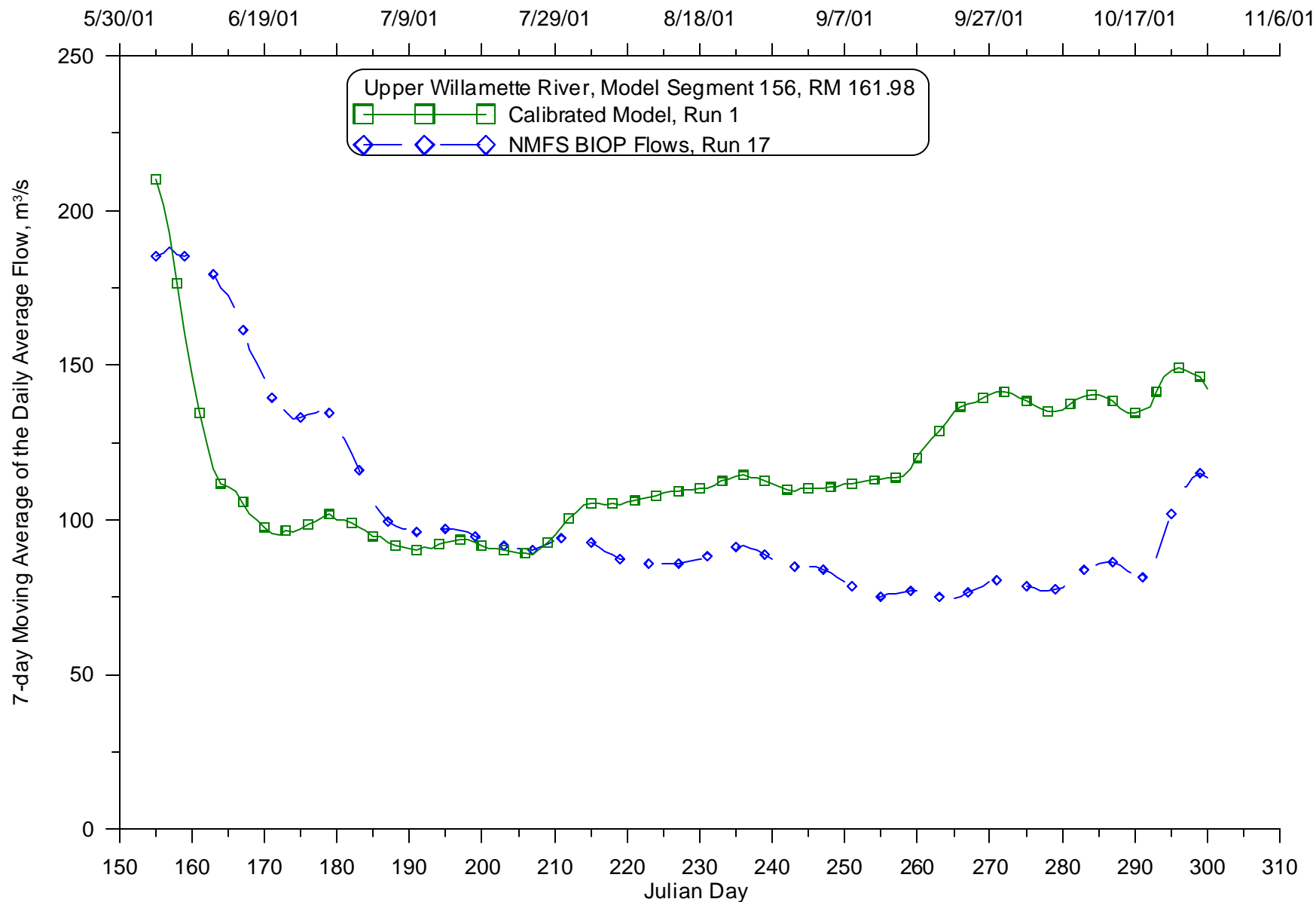


Figure 822: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 161.98

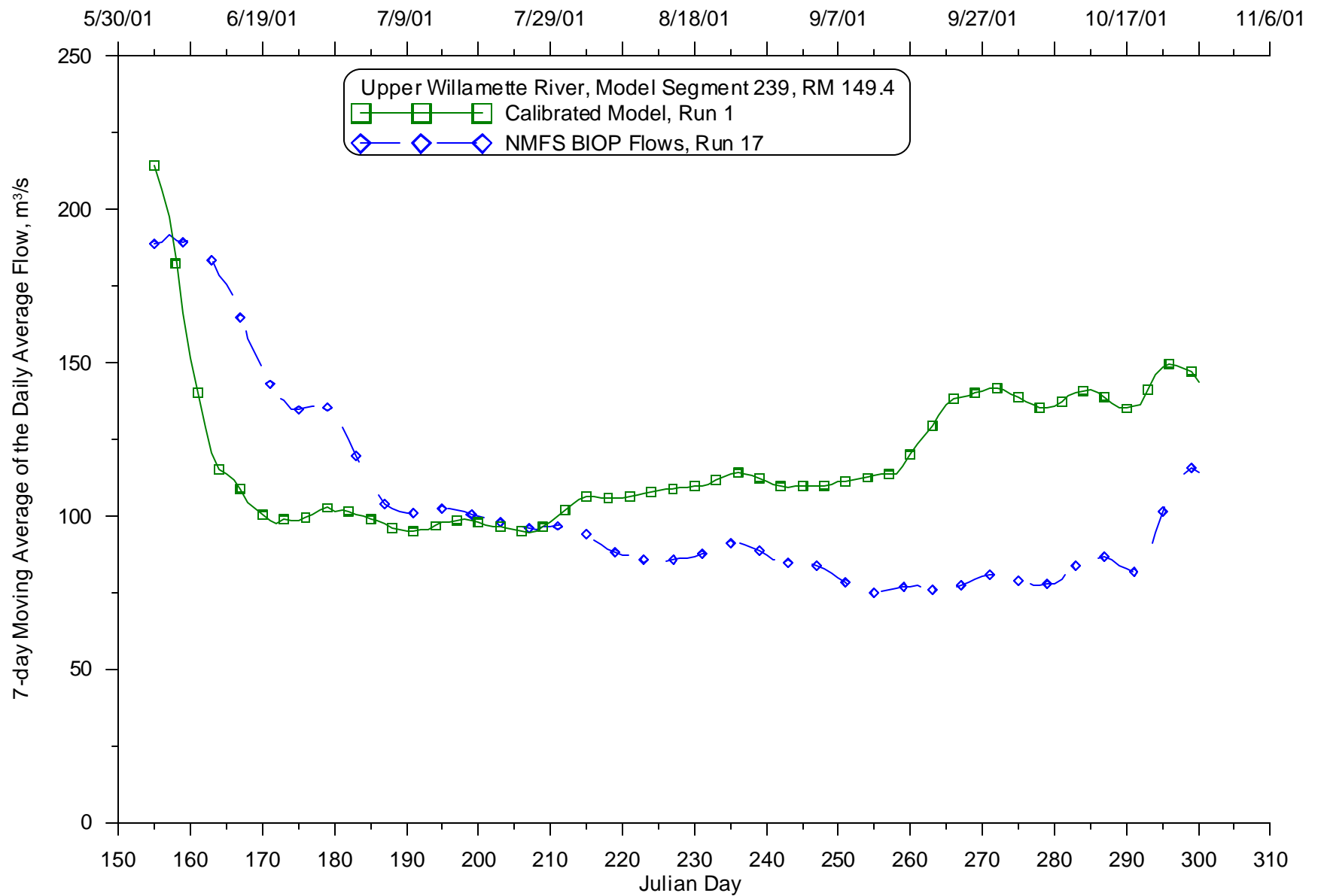


Figure 823: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 149.4

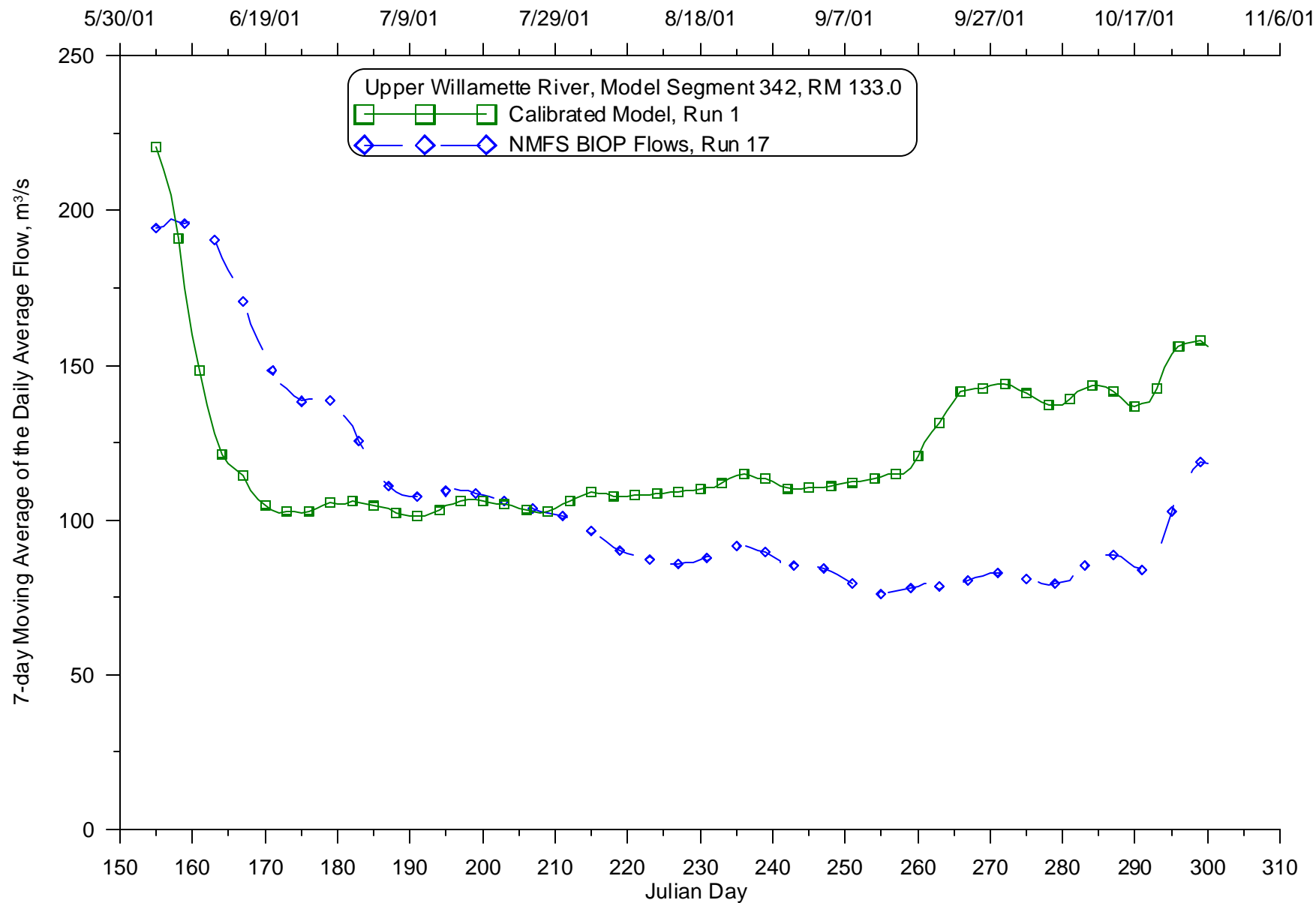


Figure 824: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 133

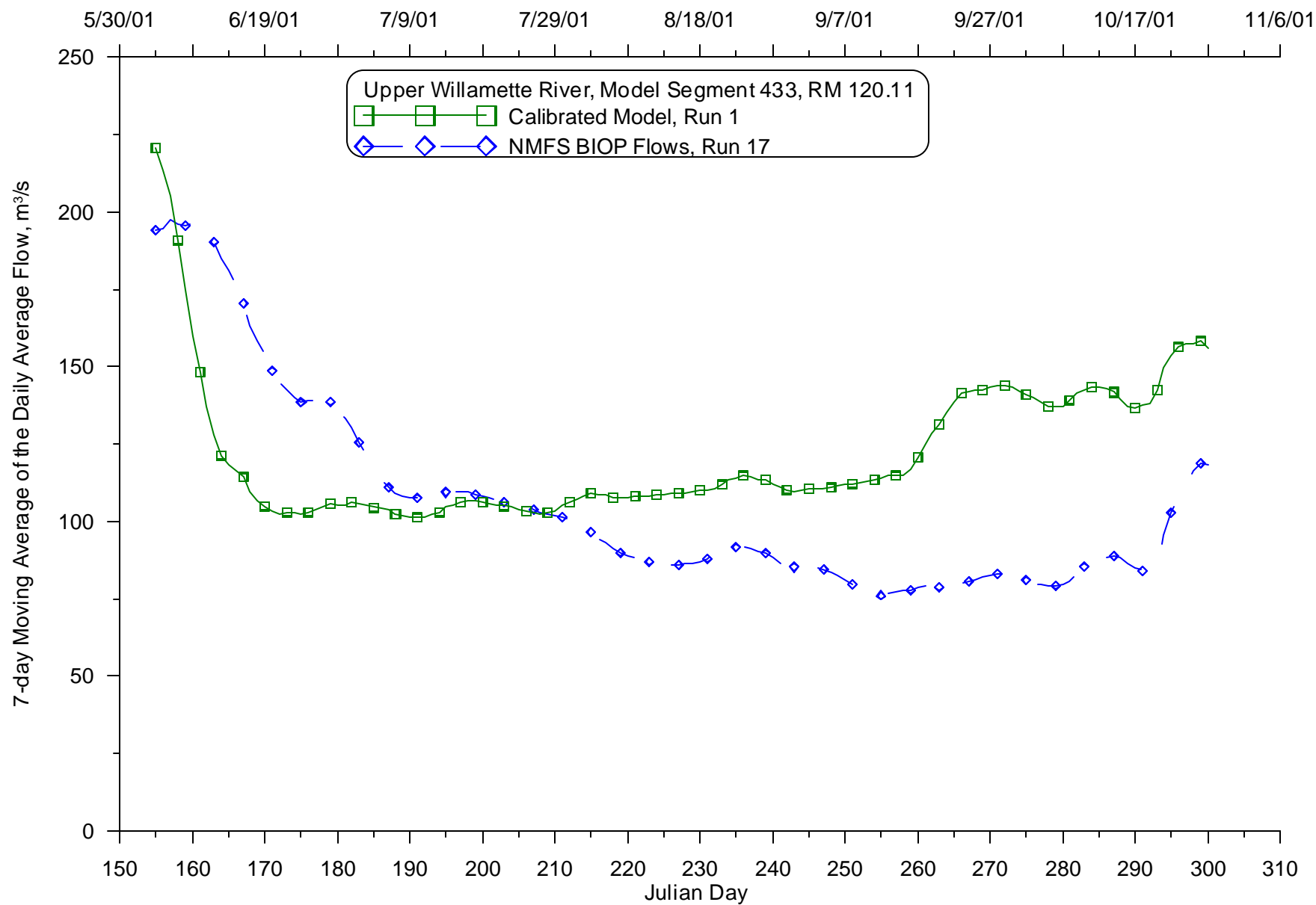


Figure 825: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 120.11

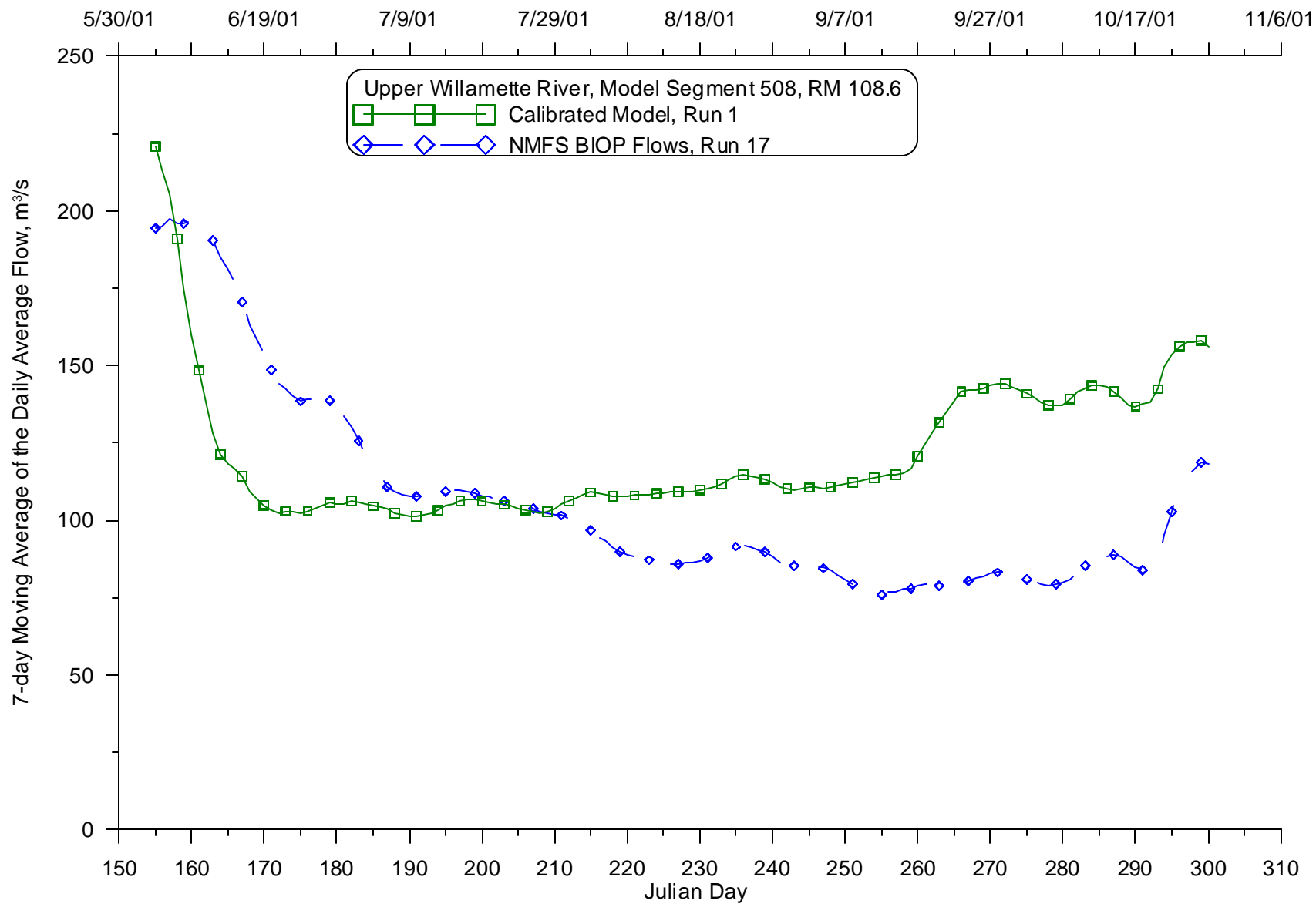


Figure 826: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 108.6

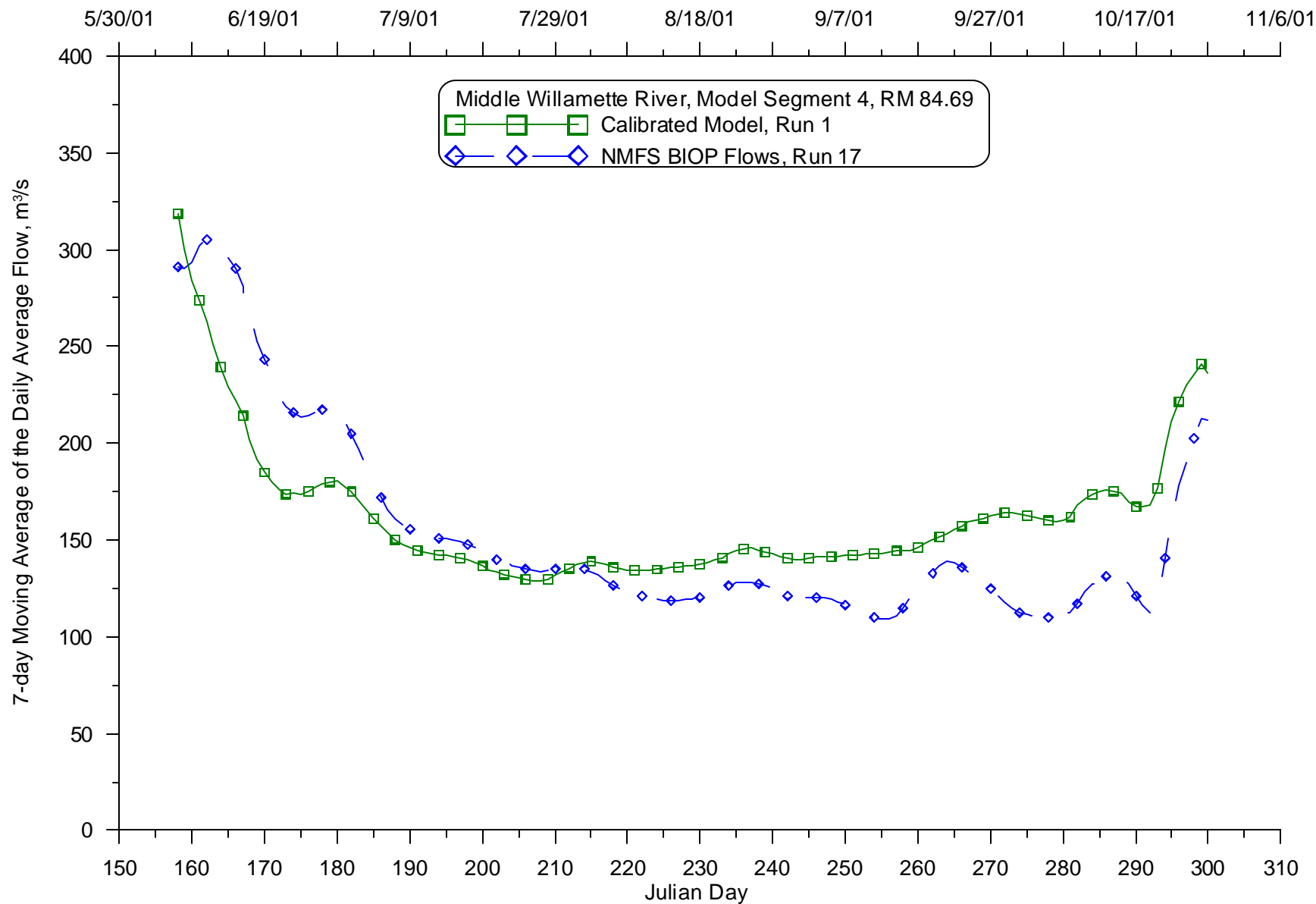
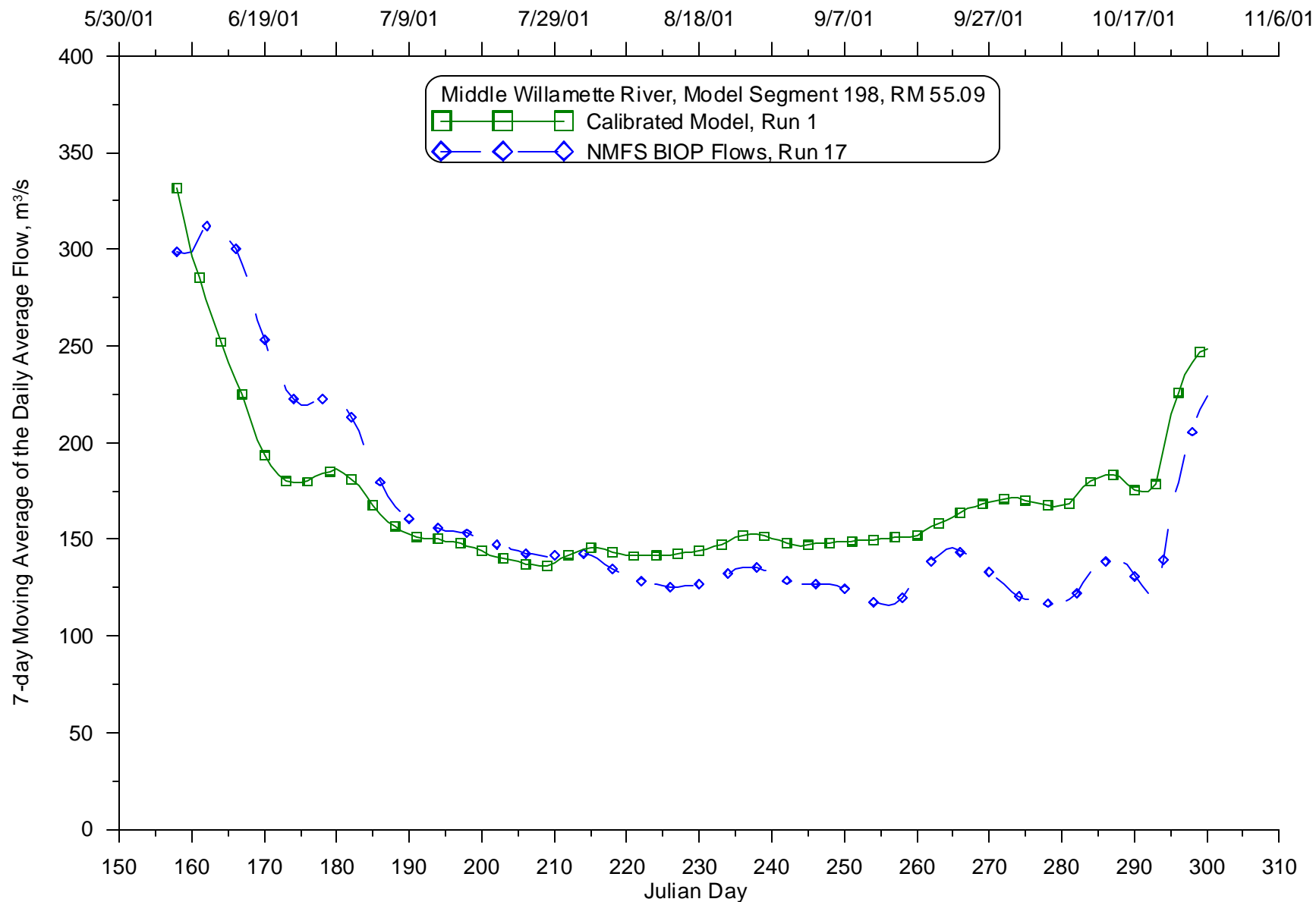


Figure 827: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 84.69



**Figure 828: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 55.09**

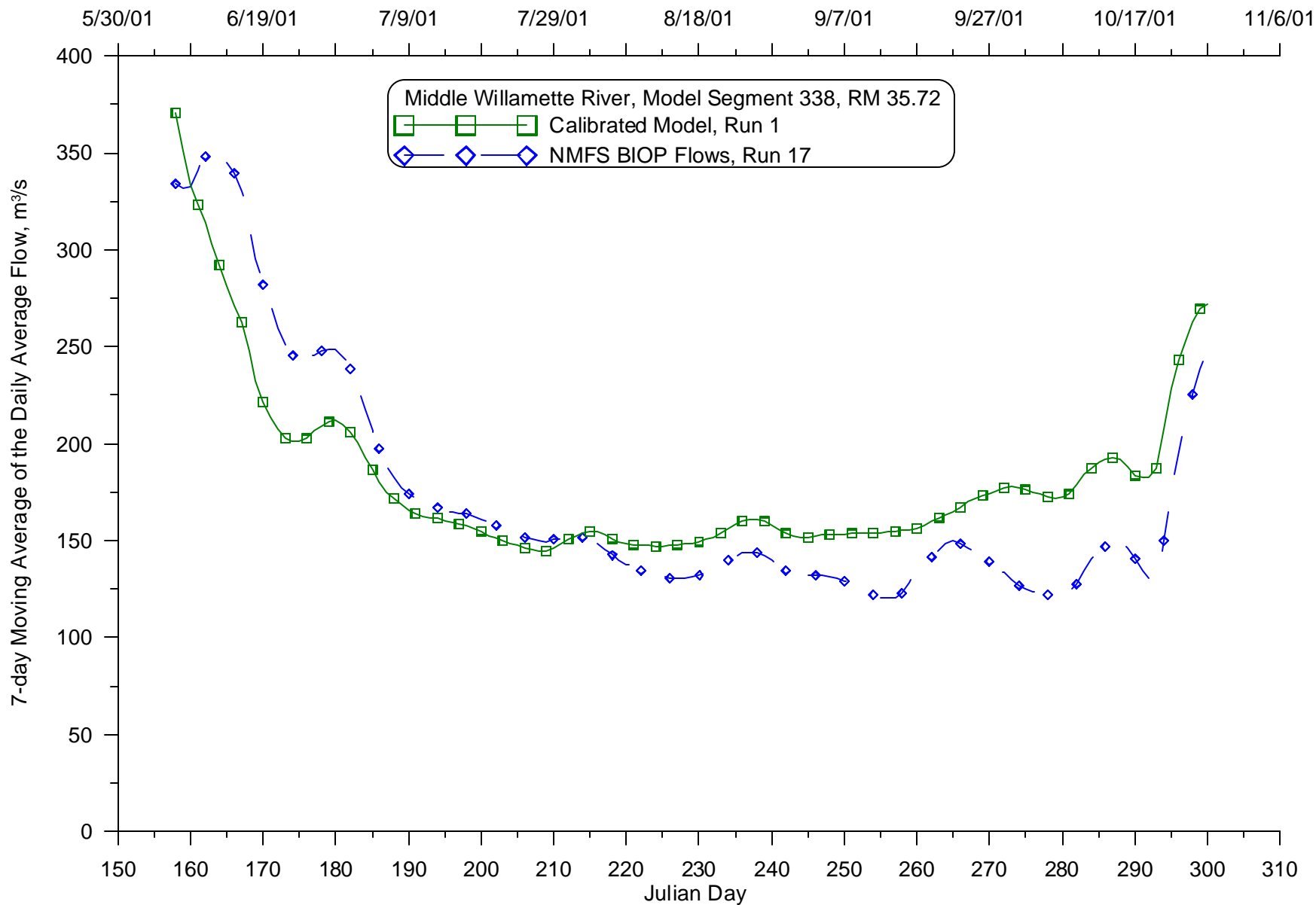


Figure 829: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 35.72



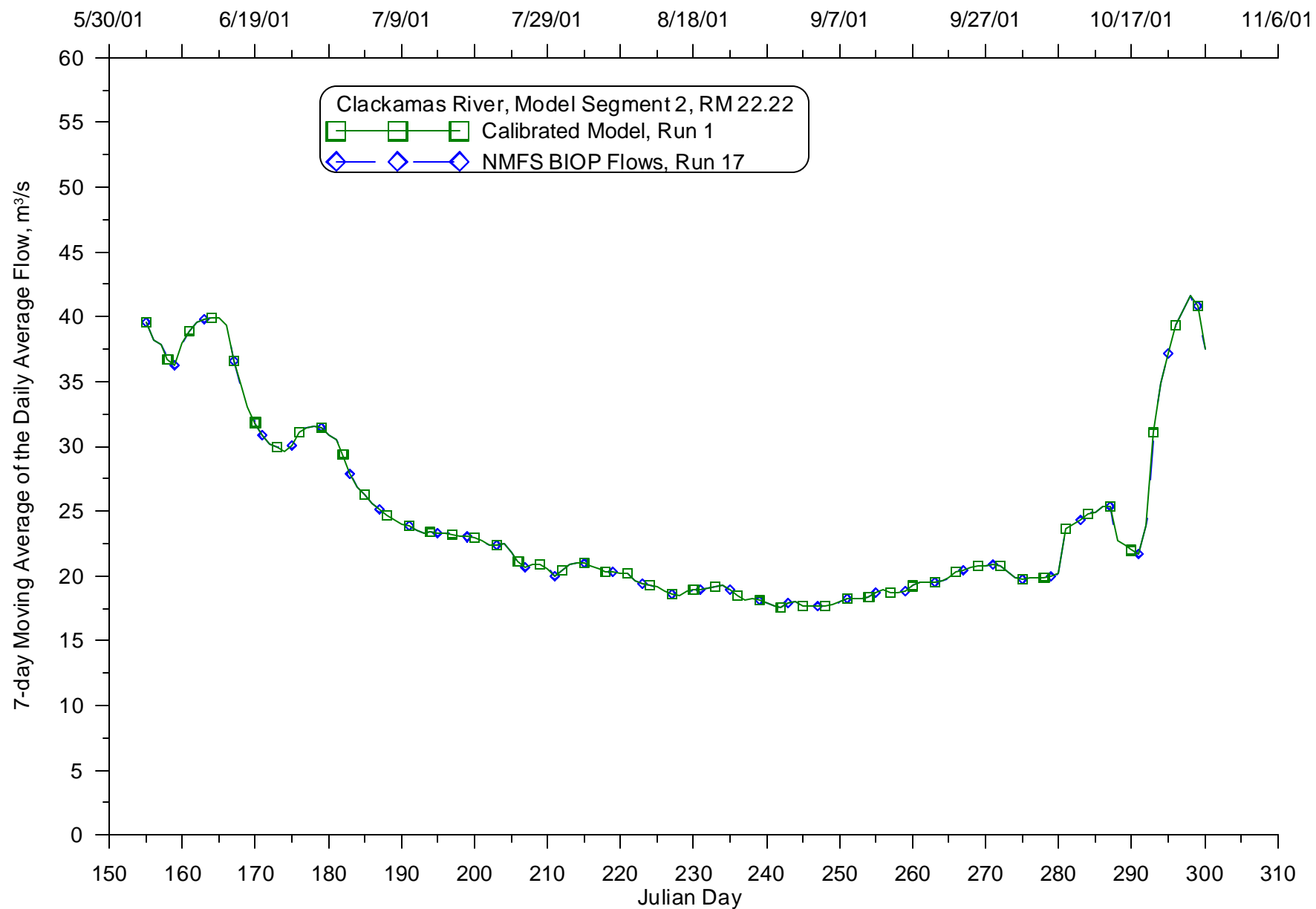


Figure 830: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Clackamas River at RM 22.22

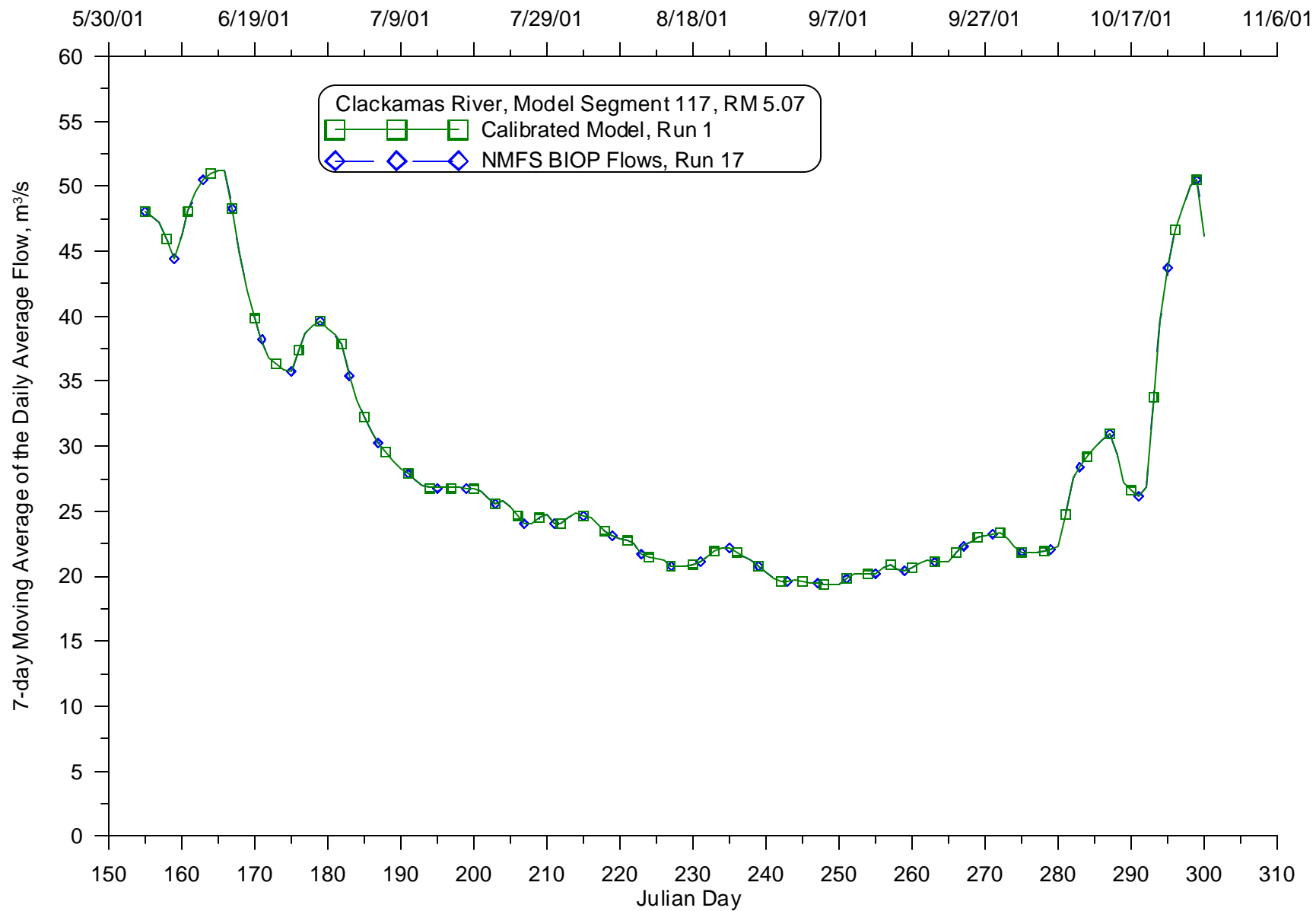


Figure 831: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Clackamas River at RM 5.07

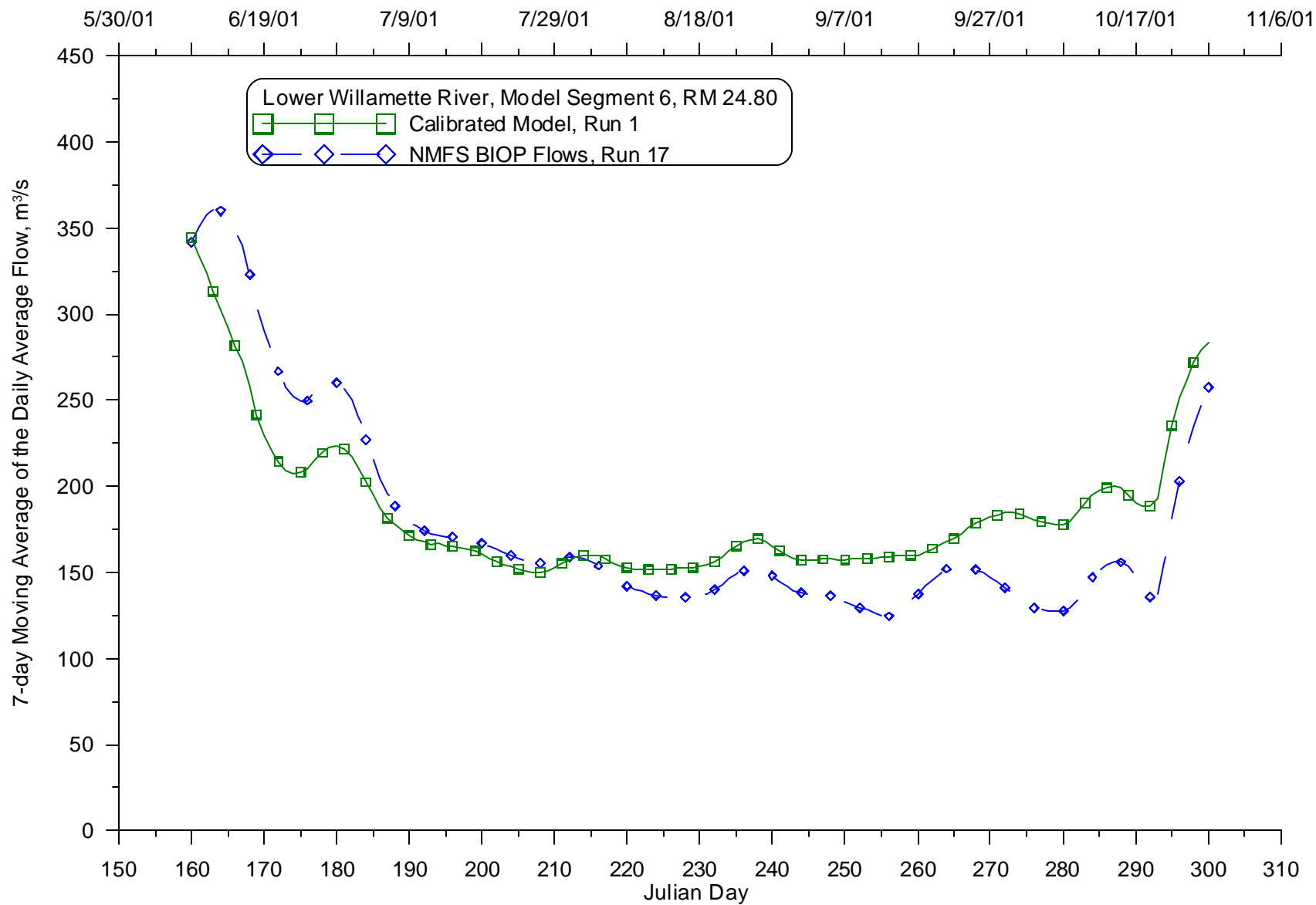


Figure 832: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 24.8

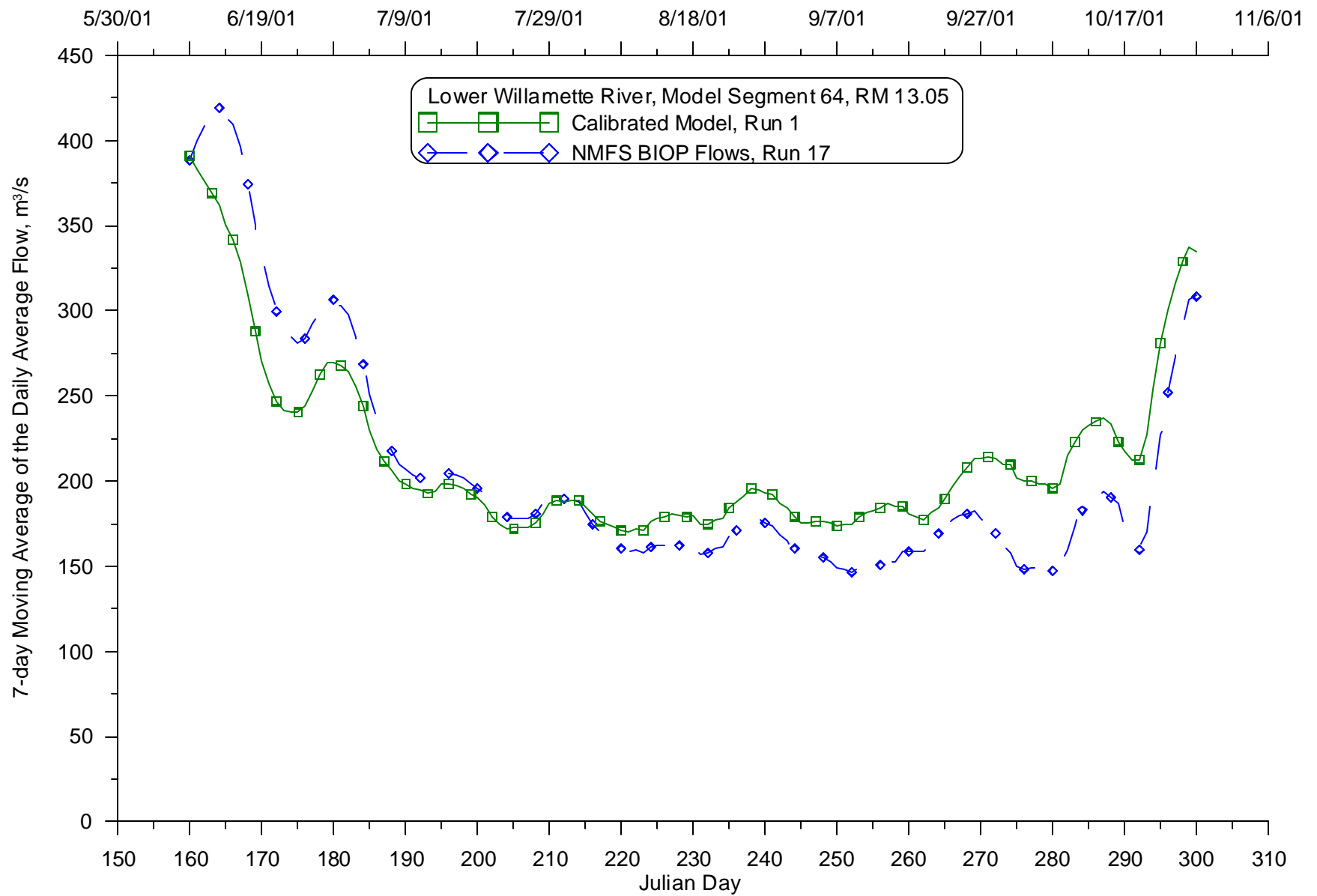


Figure 833: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 13.05

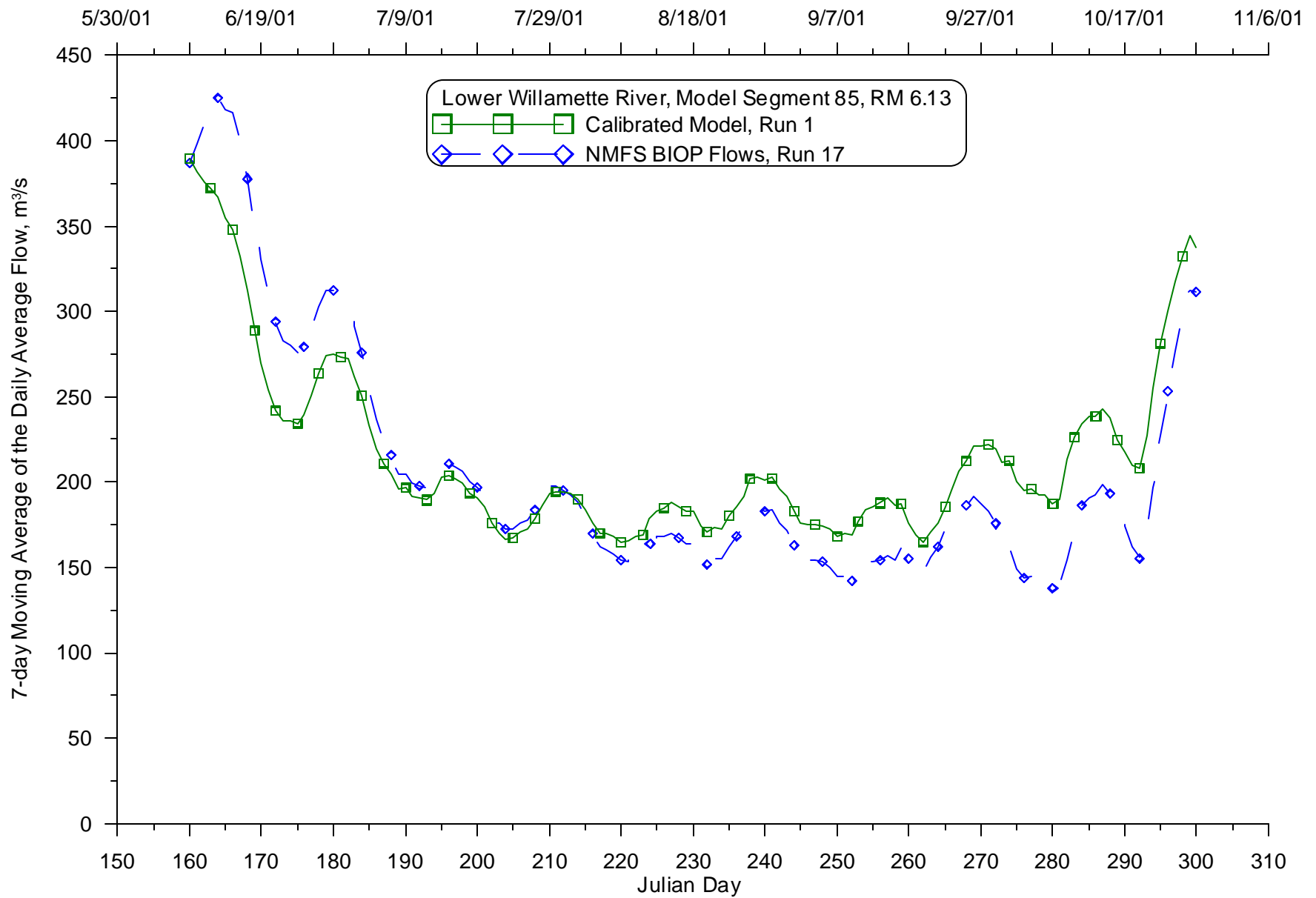
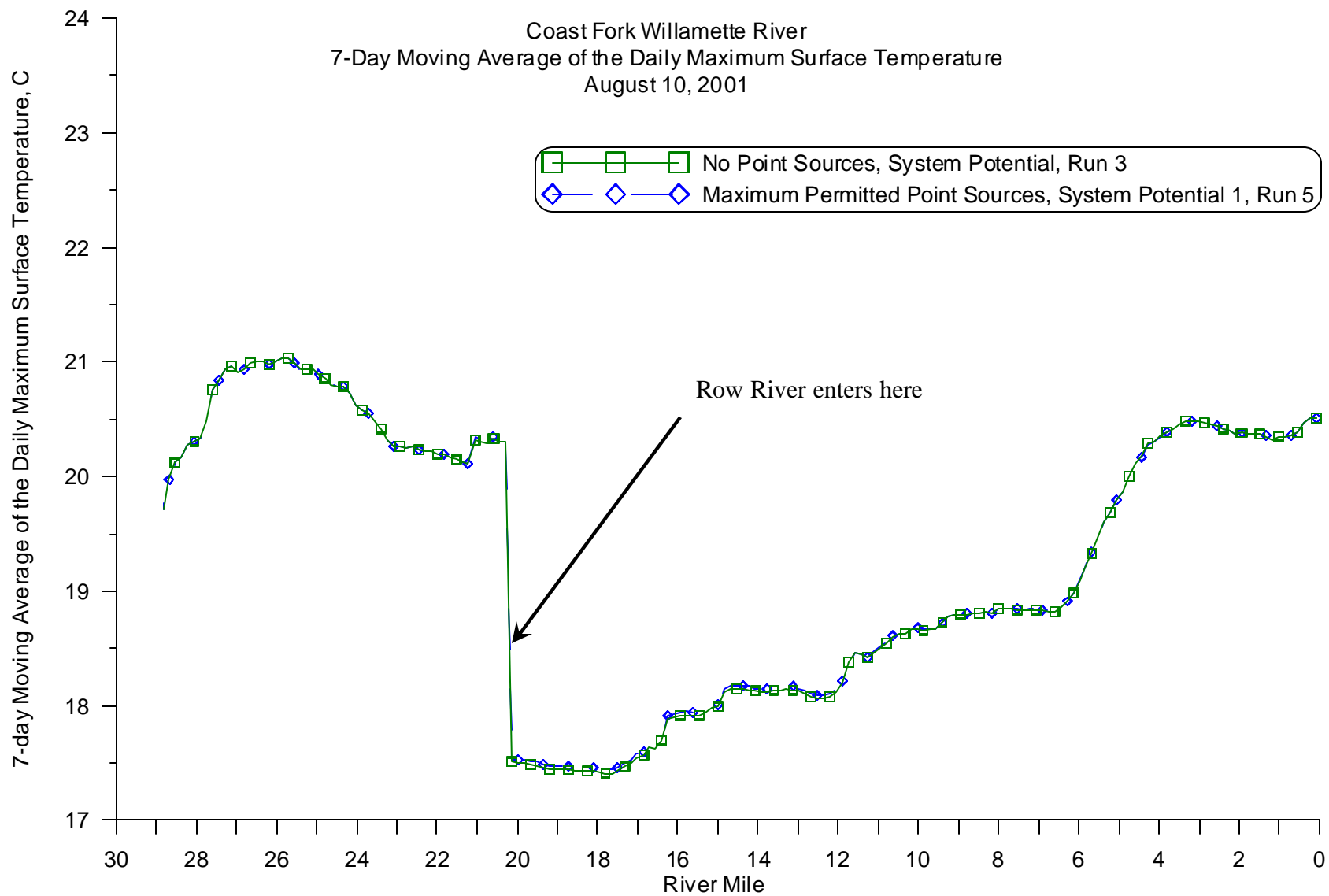


Figure 834: Calibrated model compared with NMFS Biological Opinion flows, 7-day average of the daily average flow for 2001 for the Willamette River at RM 6.13

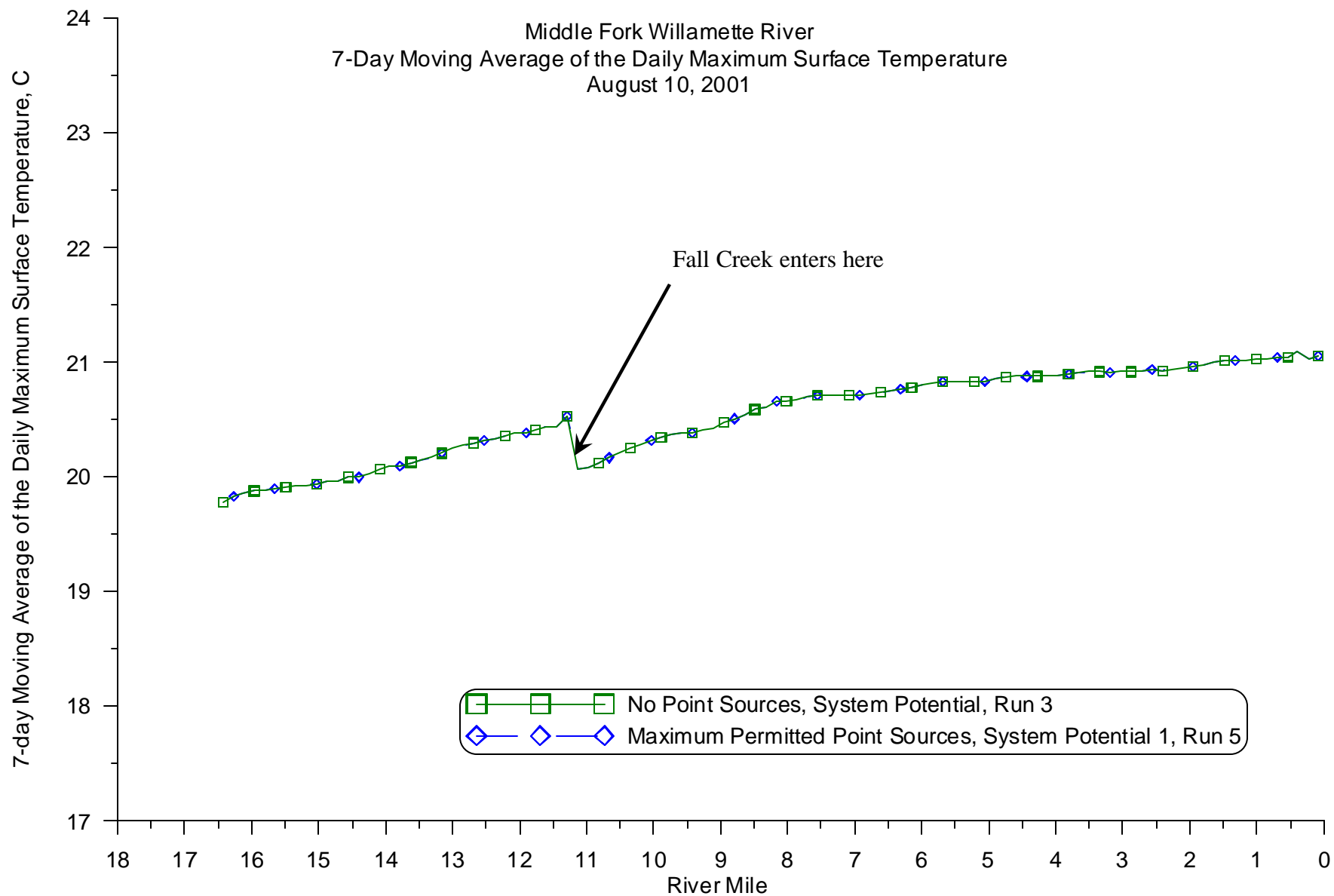
## Longitudinal Profile Comparisons

### ***Sensitivity to Point Sources***

System Potential 1 (ODEQ, 2003) was run for the summer of 2001 for two scenarios with varying discharges from the large point sources in the Willamette River system. The point sources were simulated with no discharge and their maximum permitted discharge. These results were then compared in a series of longitudinal profiles for each river reach modeled. All of the longitudinal plots show the seven-day moving average of the daily maximum temperature for August 10, 2001 (ODEQ, 2003) and begin in the furthest upstream reaches of the watershed and move downstream.



**Figure 835: Maximum Permitted Point Sources vs. No Point Sources longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**



**Figure 836: Maximum Permitted Point Sources vs. No Point Sources longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**



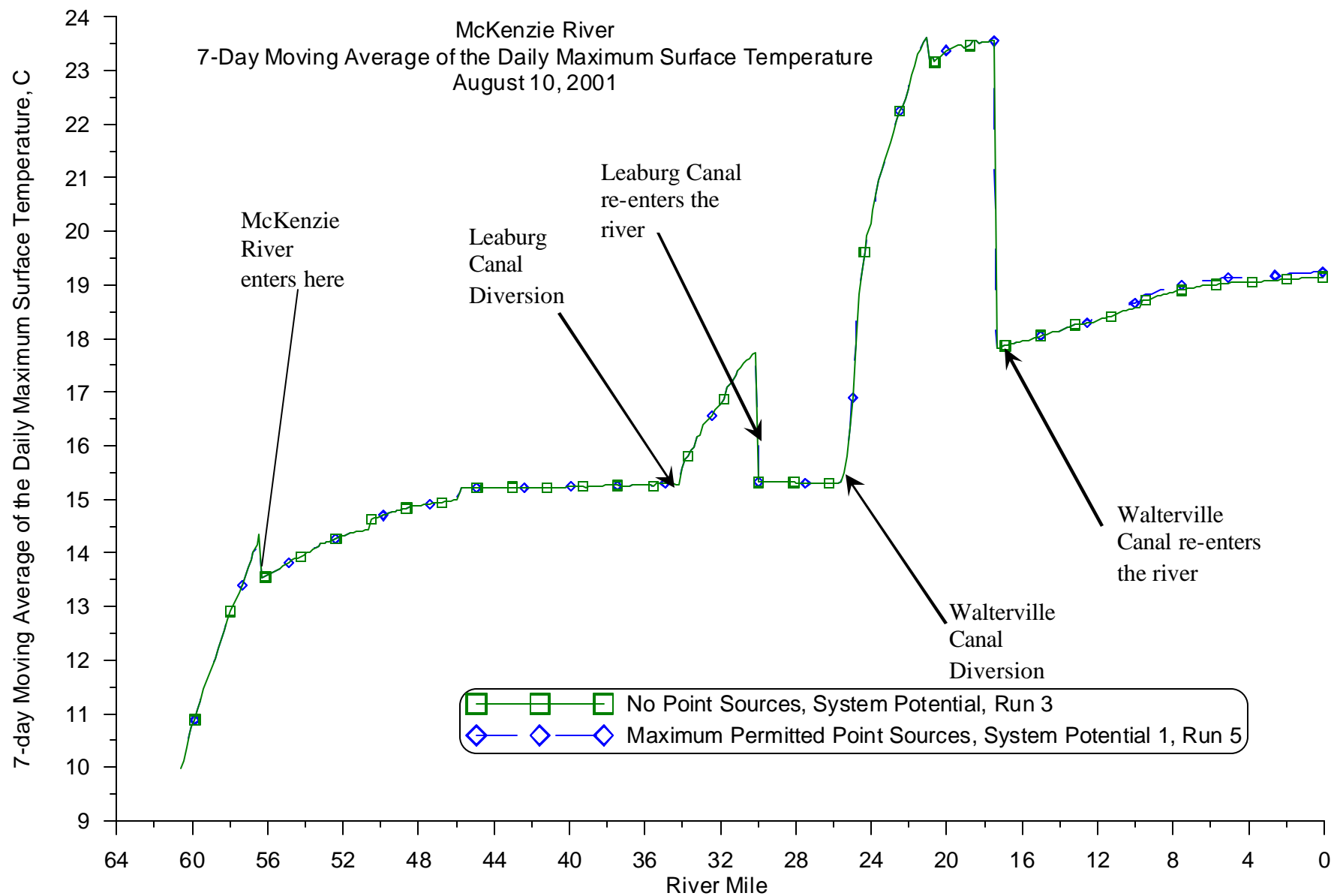
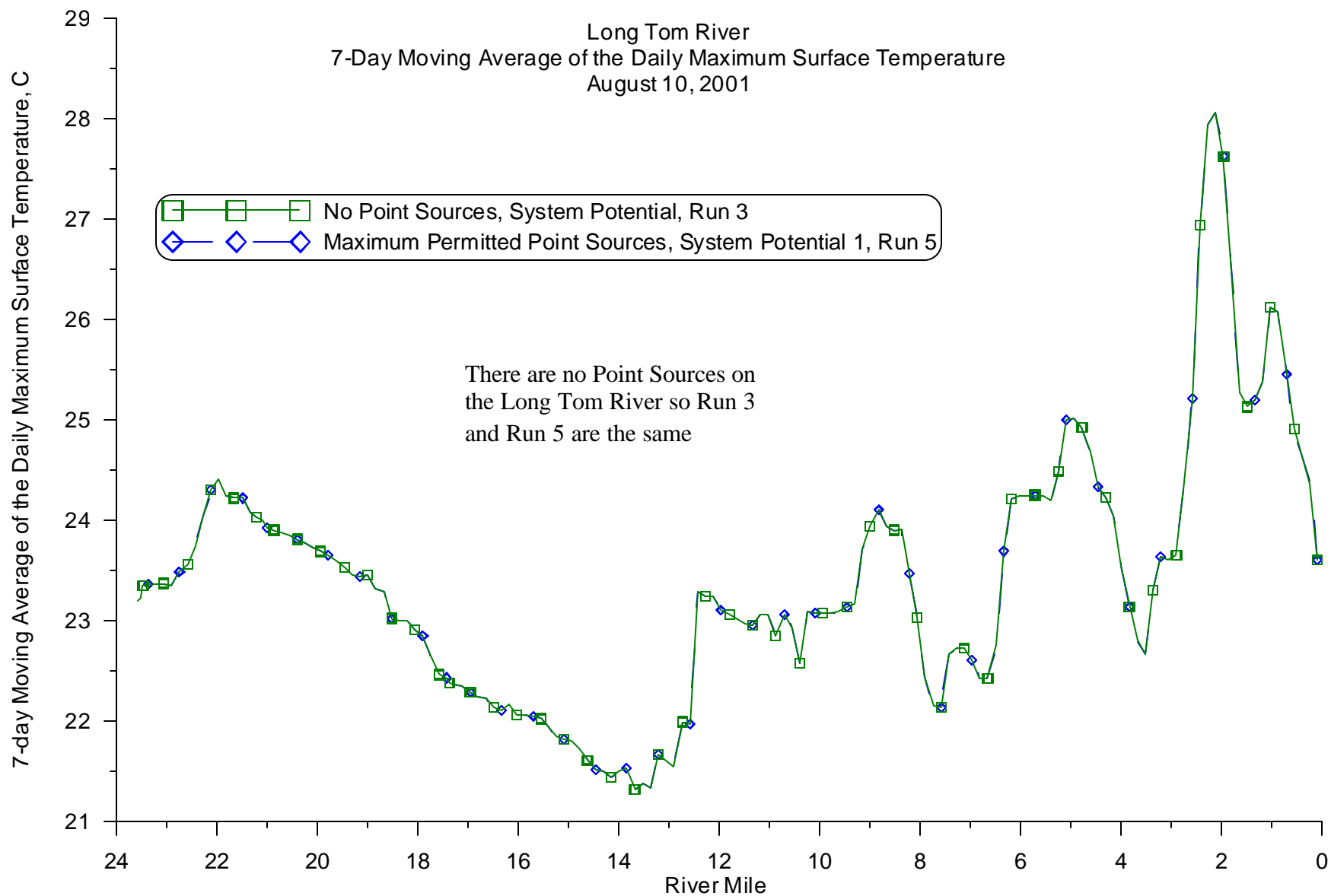
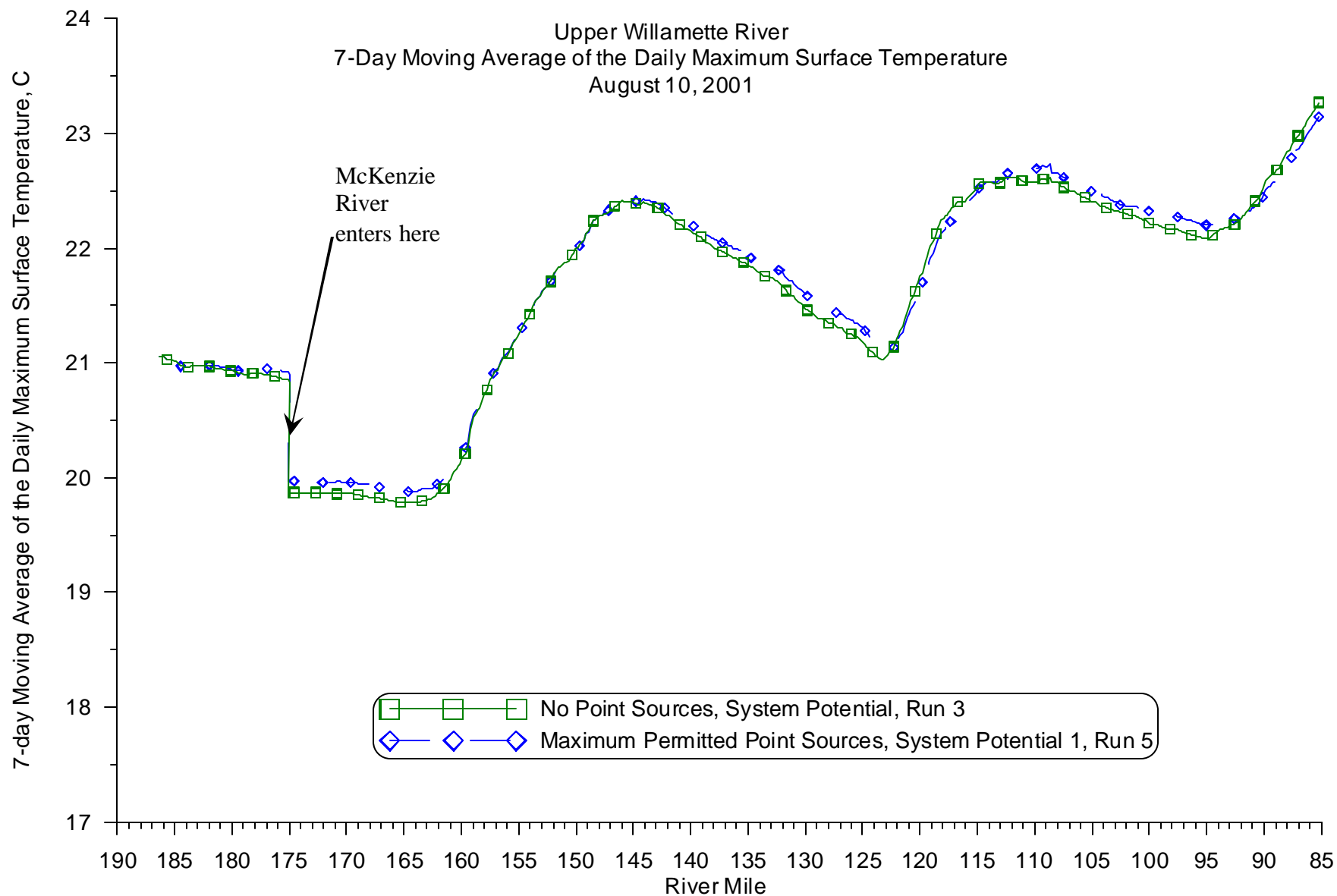


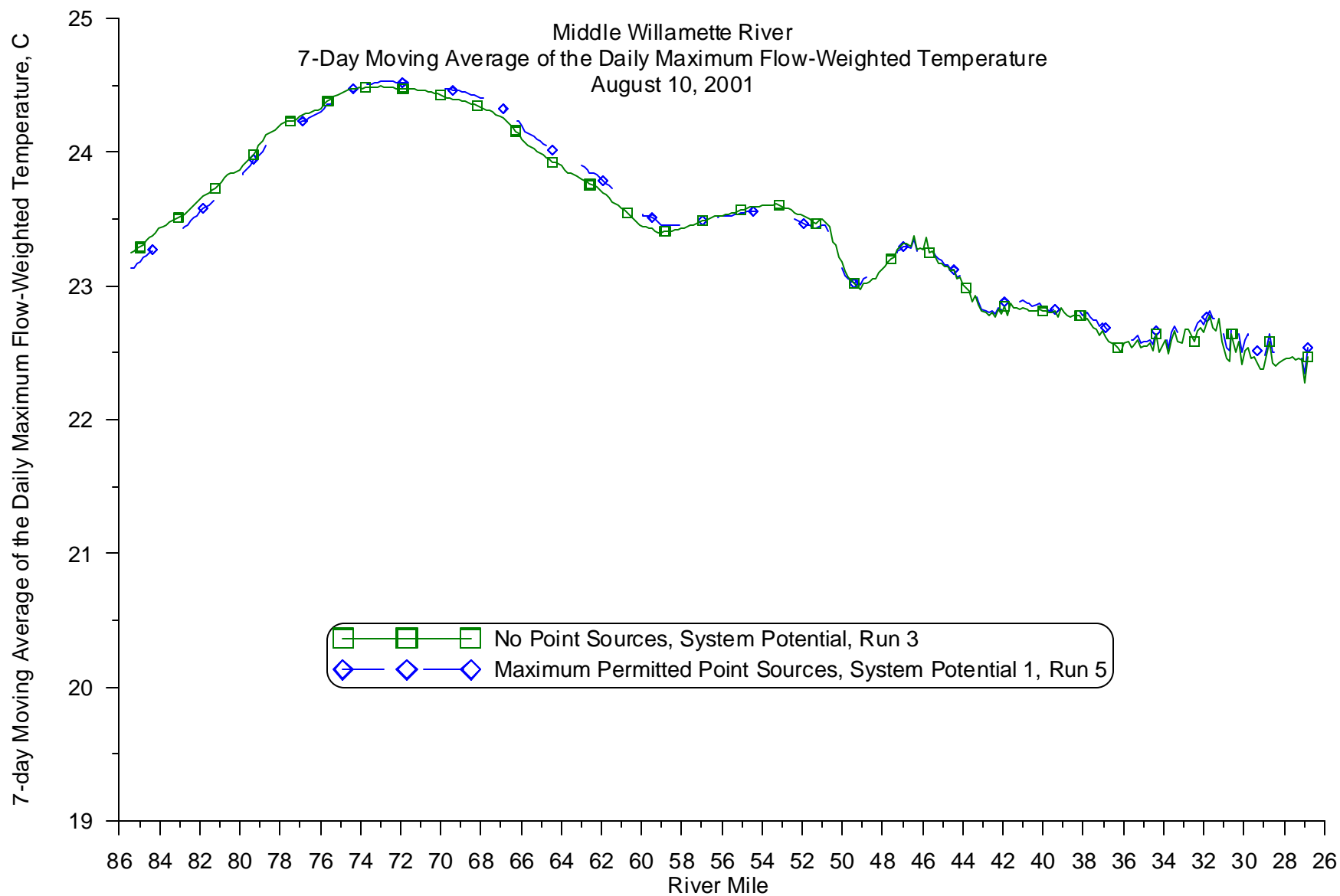
Figure 837: Maximum Permitted Point Sources vs. No Point Sources longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River



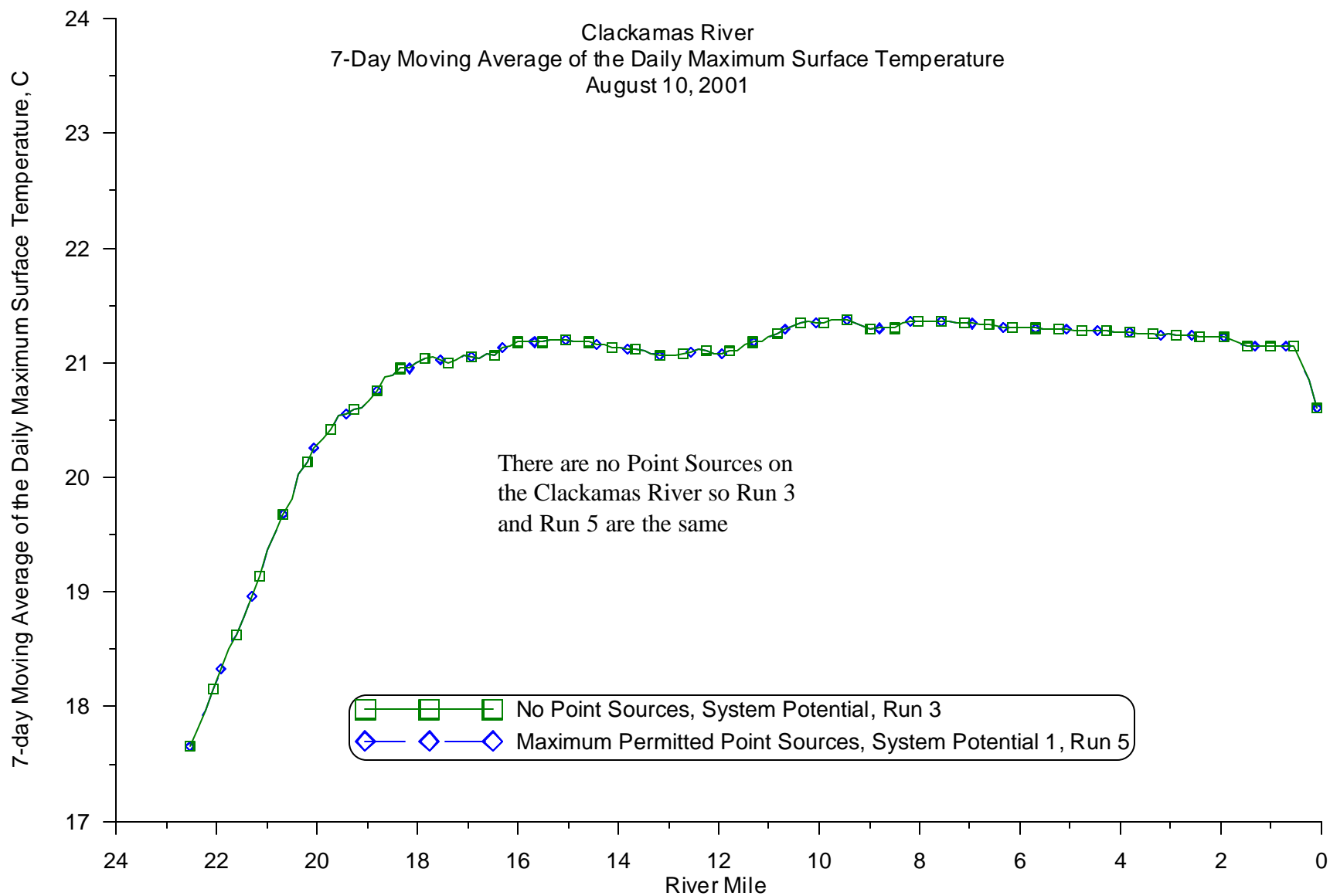
**Figure 838: Maximum Permitted Point Sources vs. No Point Sources longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River**



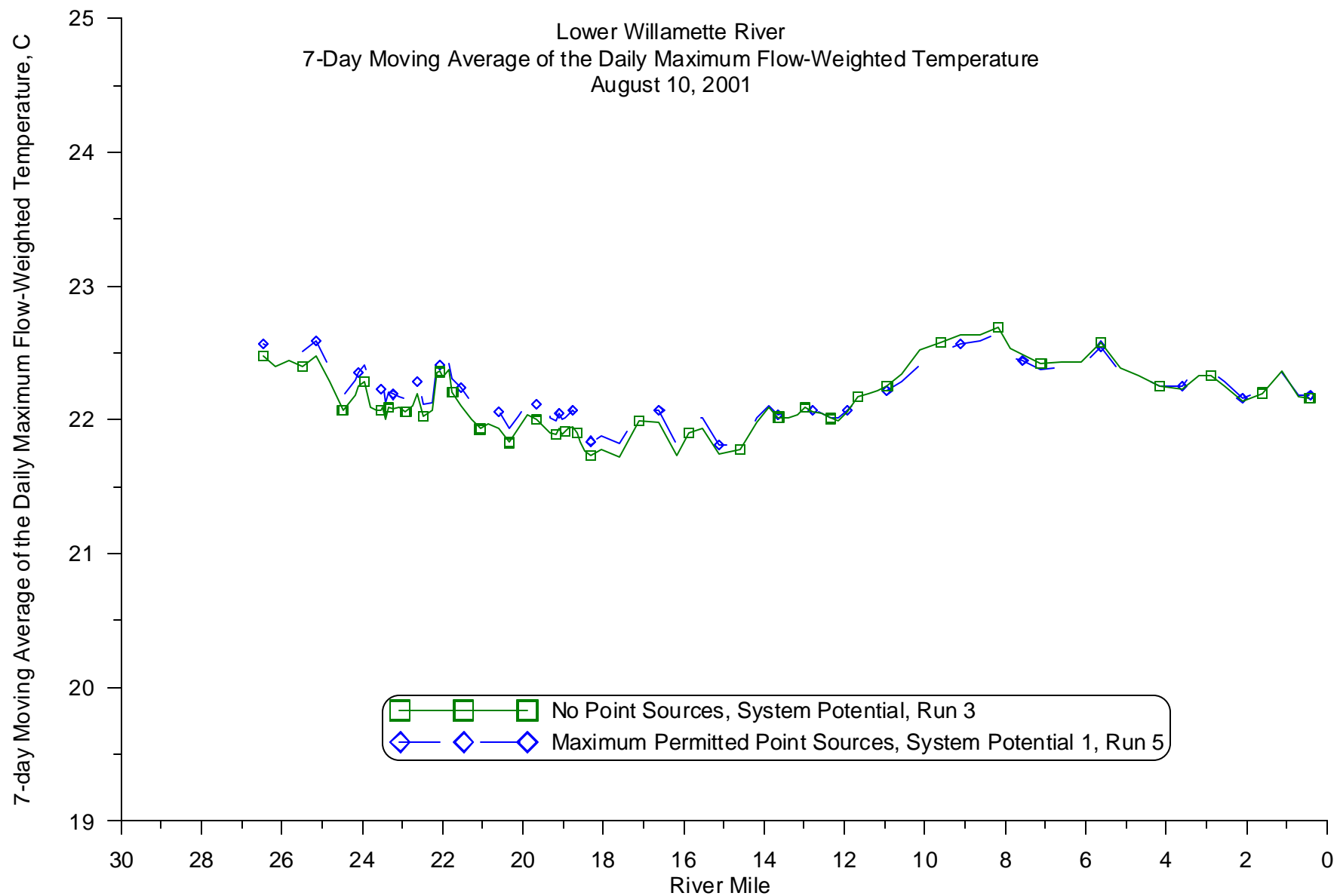
**Figure 839: Maximum Permitted Point Sources vs. No Point Sources longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 840: Maximum Permitted Point Sources vs. No Point Sources longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**



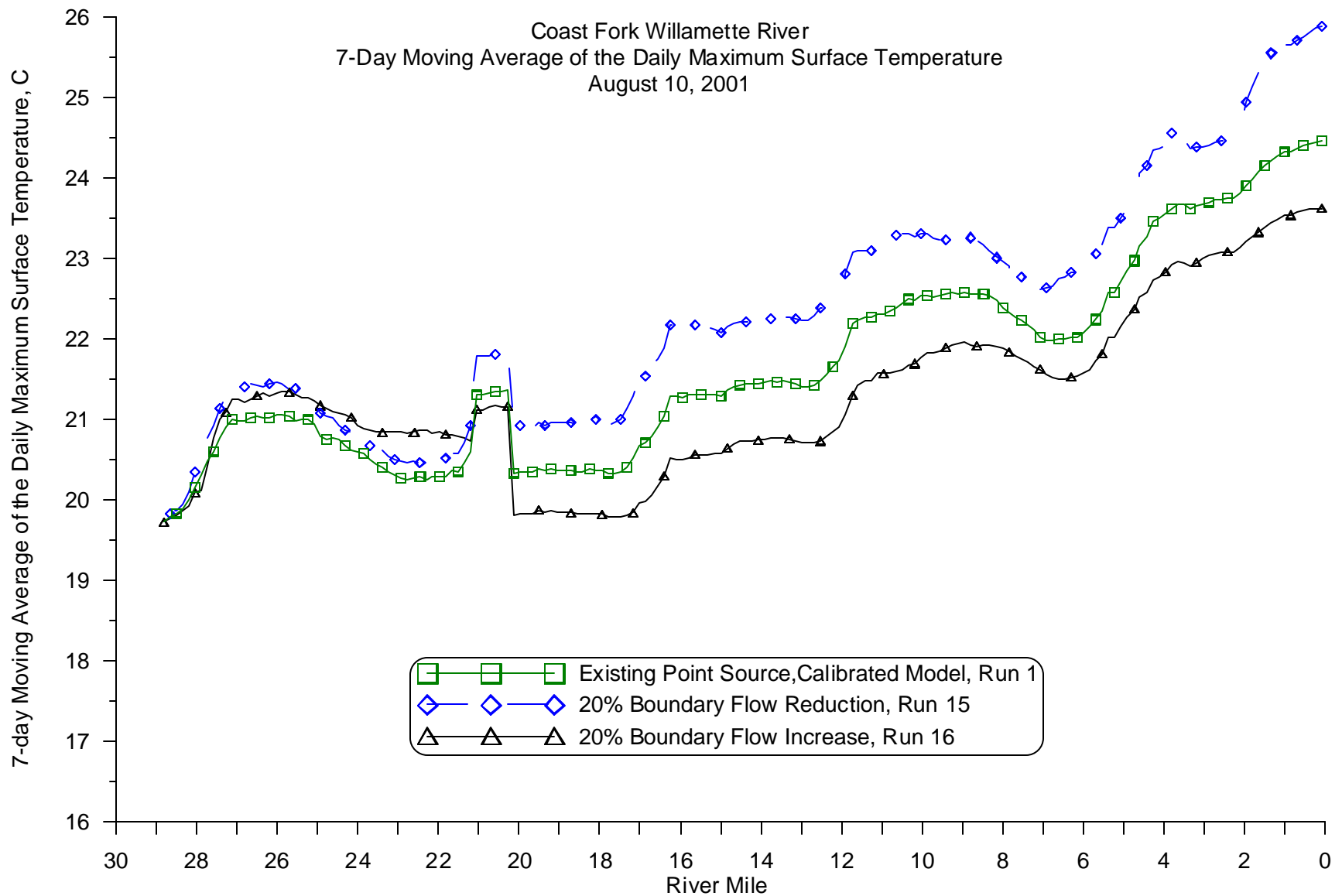
**Figure 841: Maximum Permitted Point Sources vs. No Point Sources longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River**



**Figure 842: Maximum Permitted Point Sources vs. No Point Sources longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

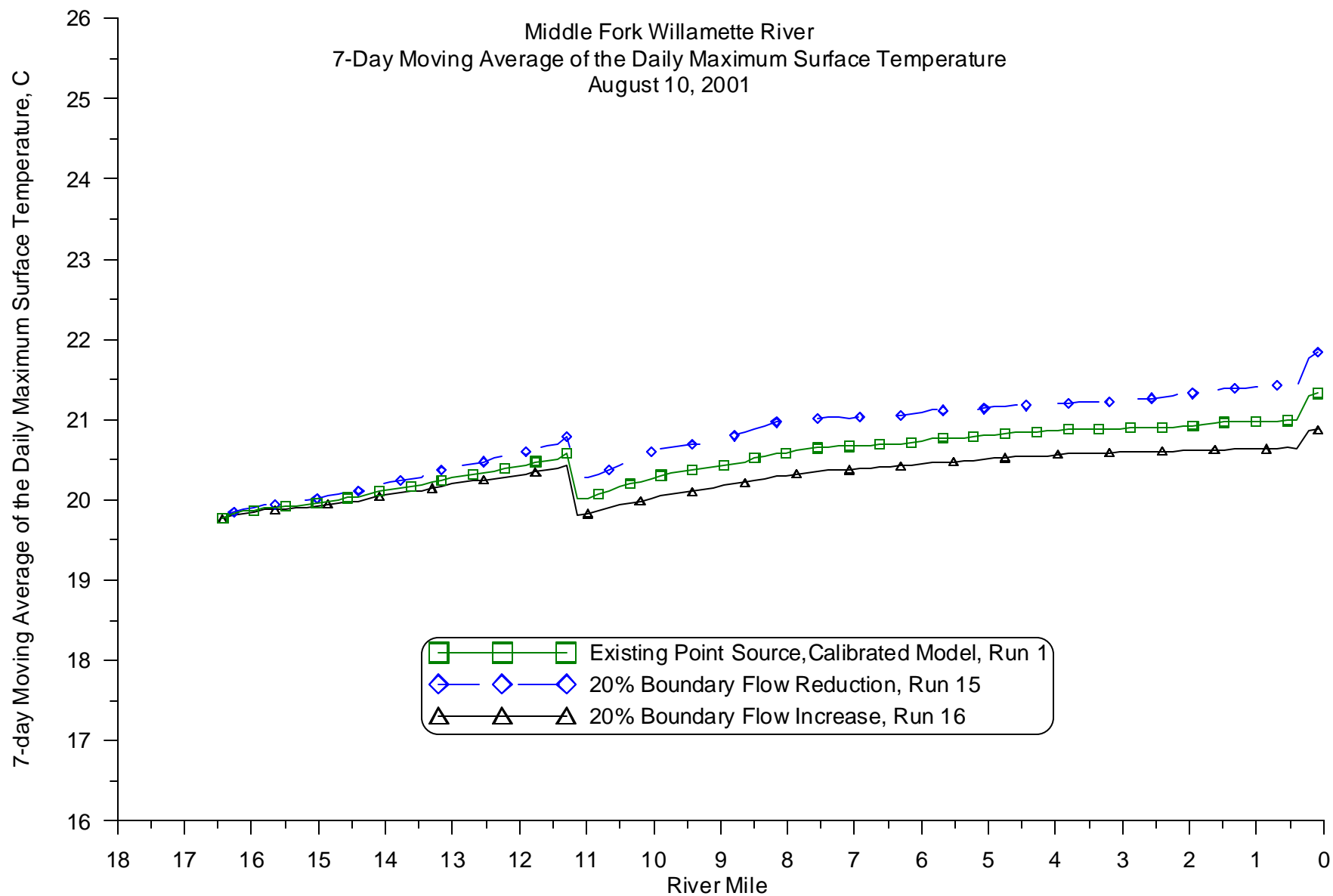
### ***Sensitivity to boundary flow rate***

The sensitivity of the model to upstream boundary flows was examined by simulating the summer of 2001 and adjusting the upstream boundary flows by  $\pm 20\%$ . These results were then compared with the results of the calibrated model in a series of longitudinal profiles for each river reach modeled. All of the longitudinal plots show the seven-day moving average of the daily maximum temperature for August 10, 2001 (ODEQ, 2003) and begin in the furthest upstream reaches of the watershed and move downstream.

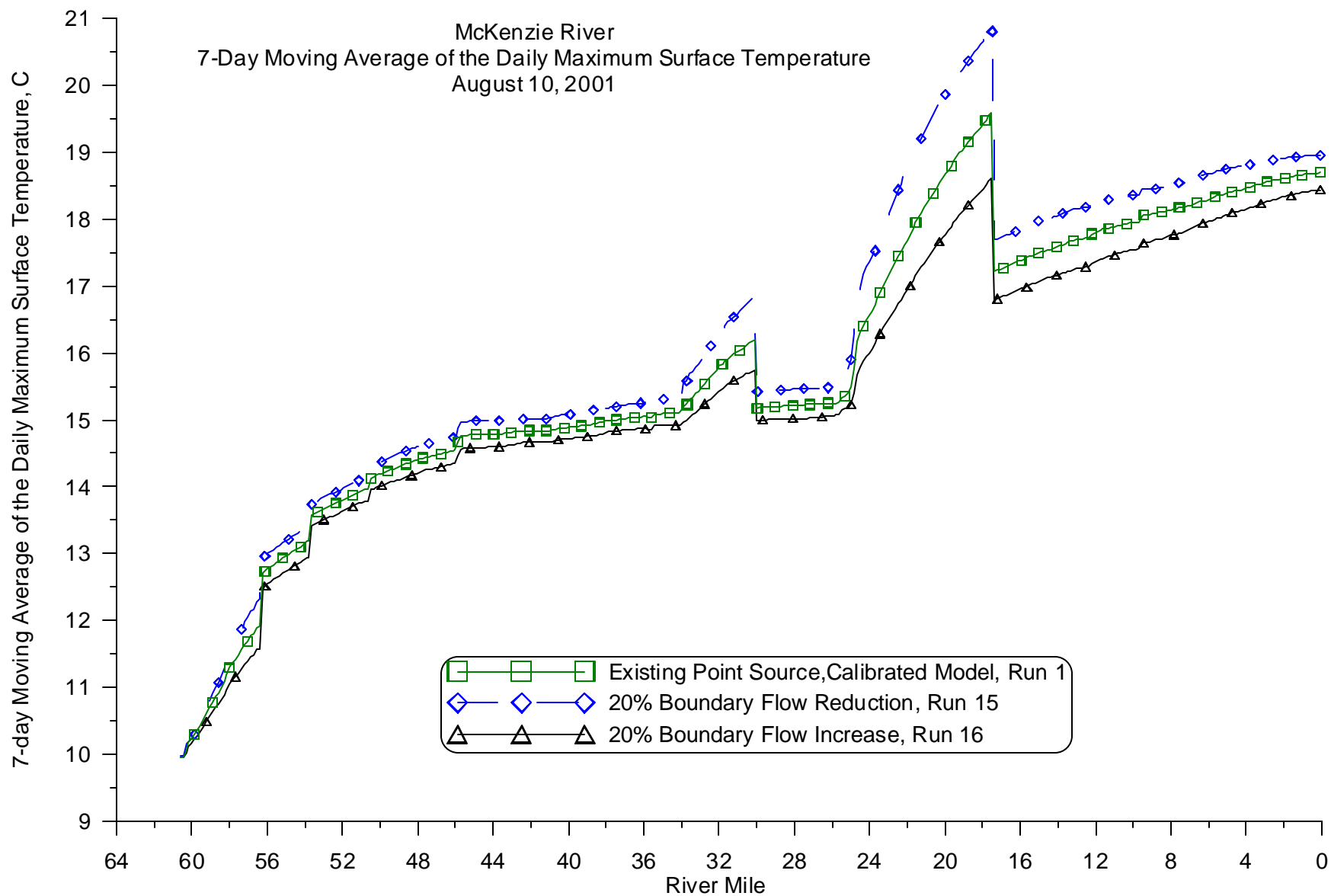


**Figure 843: Calibrated model vs. varying boundary flows (+/- 20%) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**

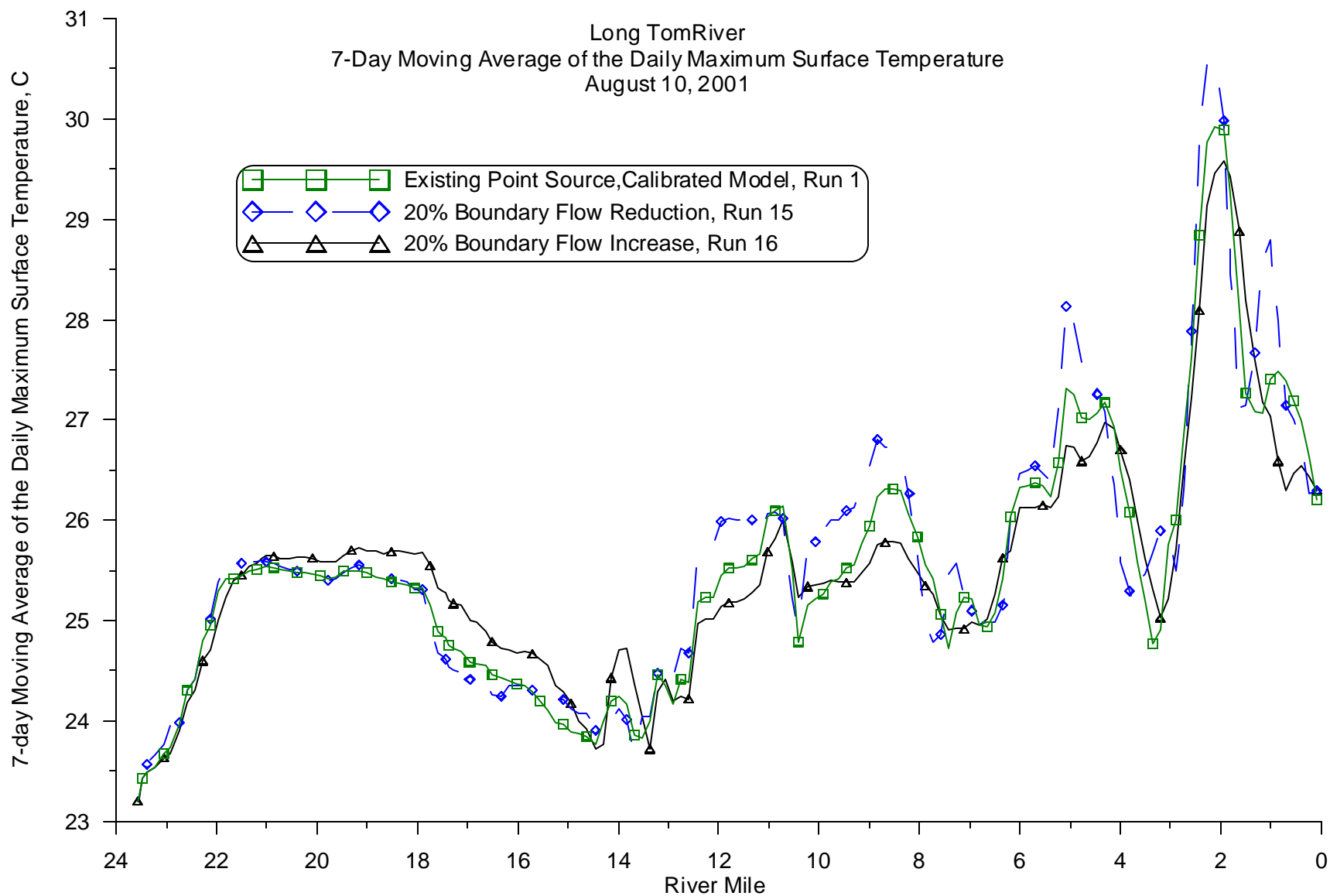




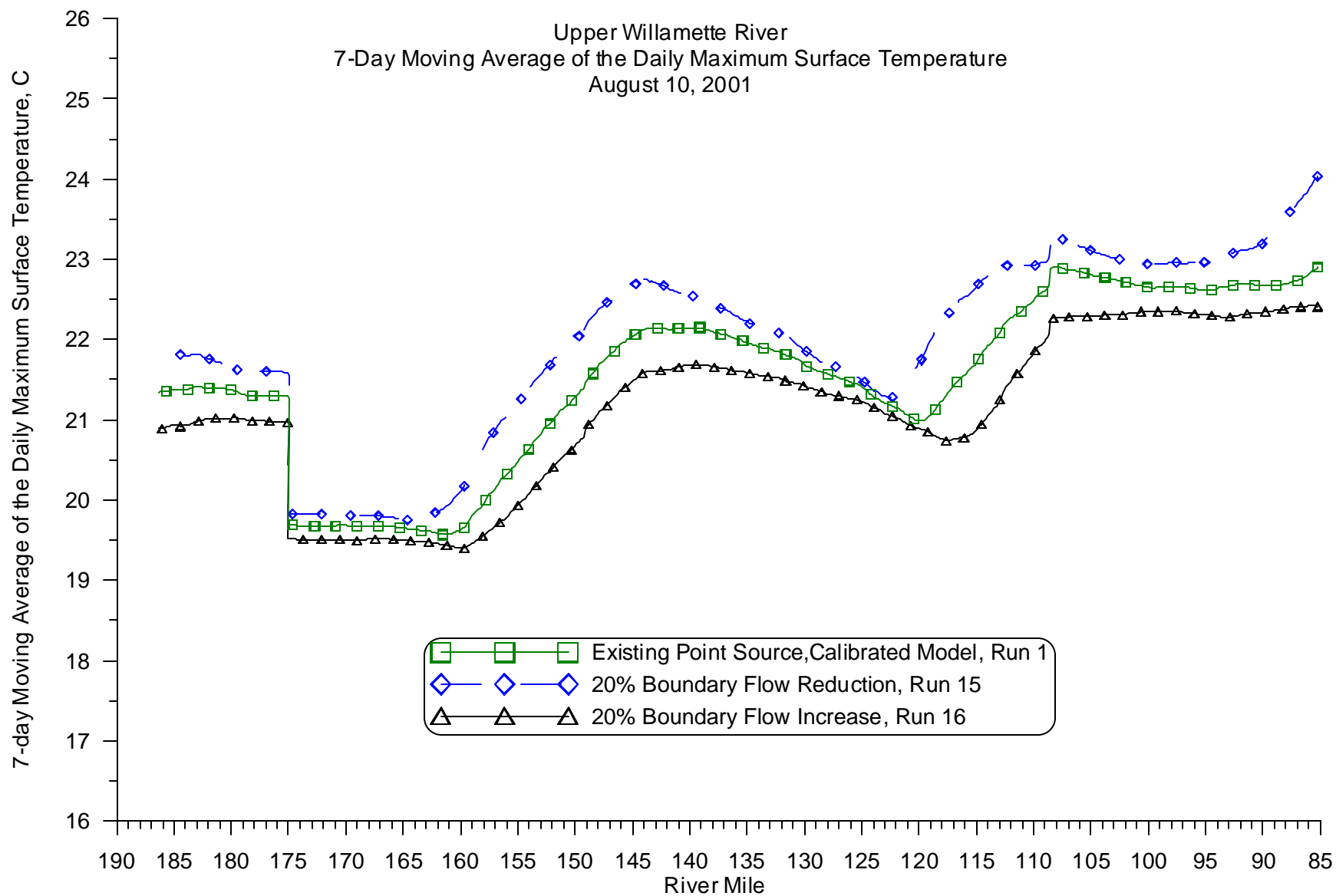
**Figure 844: Calibrated model vs. varying boundary flows (+/- 20%) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**



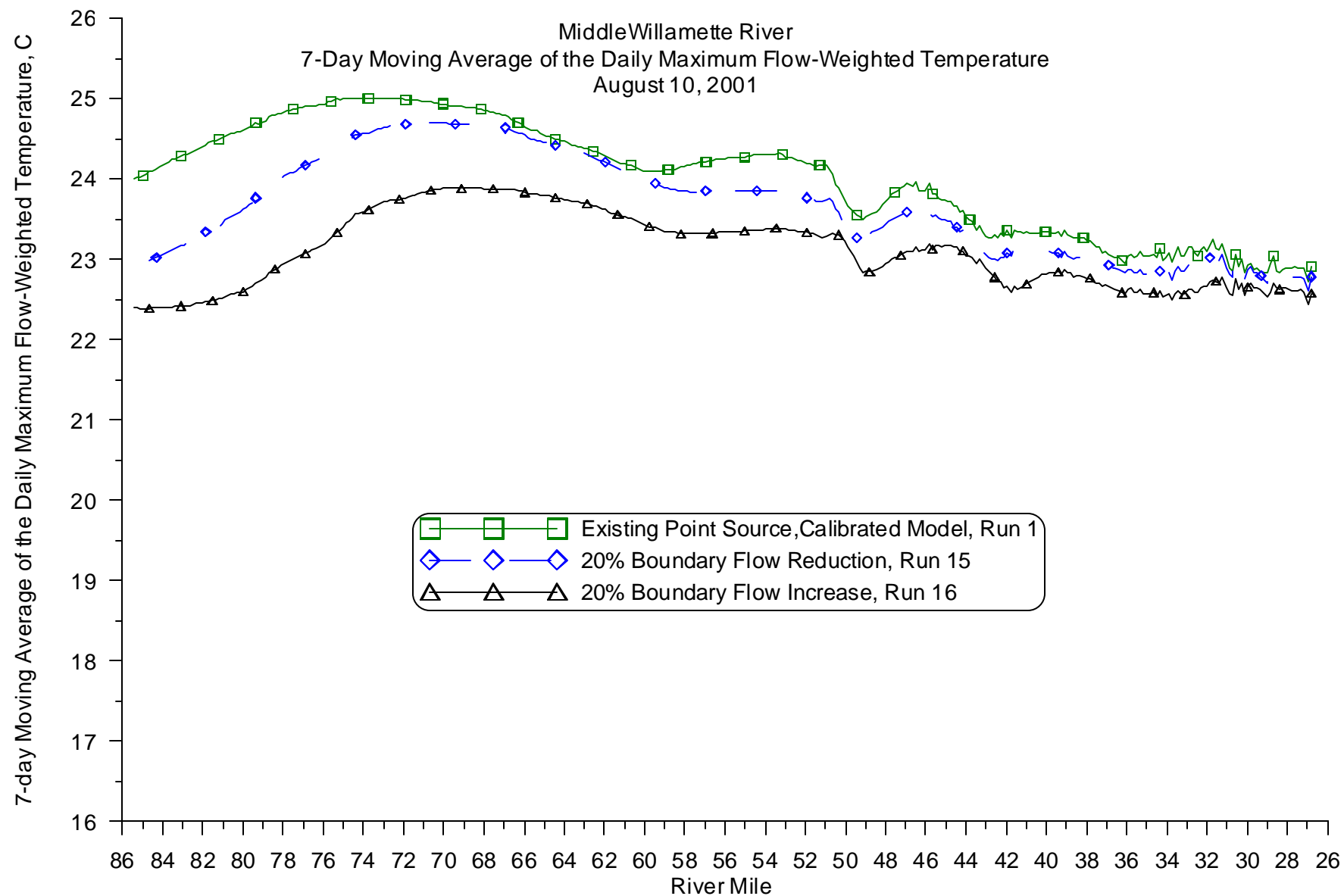
**Figure 845: Calibrated model vs. varying boundary flows (+/- 20%) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River**



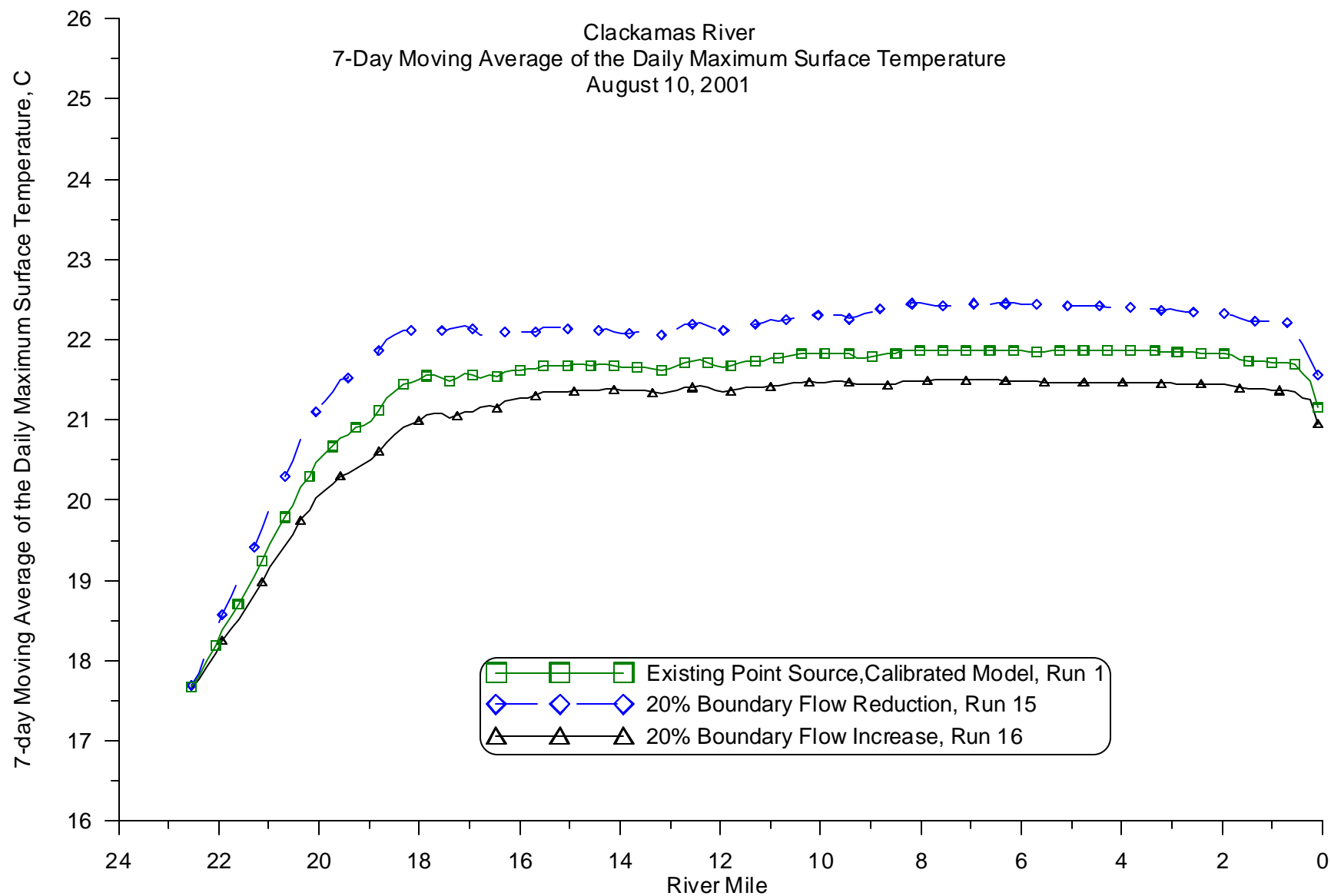
**Figure 846: Calibrated model vs. varying boundary flows (+/- 20%) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River**



**Figure 847: Calibrated model vs. varying boundary flows (+/- 20%) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 848: Calibrated model vs. varying boundary flows (+/- 20%) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**



**Figure 849: Calibrated model vs. varying boundary flows (+/- 20%) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River**

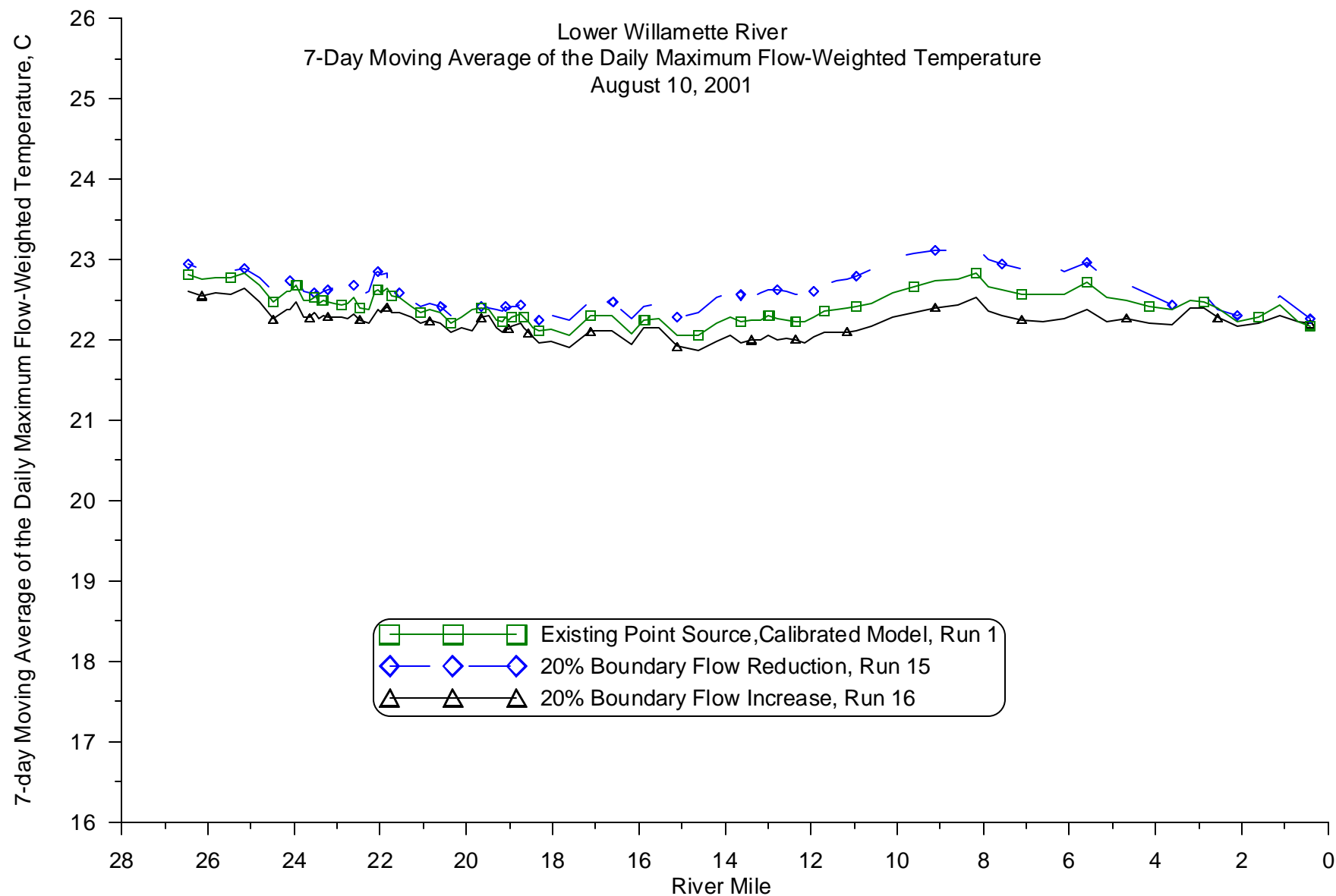
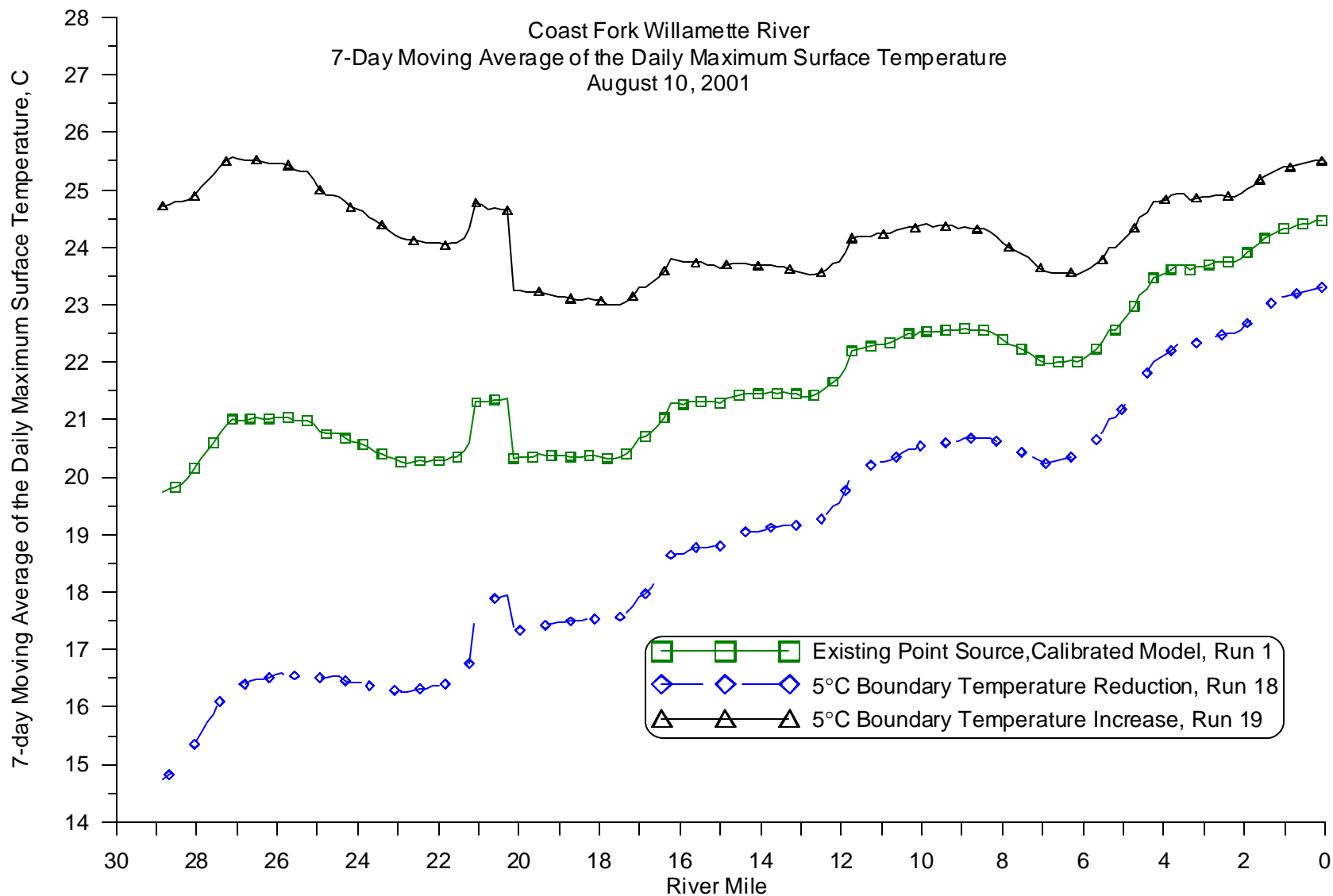


Figure 850: Calibrated model vs. varying boundary flows (+/- 20%) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River

### ***Sensitivity to boundary temperature***

The sensitivity of the model to the upstream boundary temperature was examined by simulating the summer of 2001 and adjusting the upstream boundary temperatures by  $\pm 5^{\circ}\text{C}$ . These results were then compared with the results of the calibrated model in a series of longitudinal profiles for each river reach modeled. All of the longitudinal plots show the seven-day moving average of the daily maximum temperature for August 10, 2001 (ODEQ, 2003) and begin in the furthest upstream reaches of the watershed and move downstream.





**Figure 851: Calibrated model vs. varying boundary temperature (+/- 5 °C) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**

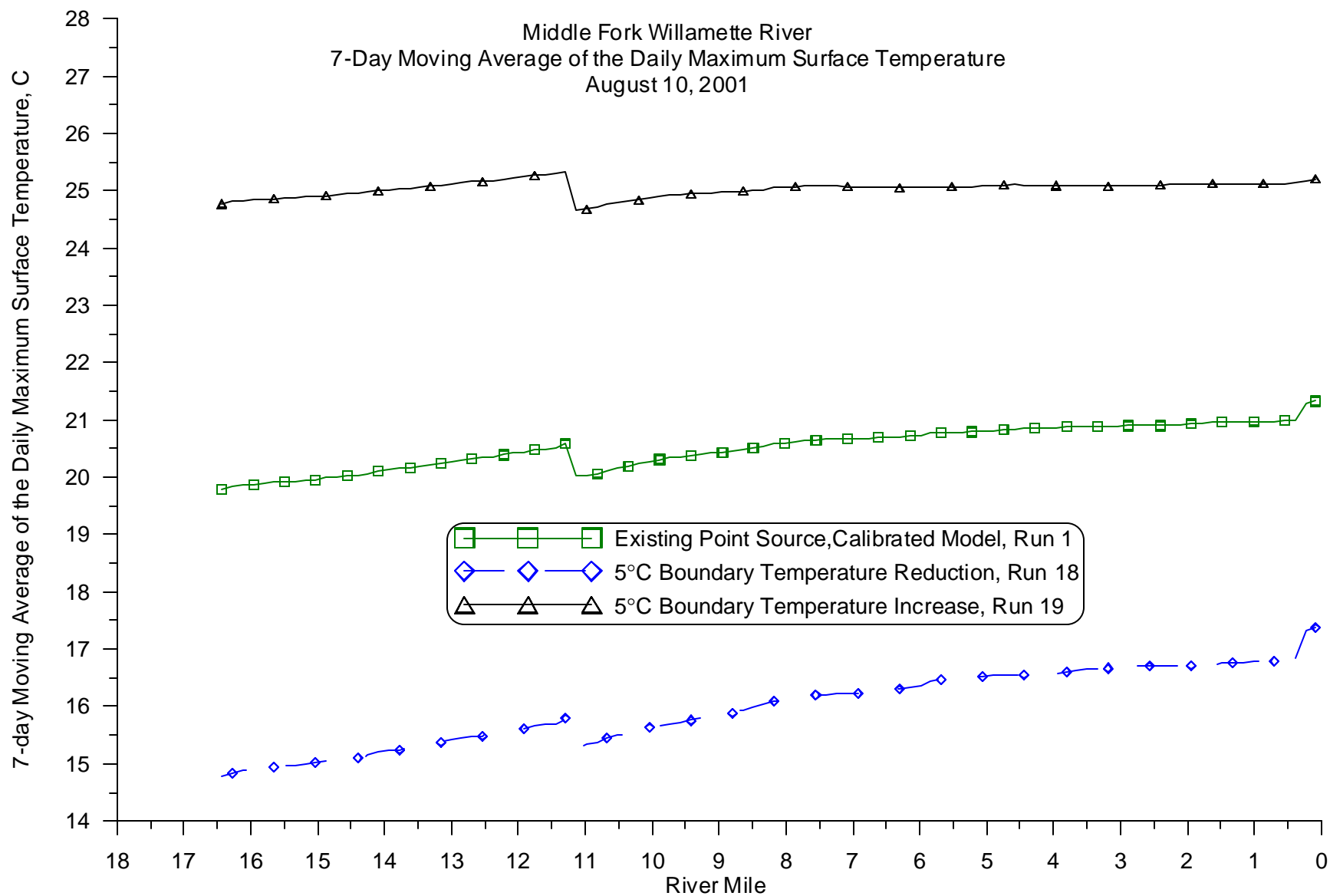


Figure 852: Calibrated model vs. varying boundary temperature (+/- 5 °C) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River

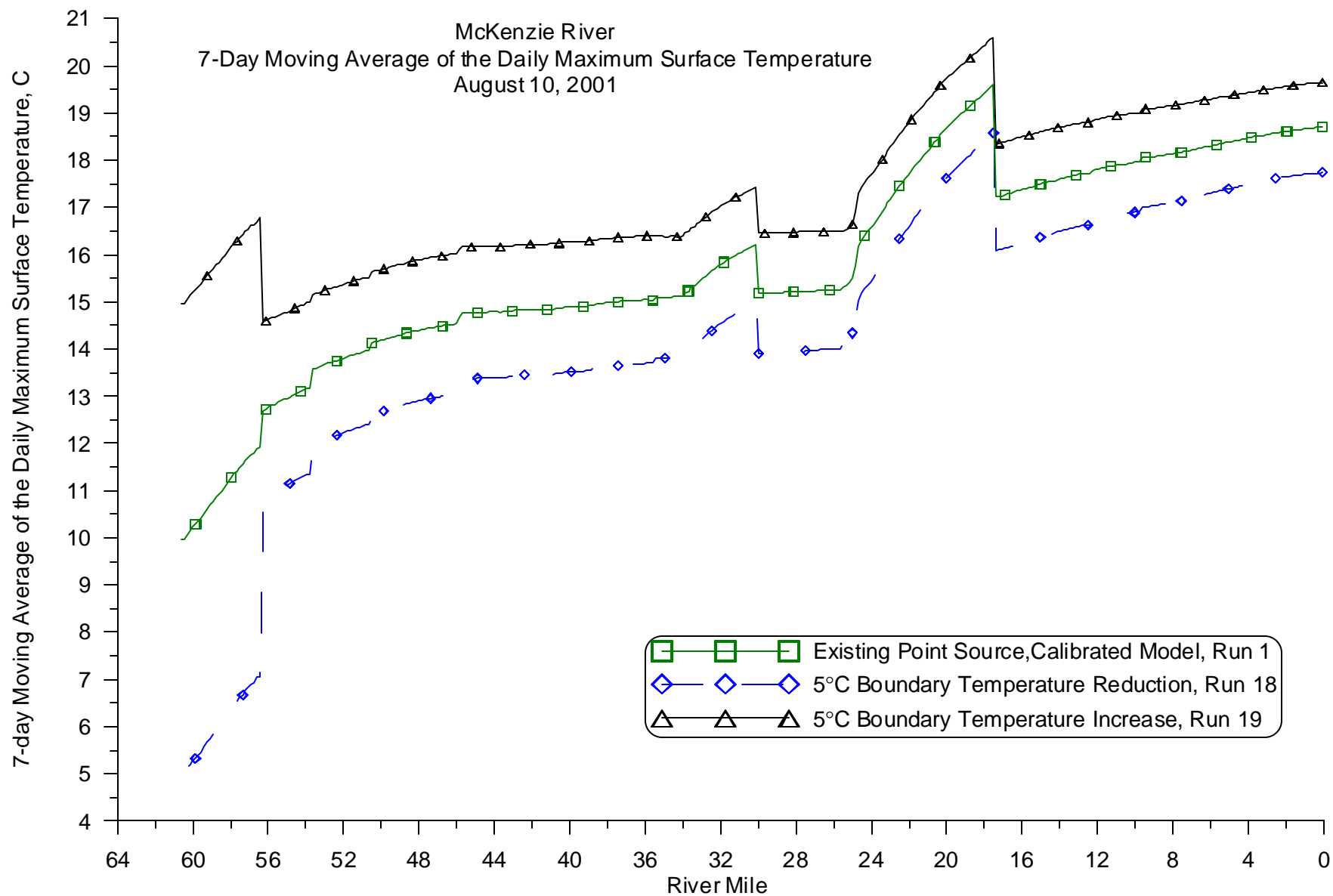


Figure 853: Calibrated model vs. varying boundary temperature (+/- 5 oC) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River

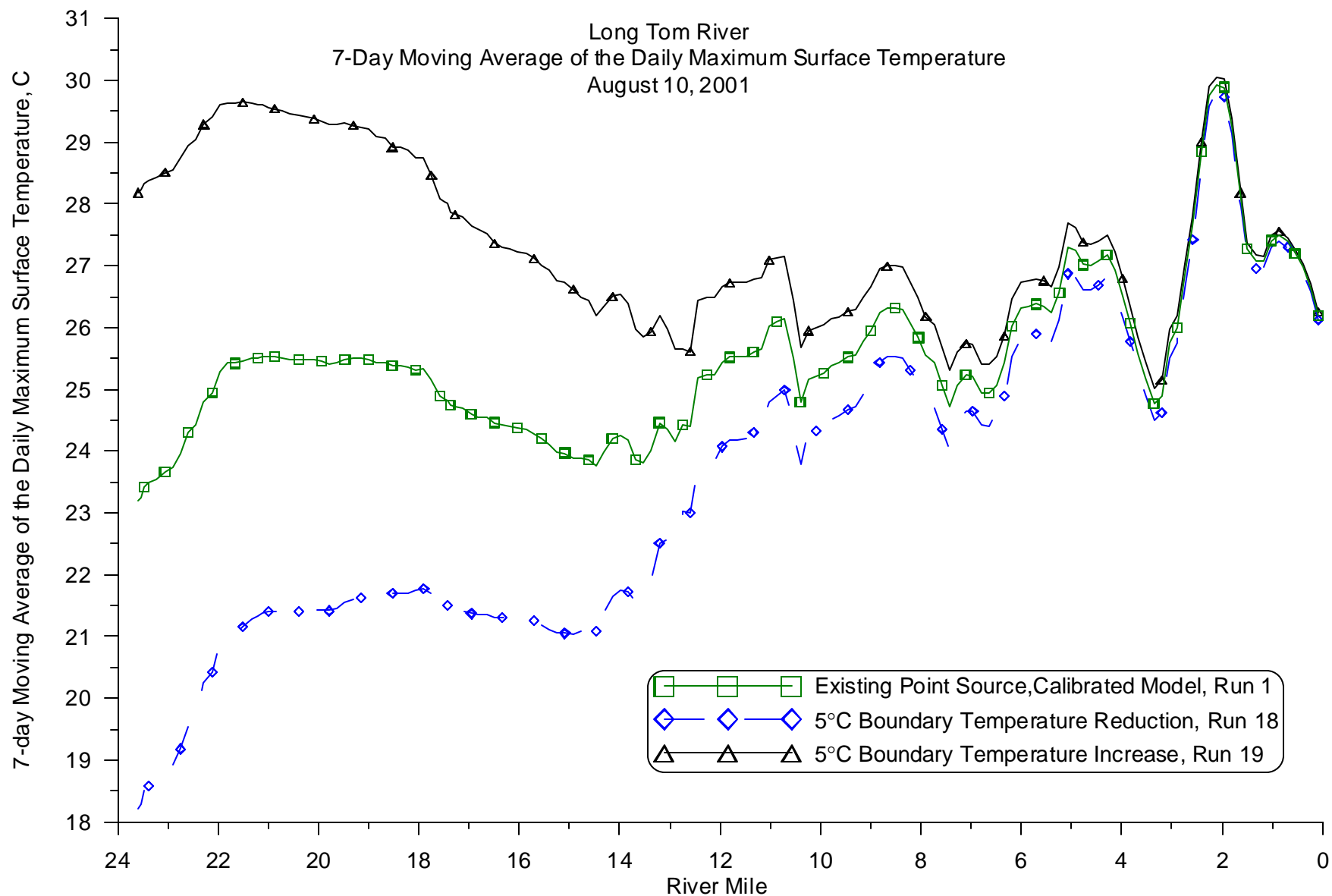
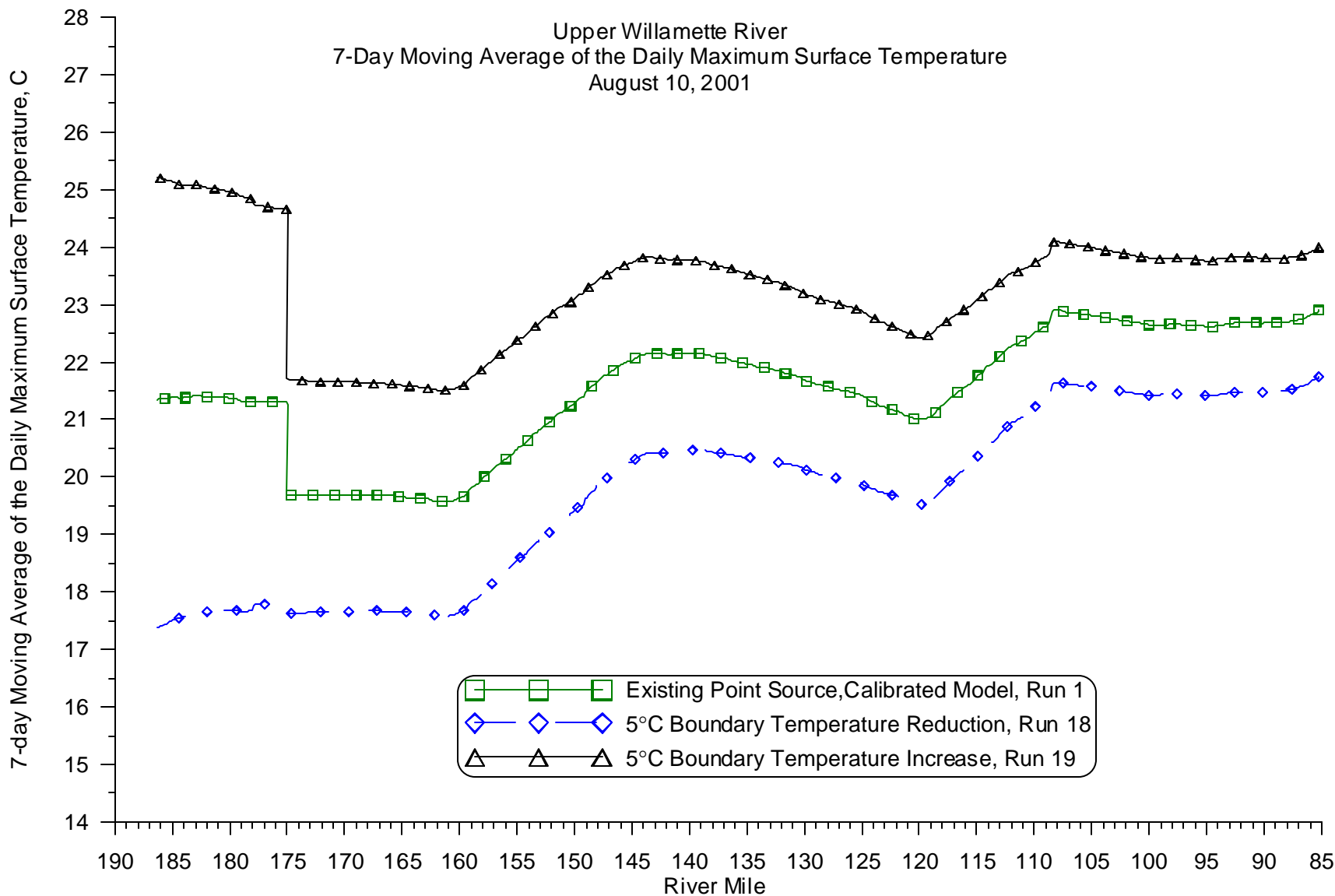


Figure 854: Calibrated model vs. varying boundary temperature (+/- 5 °C) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River



**Figure 855: Calibrated model vs. varying boundary temperature (+/- 5 oC) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**

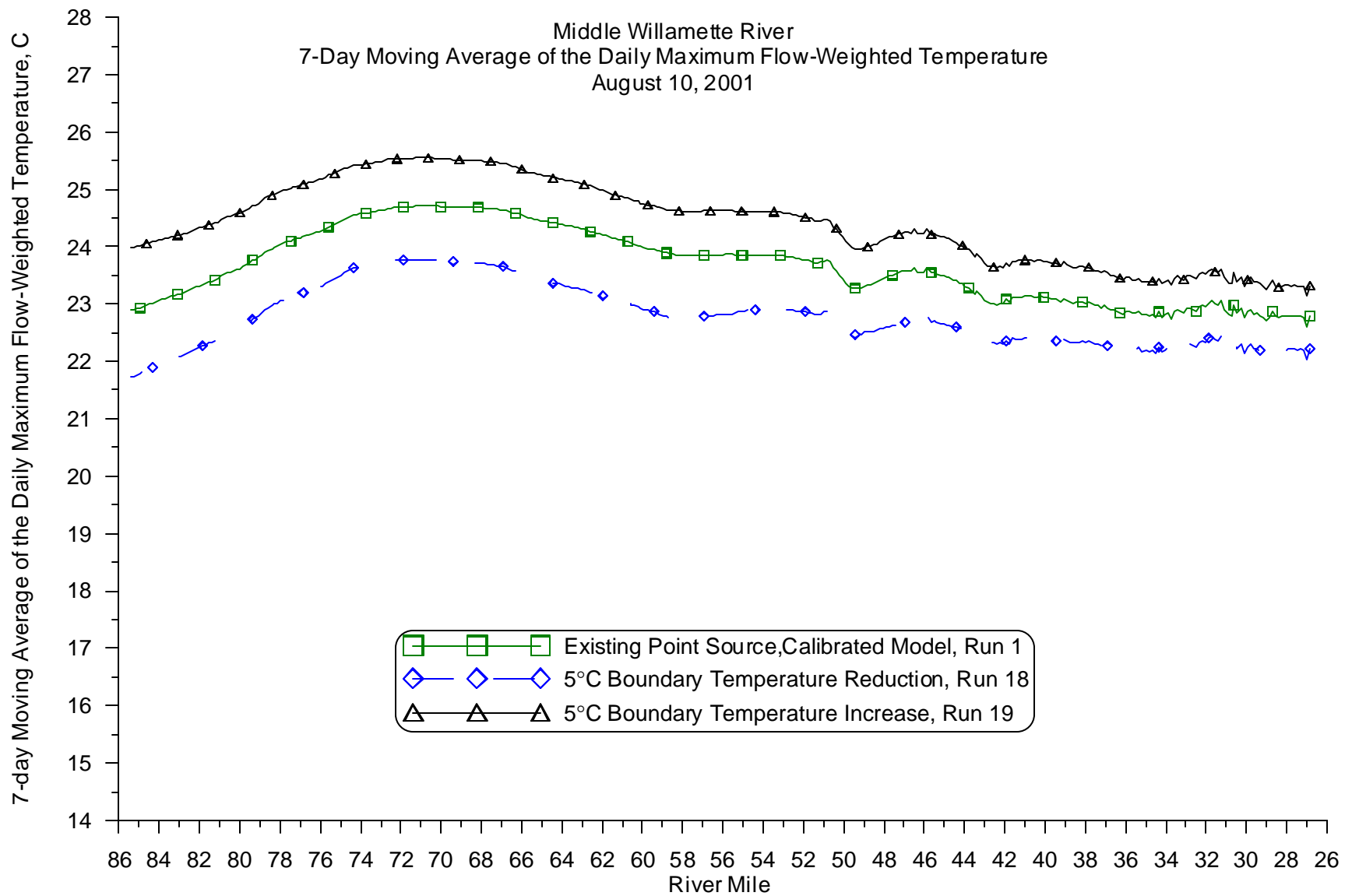
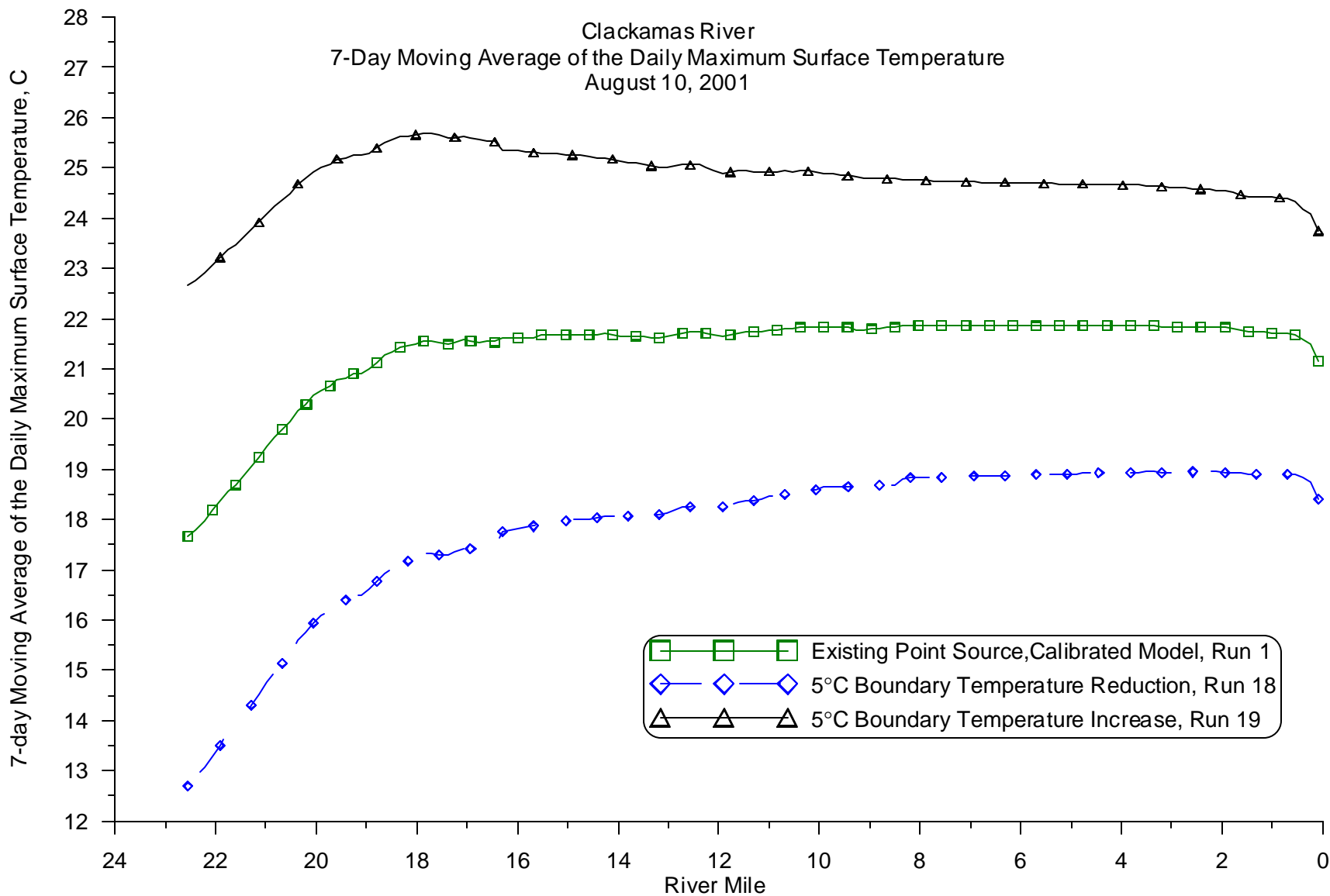
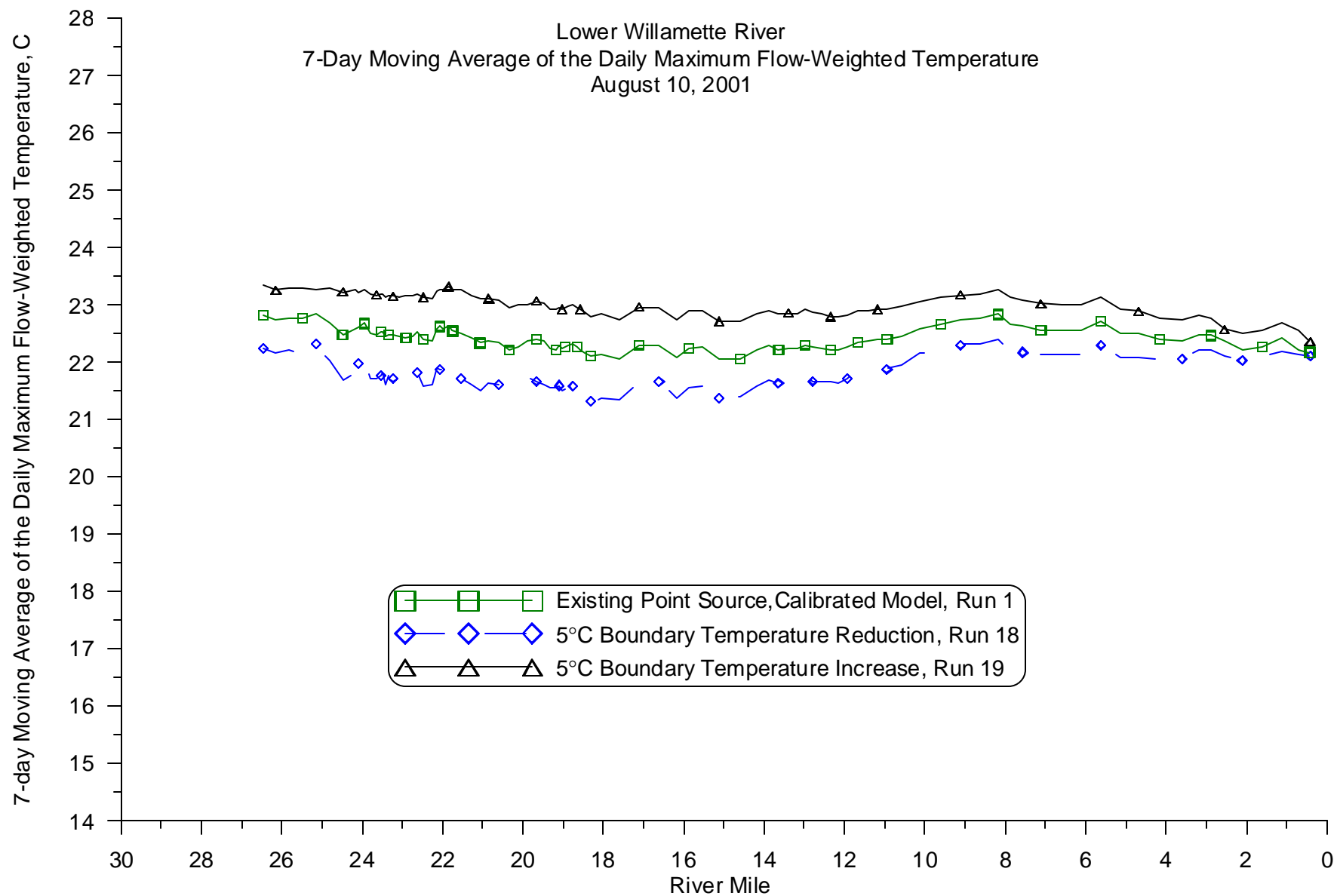


Figure 856: Calibrated model vs. varying boundary temperature (+/- 5 °C) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River



**Figure 857: Calibrated model vs. varying boundary temperature (+/- 5 oC) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River**



**Figure 858: Calibrated model vs. varying boundary temperature (+/- 5 oC) longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**



### ***Sensitivity to vegetative shade***

The sensitivity of the model to the varying vegetative shade was examined by simulating the summer of 2001 with no vegetative shade and System Potential vegetative shade. These results were then compared with the results of the calibrated model in a series of longitudinal profiles for each river reach modeled. All of the longitudinal plots show the seven-day moving average of the daily maximum temperature for August 10, 2001 (ODEQ, 2003) and begin in the furthest upstream reaches of the watershed and move downstream.

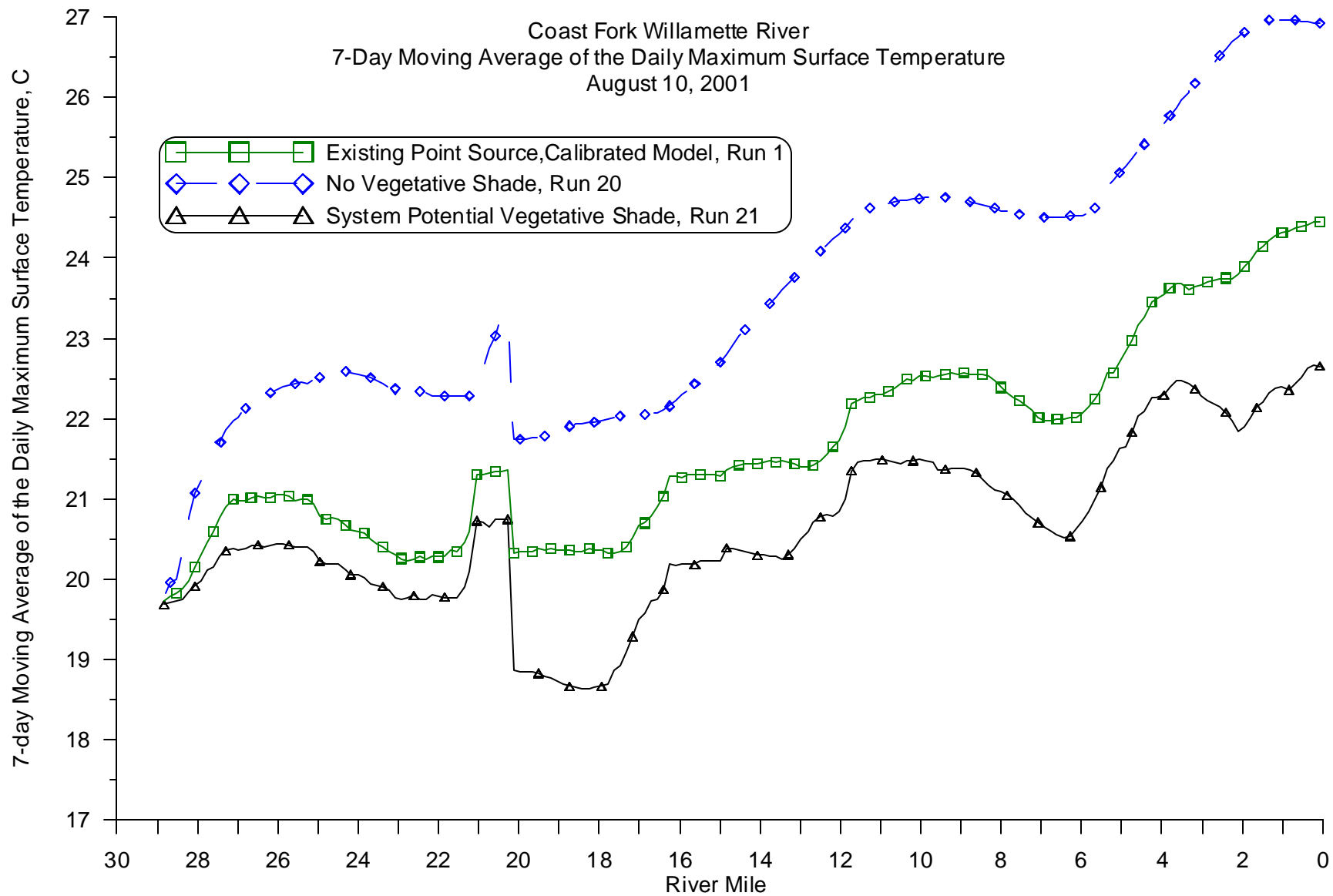
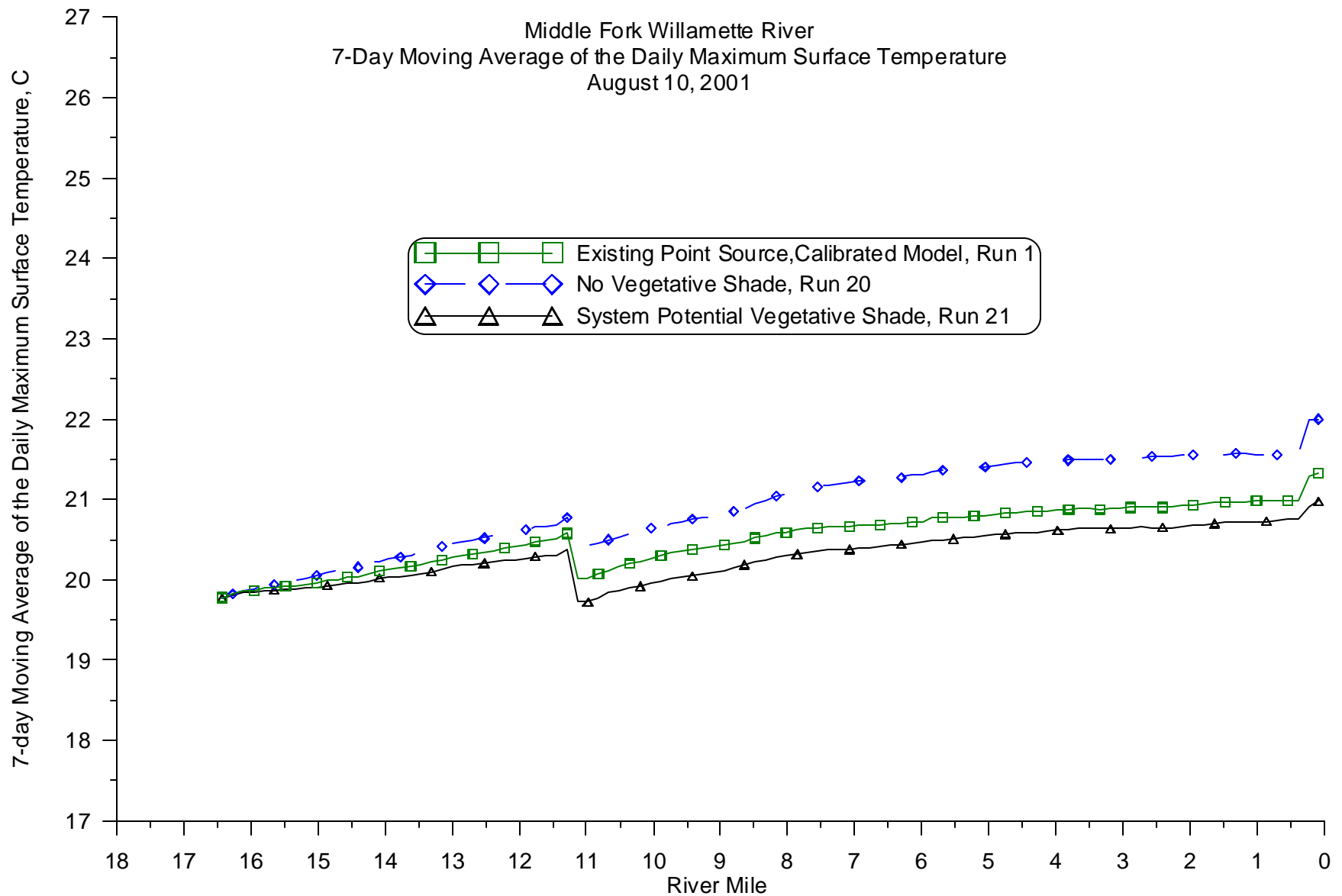
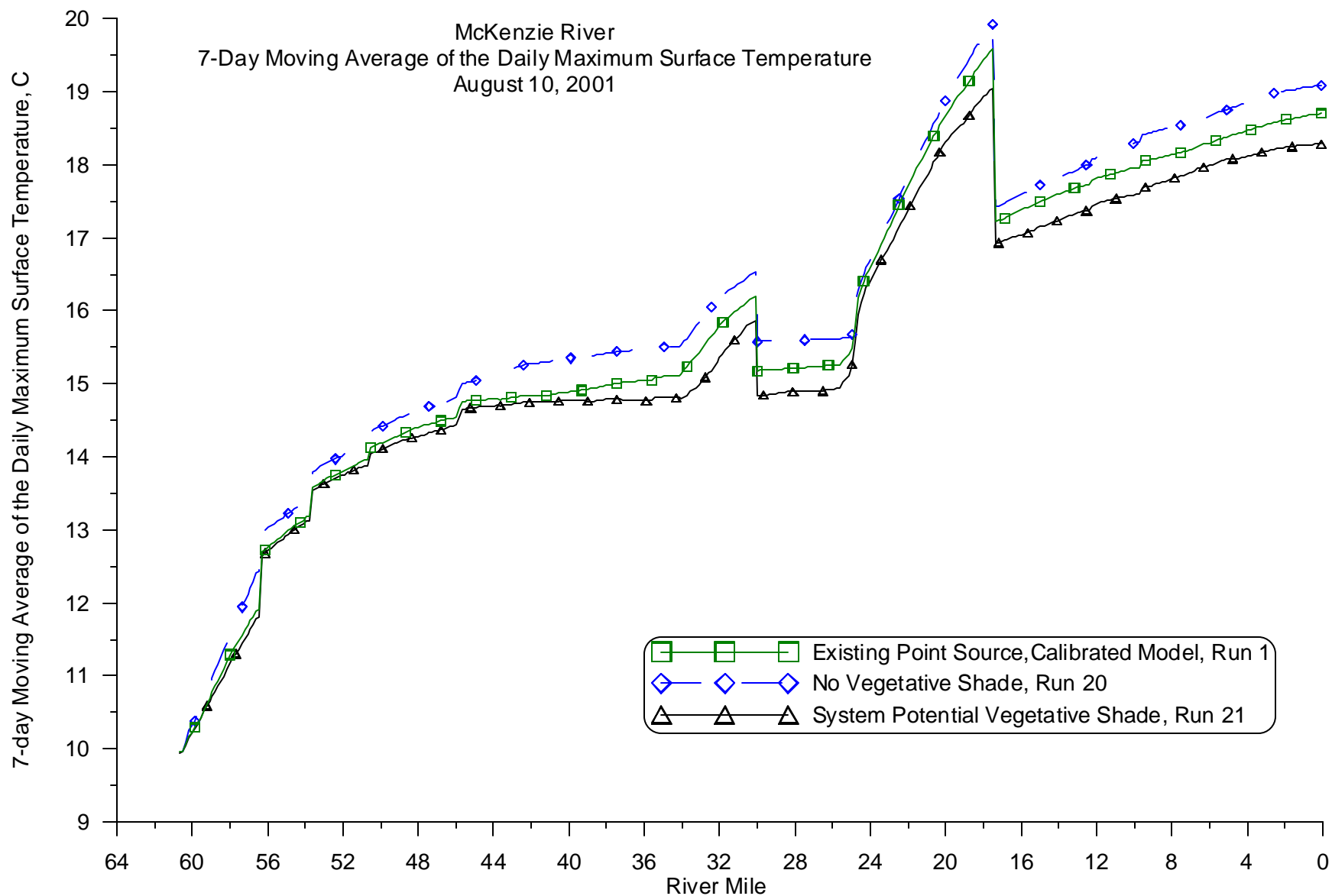


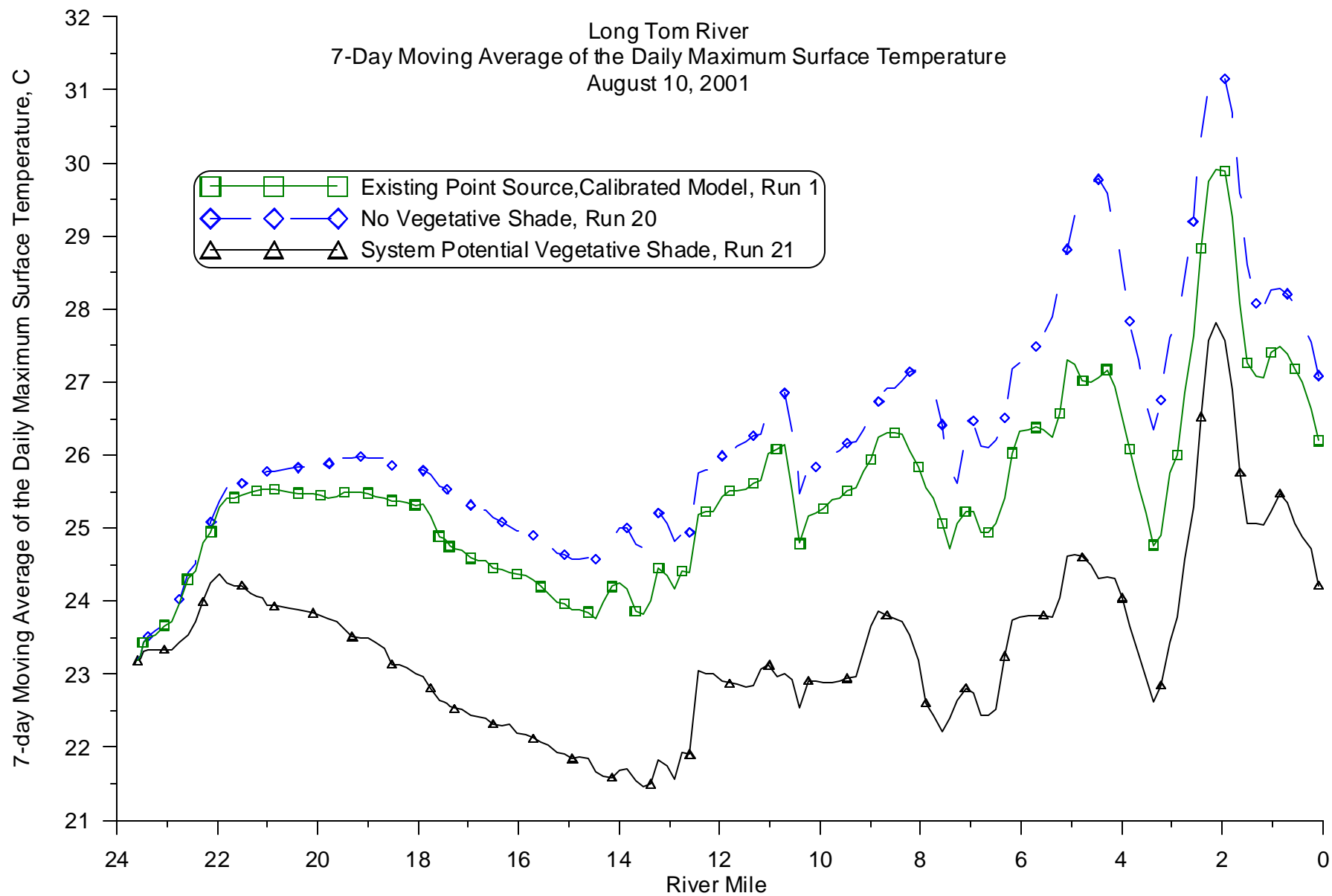
Figure 859: Calibrated model vs. varying vegetative shade longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River



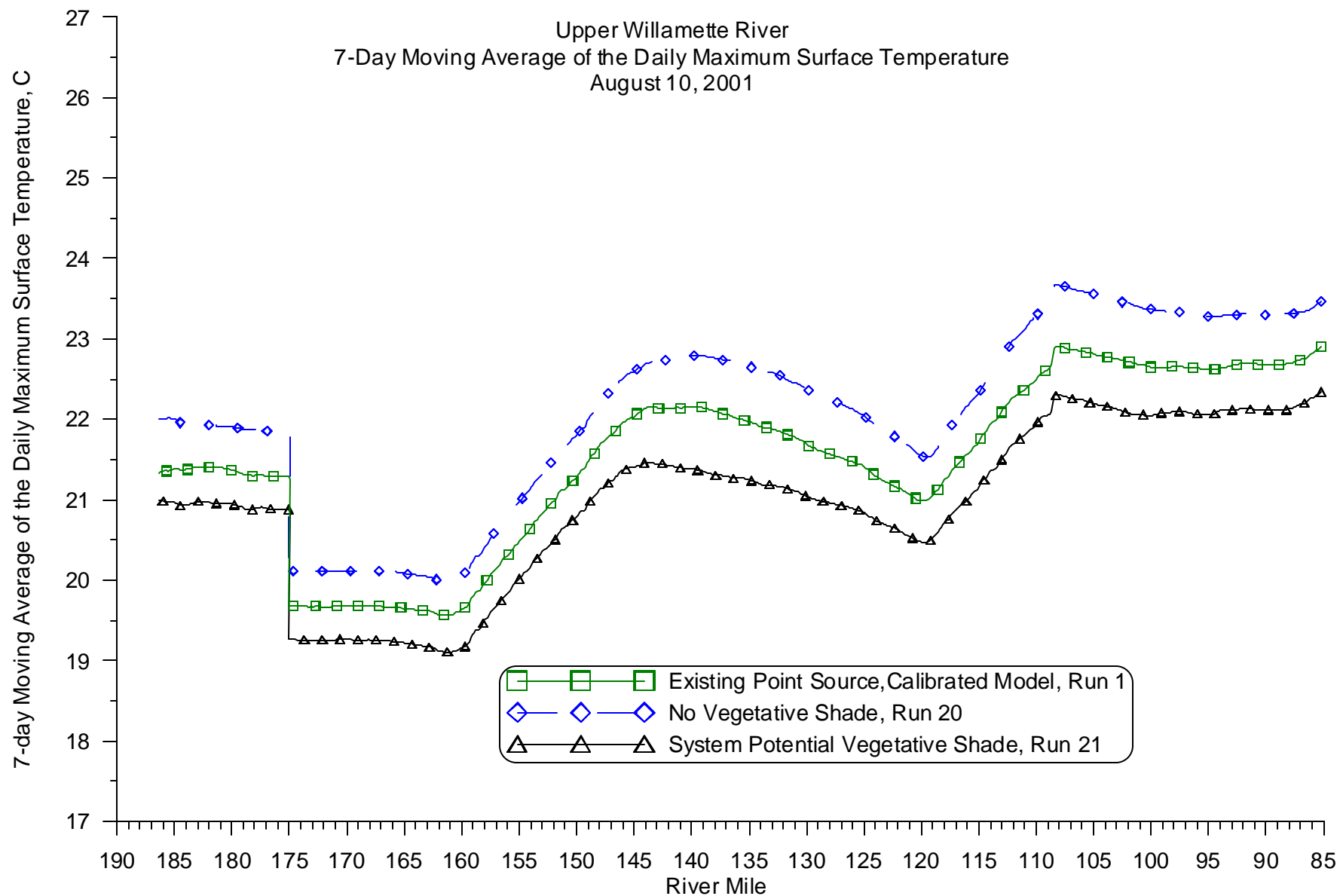
**Figure 860: Calibrated model vs. varying vegetative shade longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**



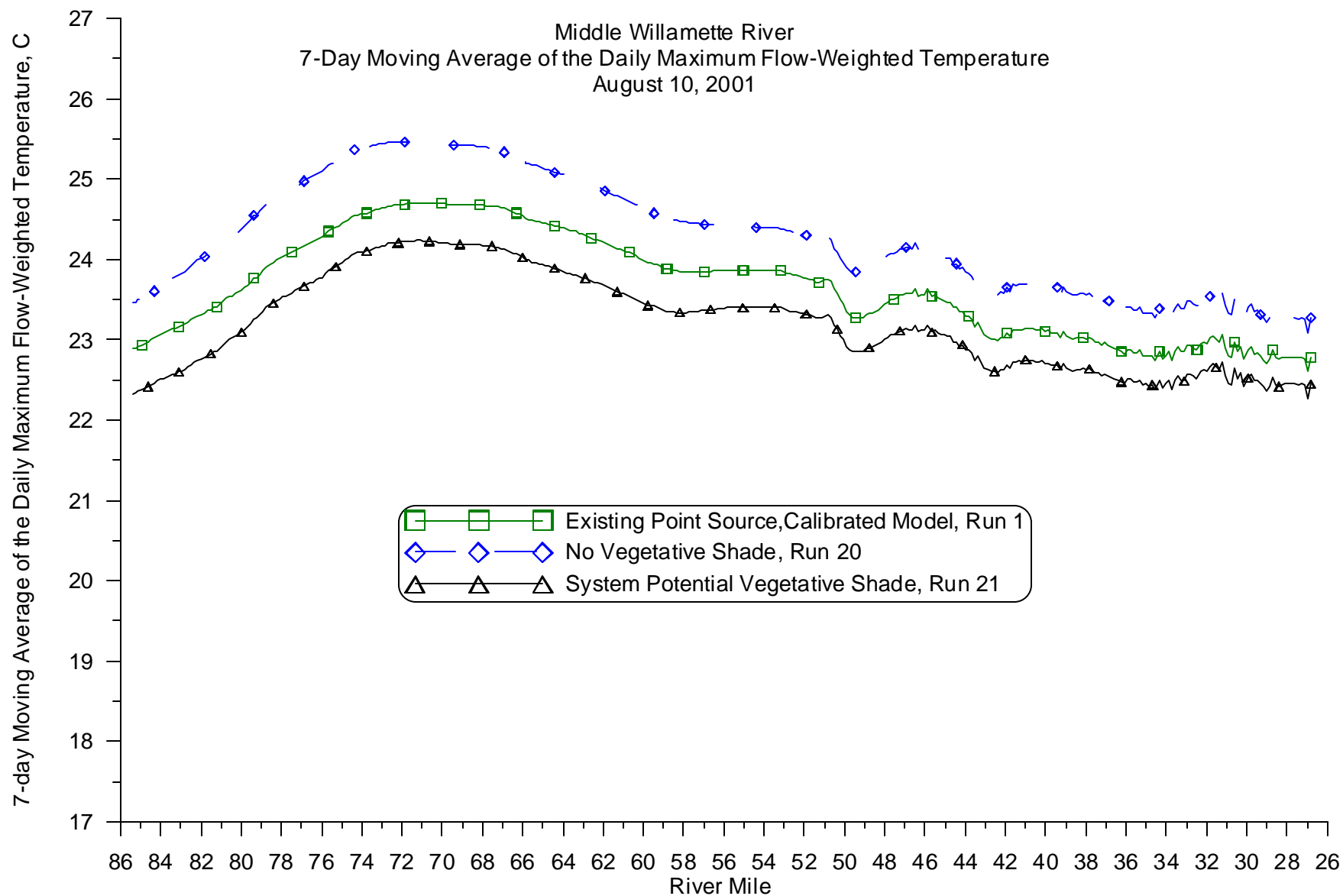
**Figure 861: Calibrated model vs. varying vegetative shade longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River**



**Figure 862: Calibrated model vs. varying vegetative shade longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River**



**Figure 863: Calibrated model vs. varying vegetative shade longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 864: Calibrated model vs. varying vegetative shade longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**

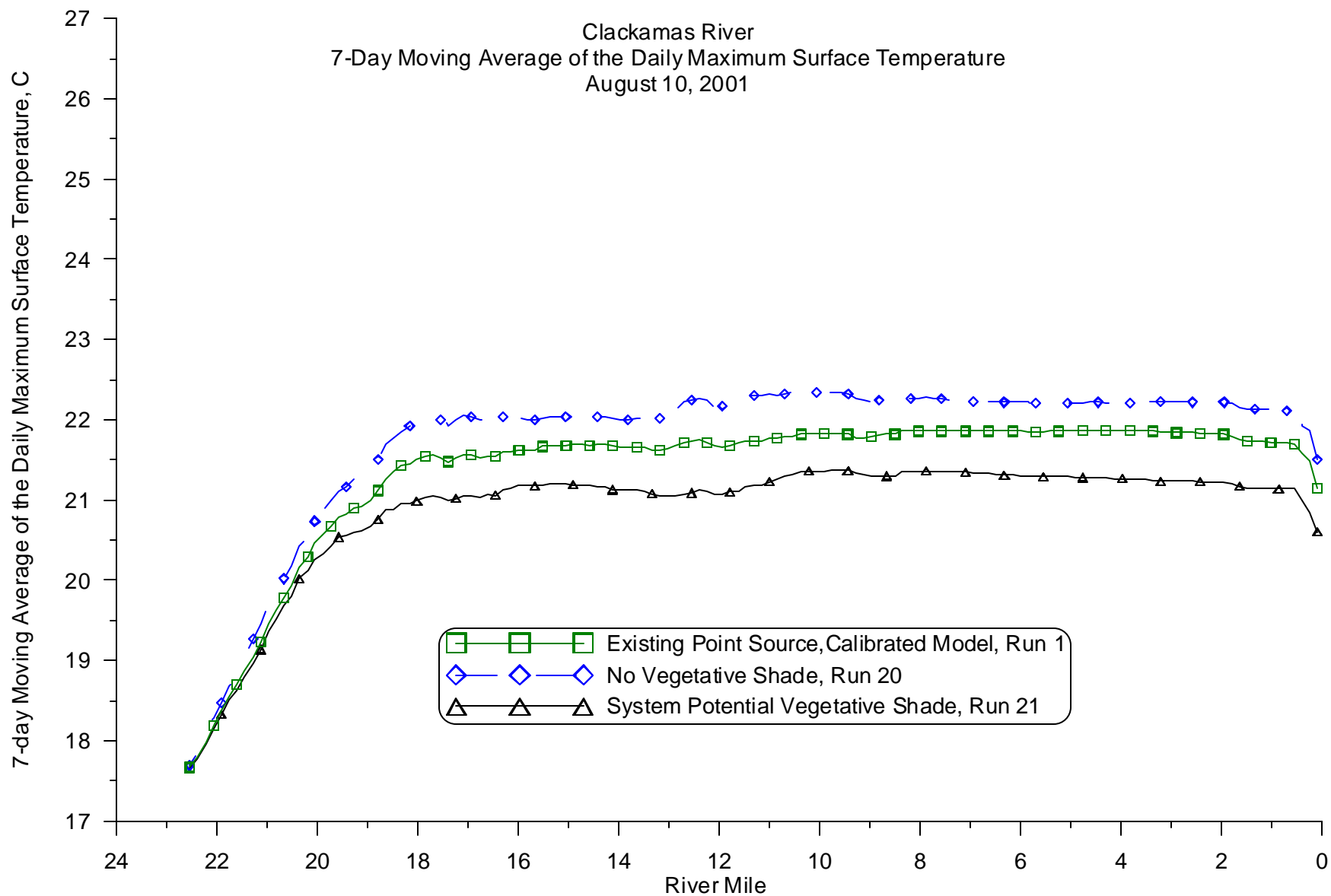
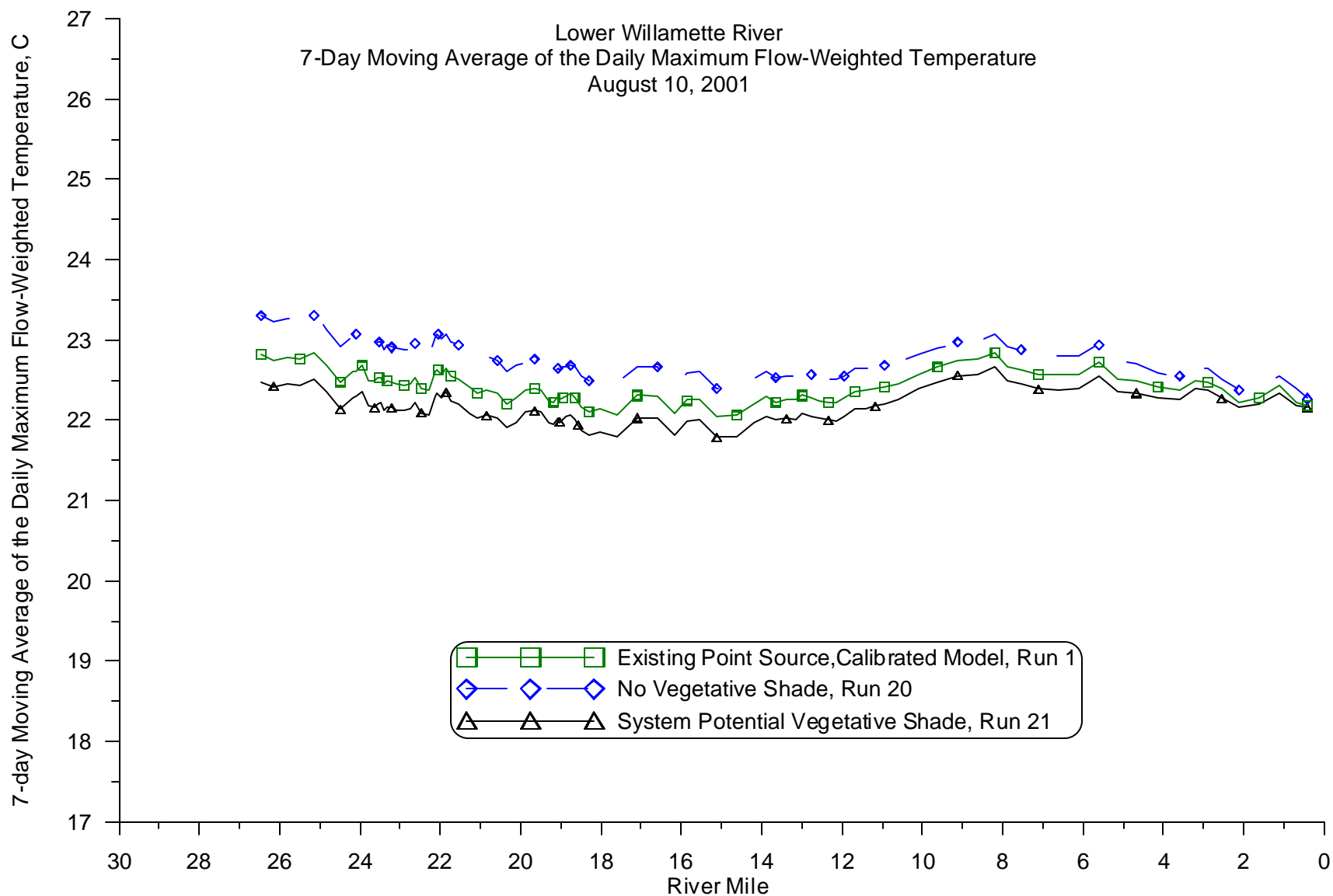


Figure 865: Calibrated model vs. varying vegetative shade longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River





**Figure 866: Calibrated model vs. varying vegetative shade longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

### ***Sensitivity to biological opinion flows***

The sensitivity of the model to using the National Marine Fisheries Service Biological Opinion (NMFS BIOP) flows for the upstream boundary flow condition was examined by simulating the summer of 2001. These results were then compared with the results of the calibrated model in a series of longitudinal profiles for each river reach modeled. All of the longitudinal plots show the seven-day moving average of the daily maximum temperature for August 10, 2001 (ODEQ, 2003) and begin in the furthest upstream reaches of the watershed and move downstream.

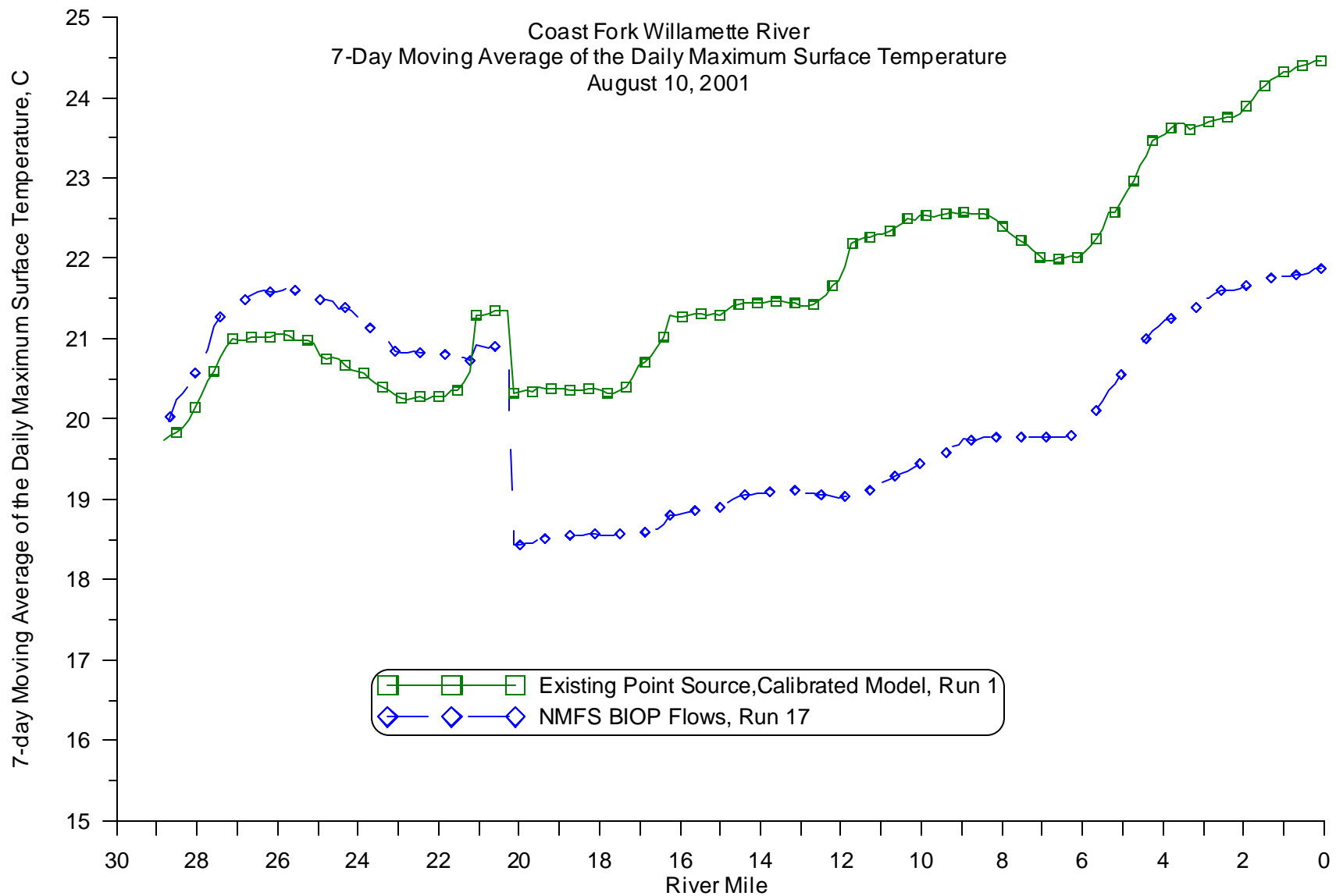


Figure 867: Calibrated model vs. Biological Opinion flow longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River

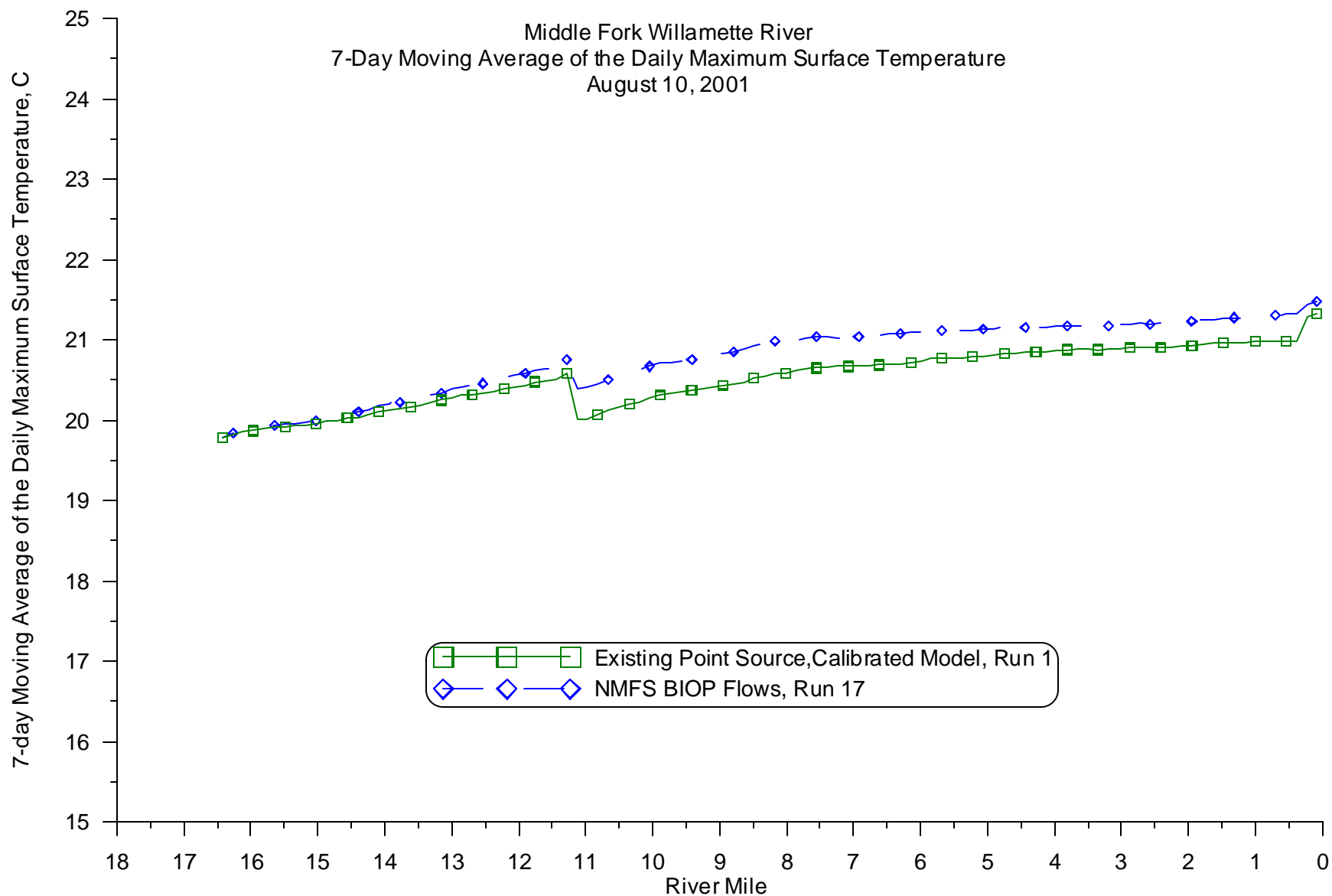


Figure 868: Calibrated model vs. Biological Opinion flow longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River

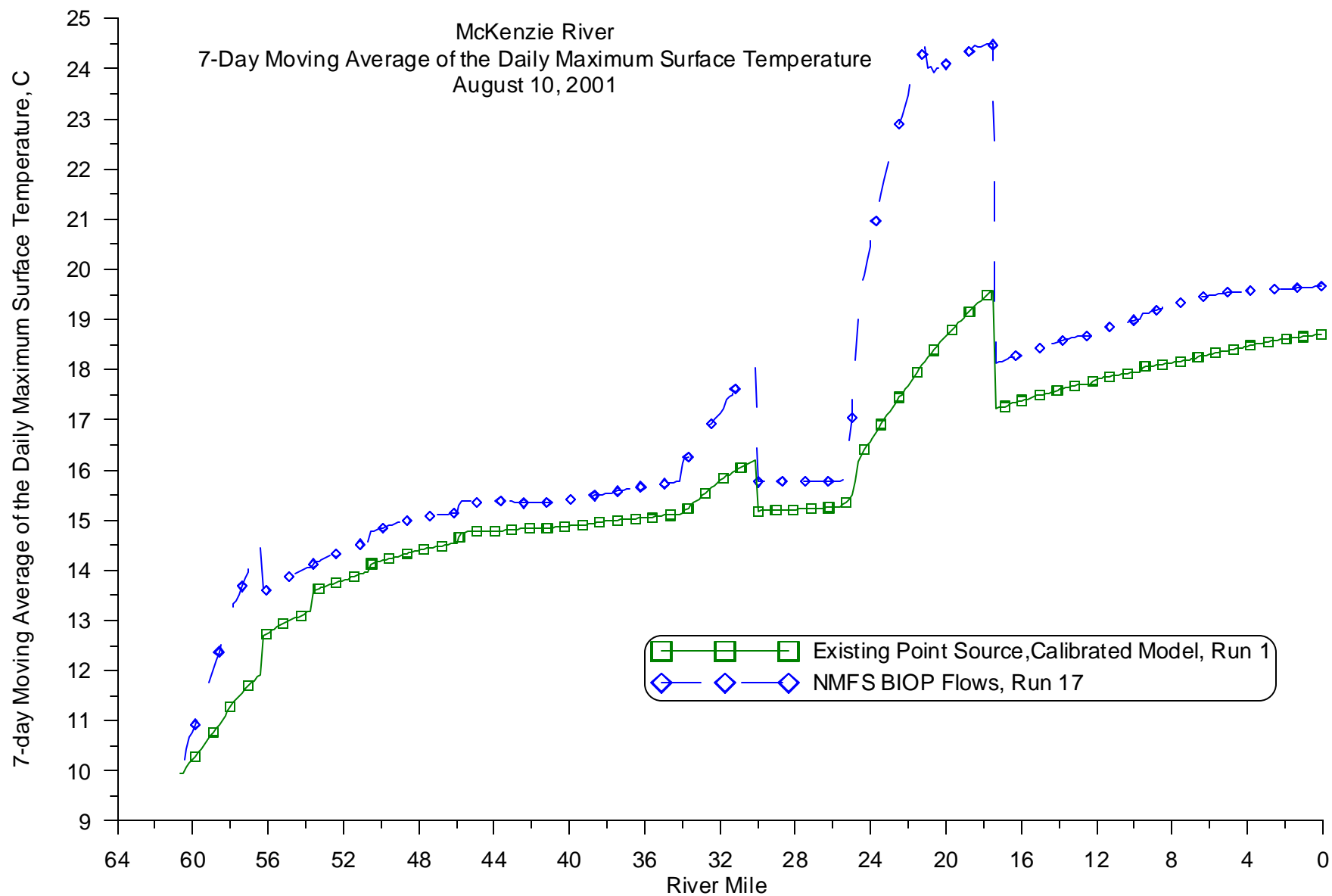


Figure 869: Calibrated model vs. Biological Opinion flow longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River

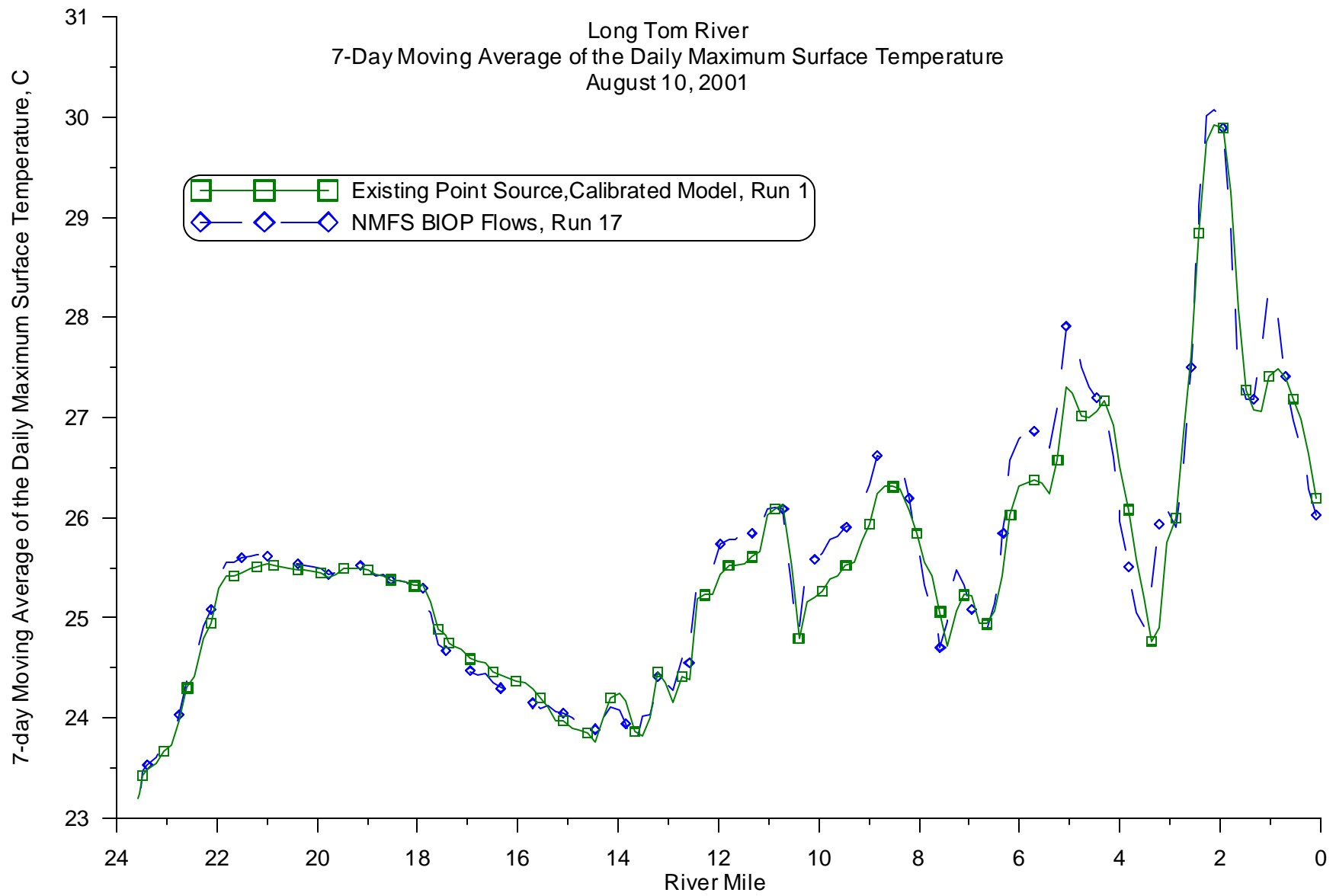
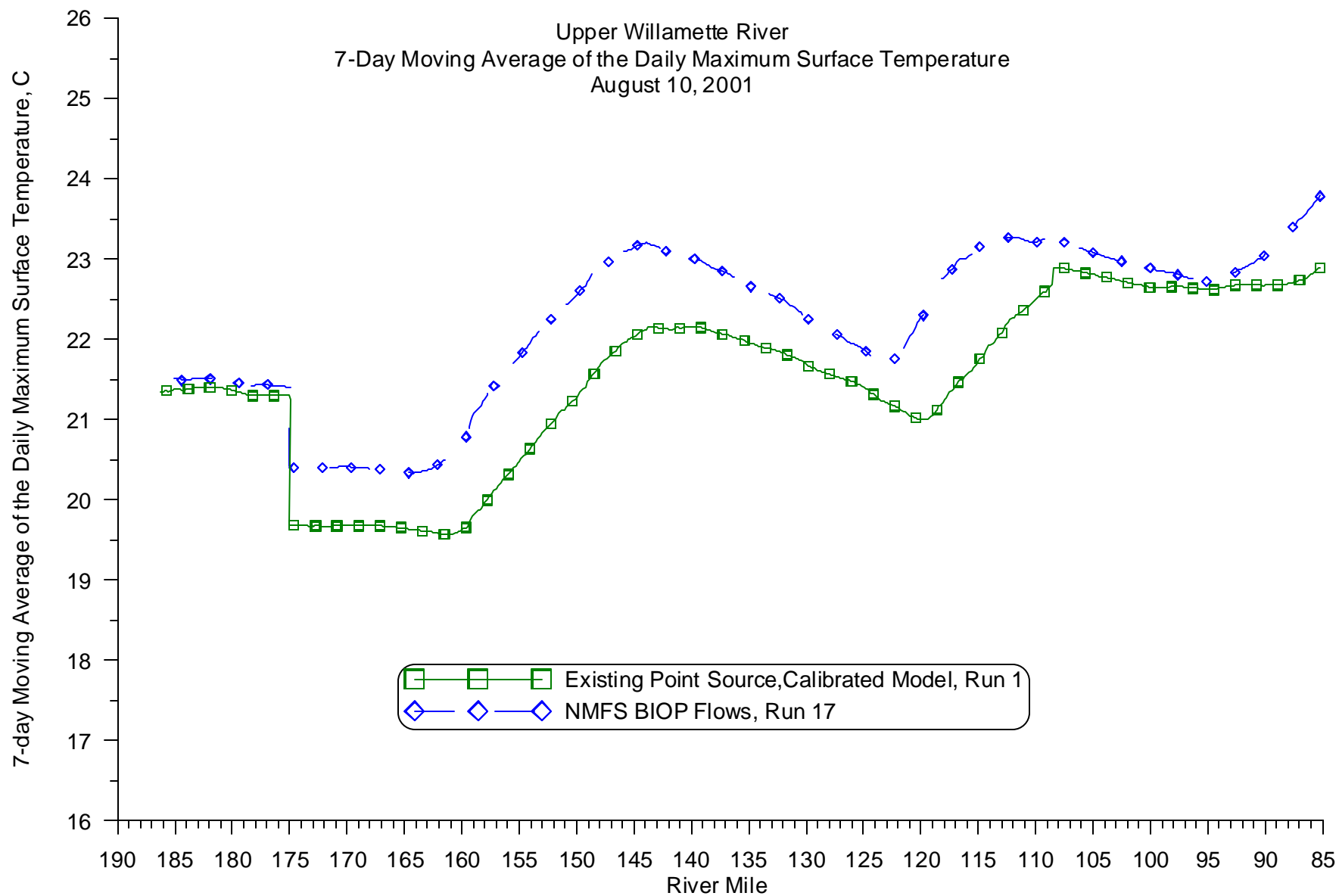
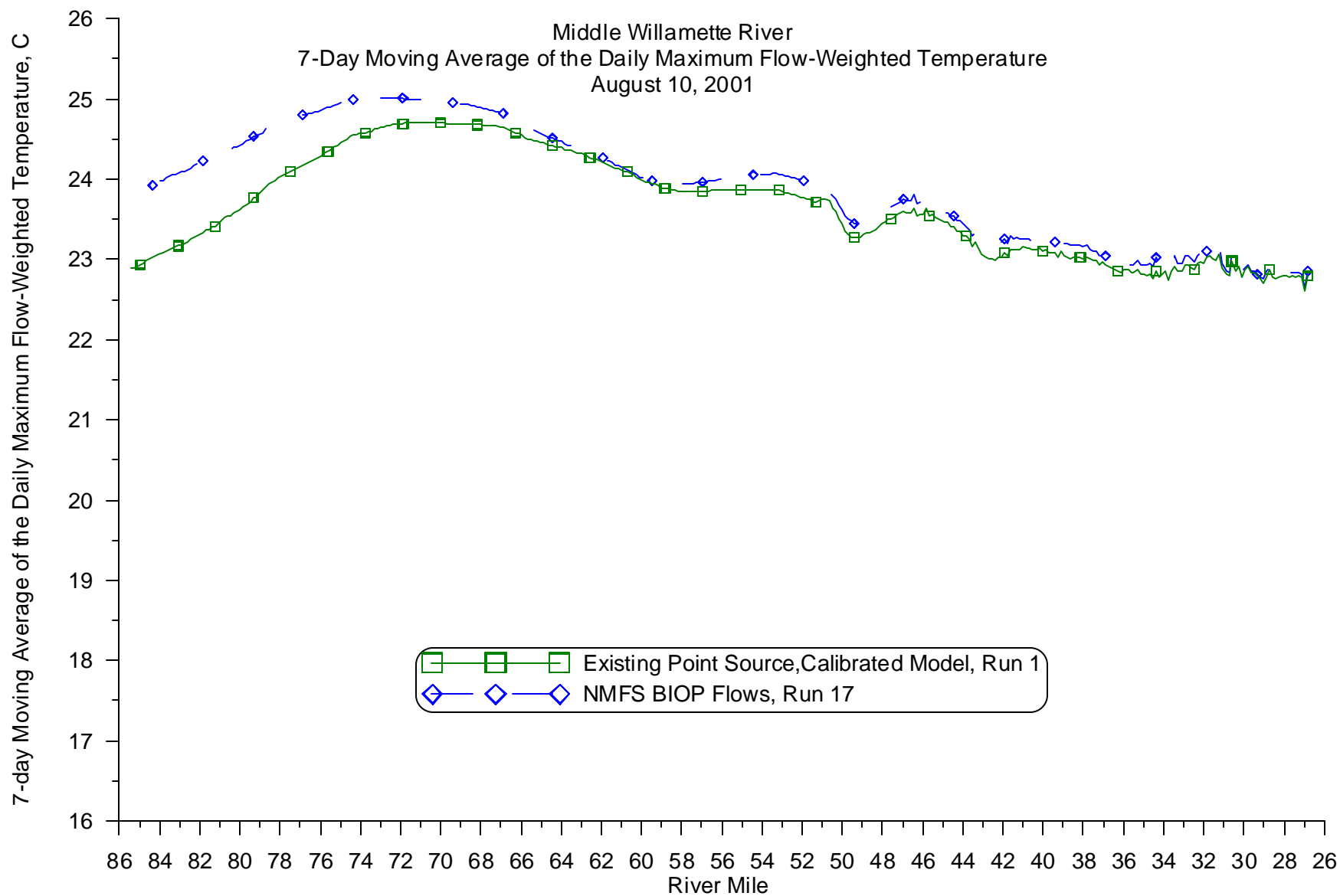


Figure 870: Calibrated model vs. Biological Opinion flow longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River

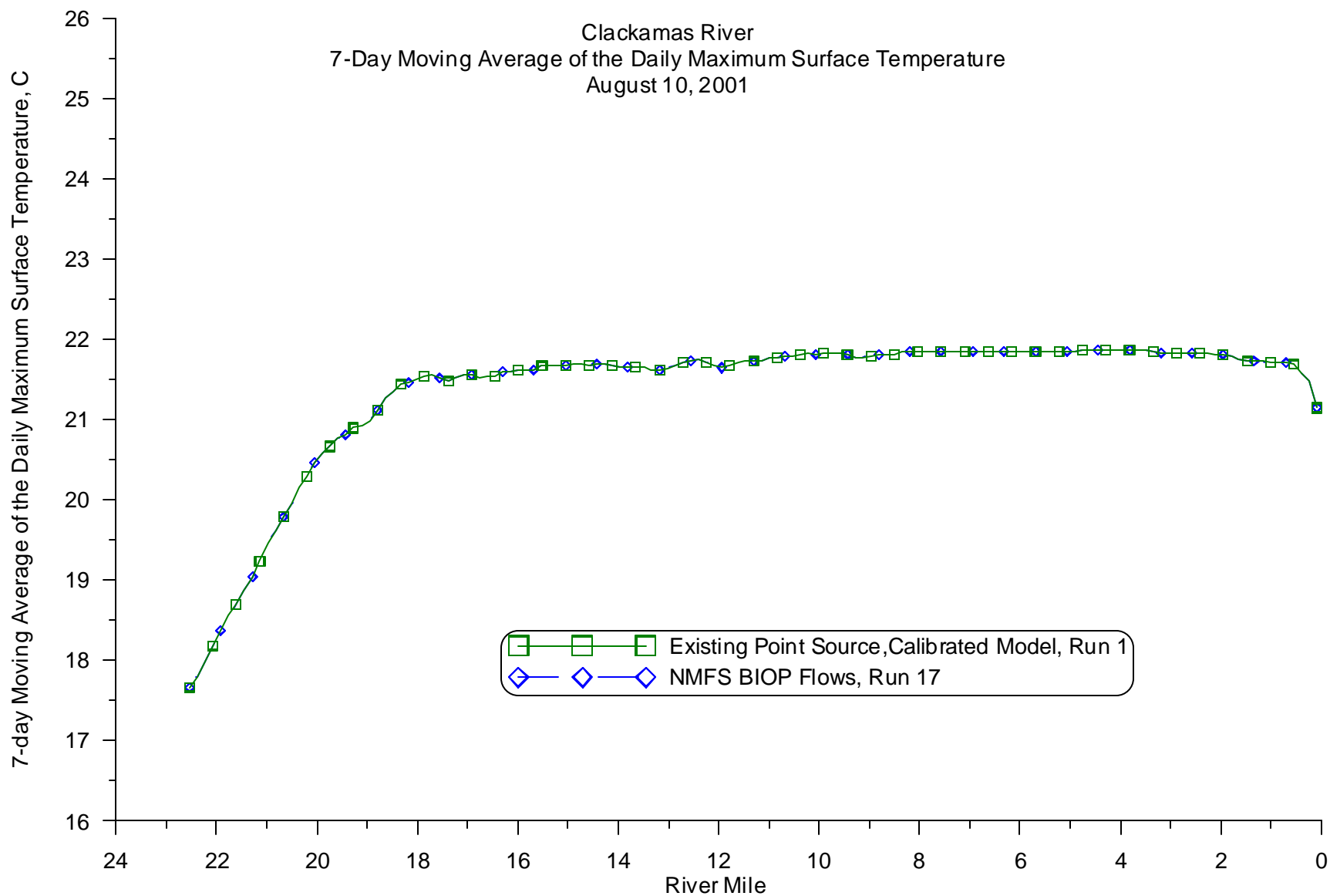


**Figure 871: Calibrated model vs. Biological Opinion flow longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**

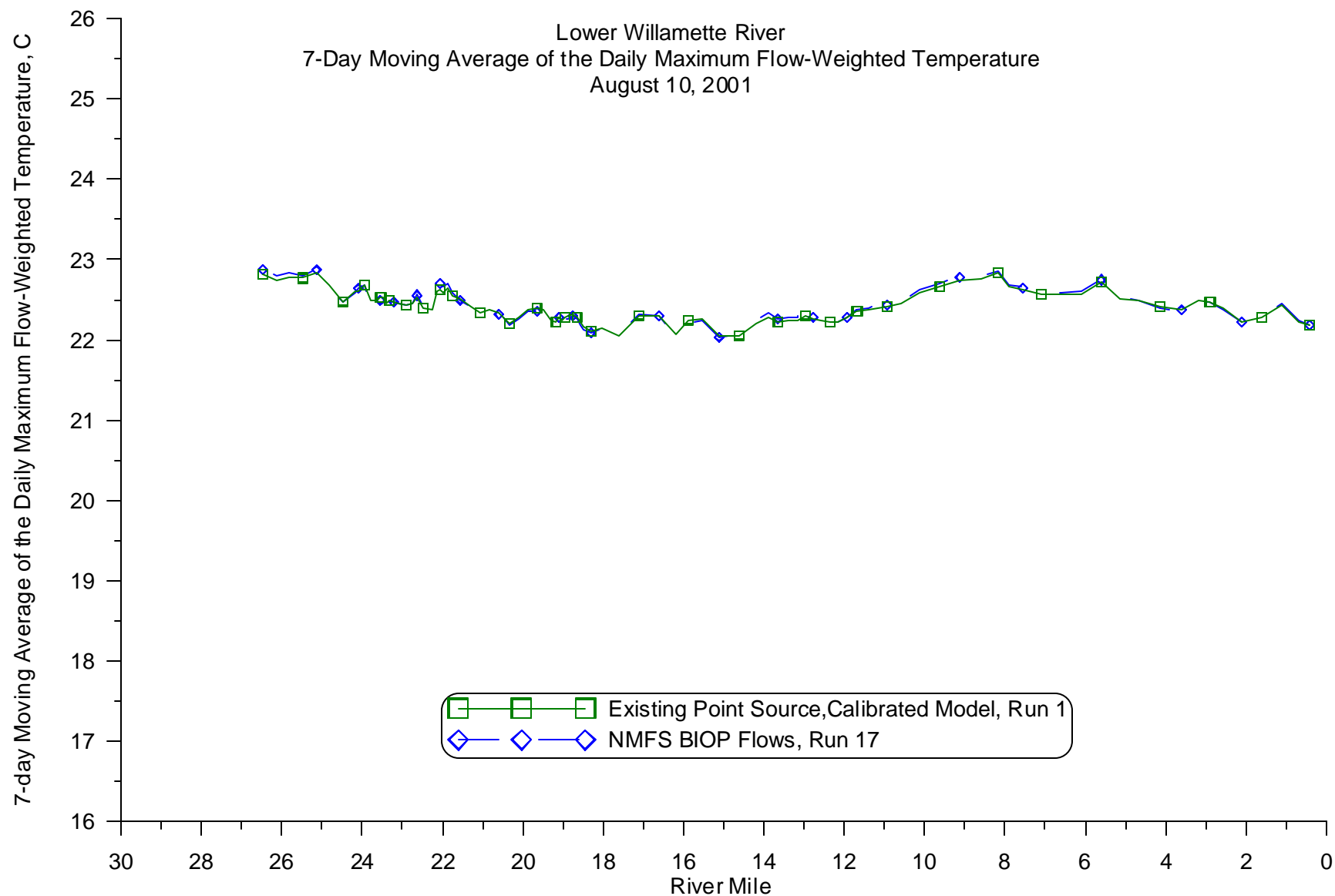


**Figure 872: Calibrated model vs. Biological Opinion flow longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**





**Figure 873: Calibrated model vs. Biological Opinion flow longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River**



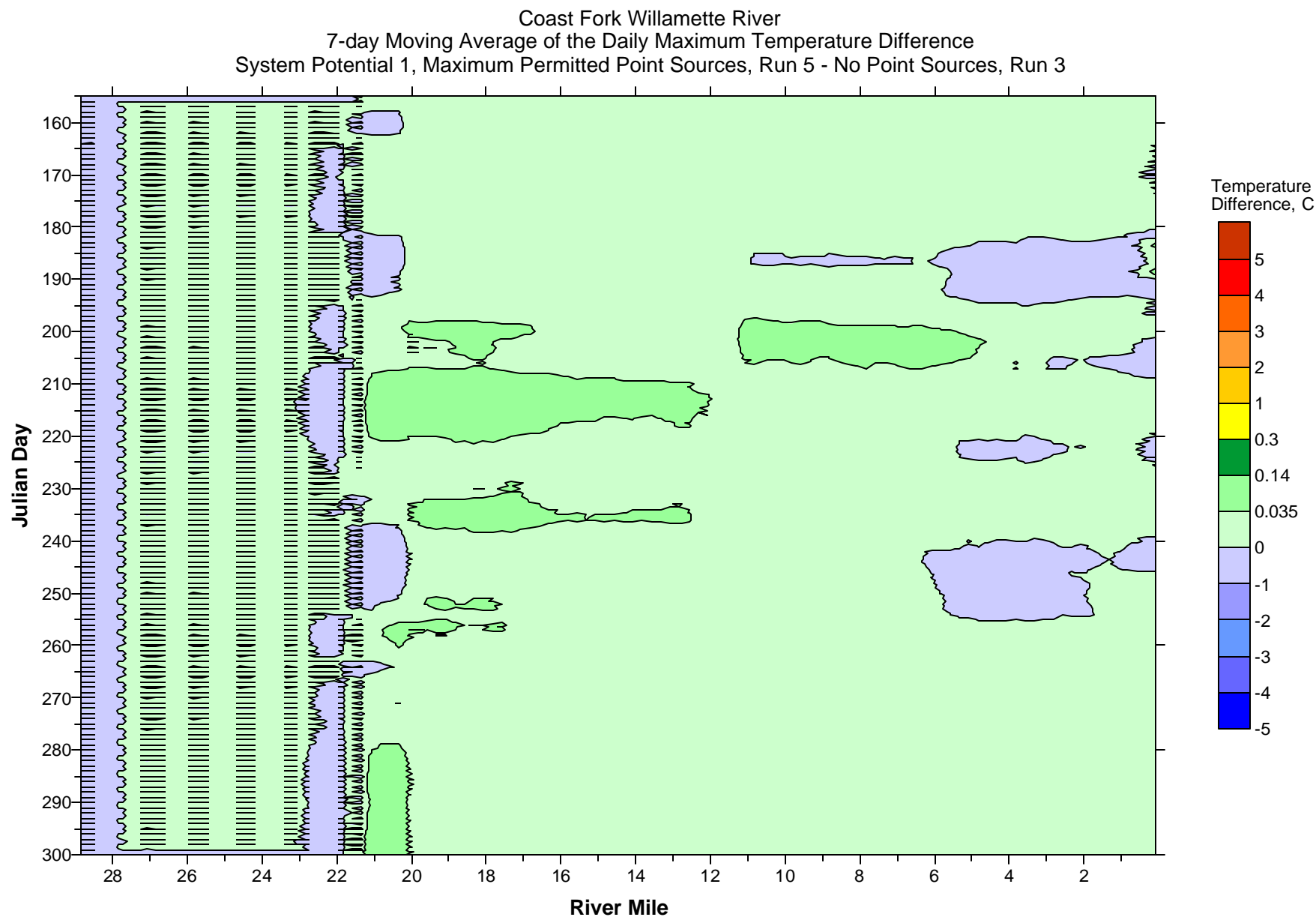
**Figure 874: Calibrated model vs. Biological Opinion flow longitudinal profile comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

## Contour Plot Comparisons

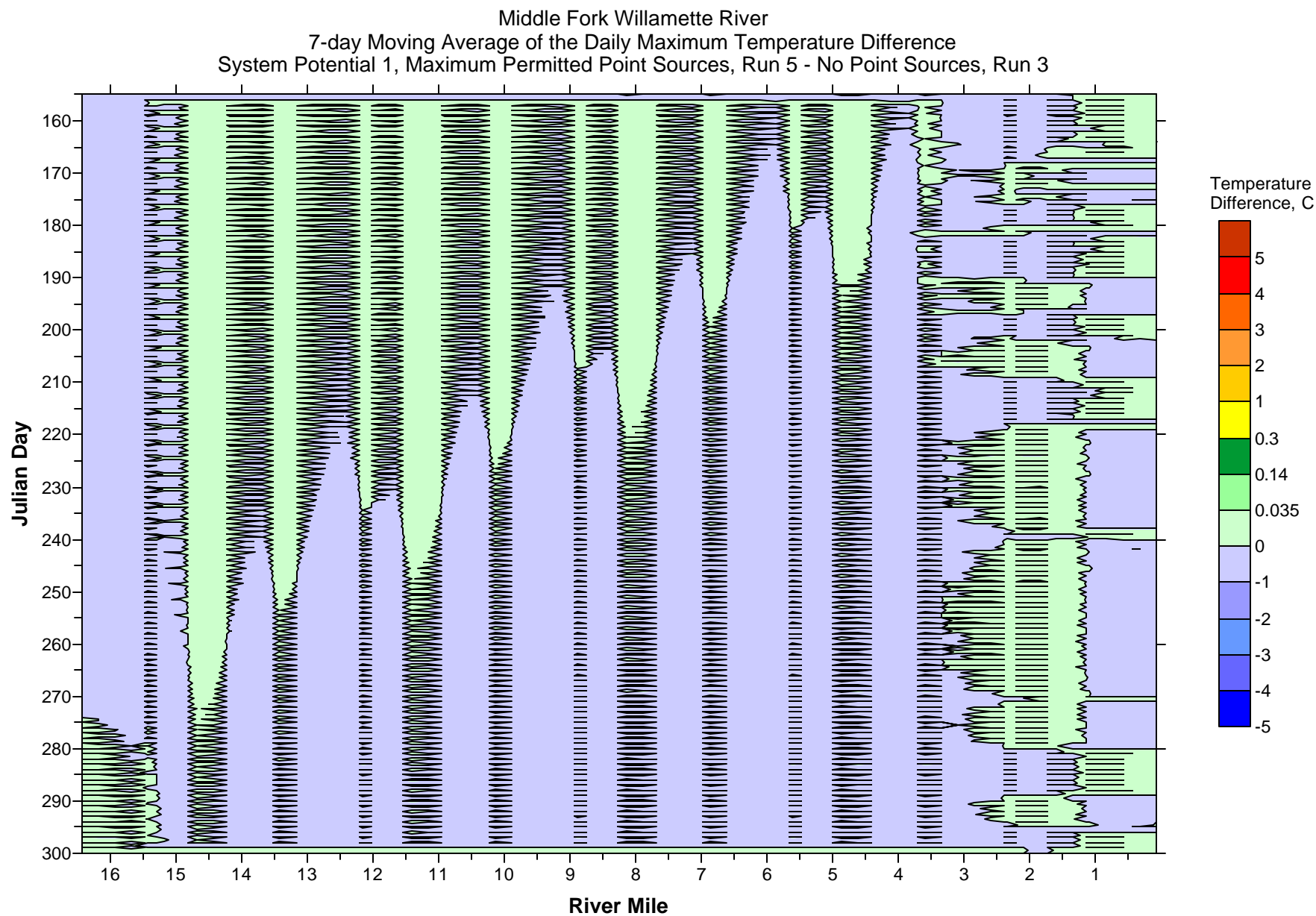
The sensitivity of the model was tested by making specific changes to the model and comparing the results with the results from other scenarios. A comprehensive way to examine the model sensitivity is generate a contour plot of the difference between two model scenarios over an entire river reach and for the duration of the summer of 2001. The model scenario results were analyzed to generate the seven-day moving average of the daily maximum temperature for each model segment and for the whole simulation period. Then one model scenario temperature statistic was subtracted from another model scenario temperature statistic. The resulting change in temperature between the two scenarios (delta plot) was then plotted a contour plot with River mile along the x-axis and Julian day along the y-axis and color gradations representing the temperature differences between the two scenarios

### ***Sensitivity to point sources***

System Potential 1 (ODEQ, 2003) was run for the summer of 2001 for two scenarios with varying discharges from the large point sources in the Willamette River system. The point sources were simulated with no discharge and their maximum permitted discharge. The difference between the seven-day moving average of the daily maximum temperature for each scenario was then taken and plotted as contour plot for each river reach modeled (ODEQ, 2003). The contour plots begin in the furthest upstream reaches of the watershed and move downstream. Since there were no point sources discharges simulated in the Long Tom River and Clackamas River model reaches the difference between the two scenarios would be zero so no contour plots were generated.



**Figure 875: Maximum Permitted Point Sources vs. No Point Sources contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**



**Figure 876: Maximum Permitted Point Sources vs. No Point Sources contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**

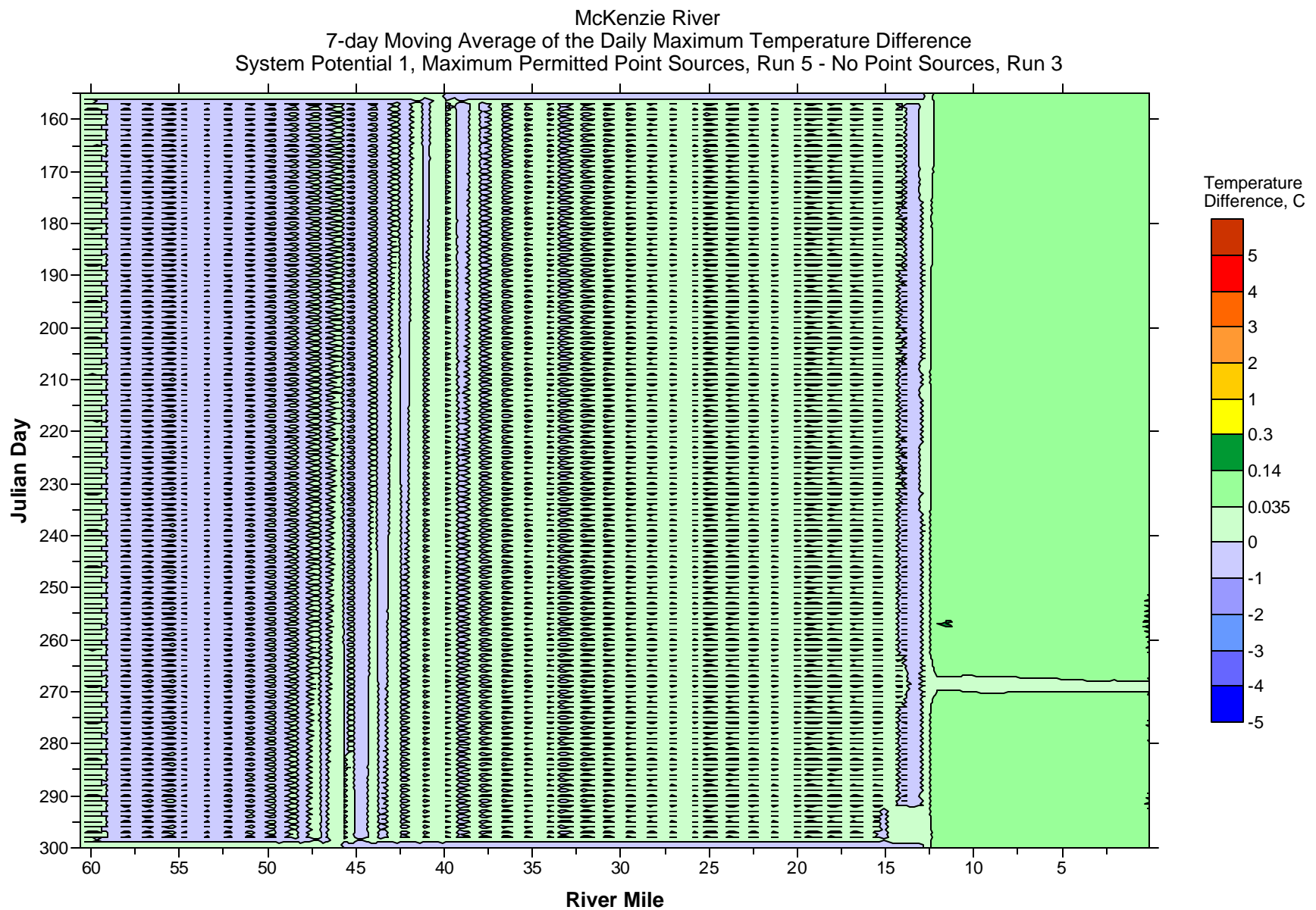
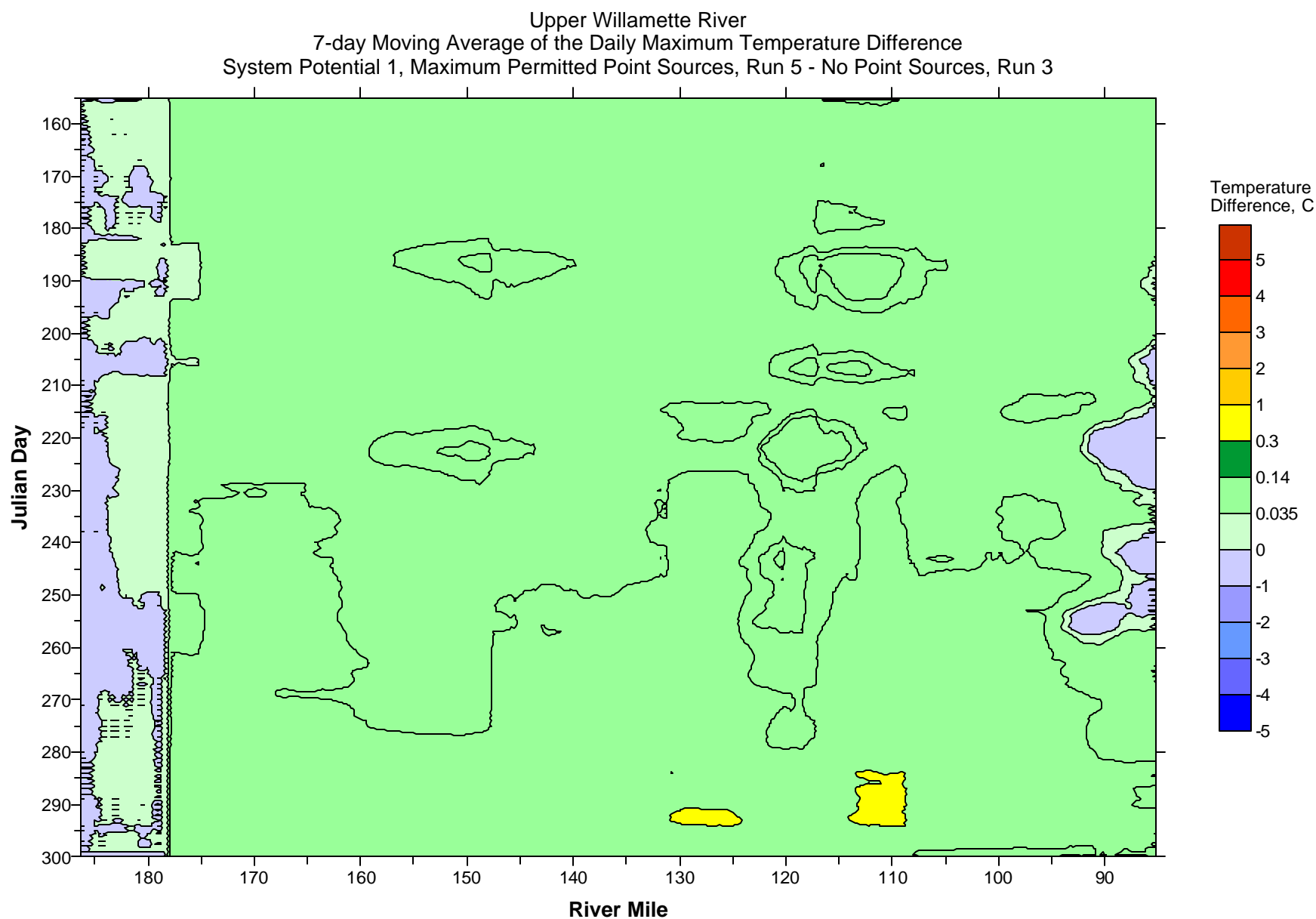
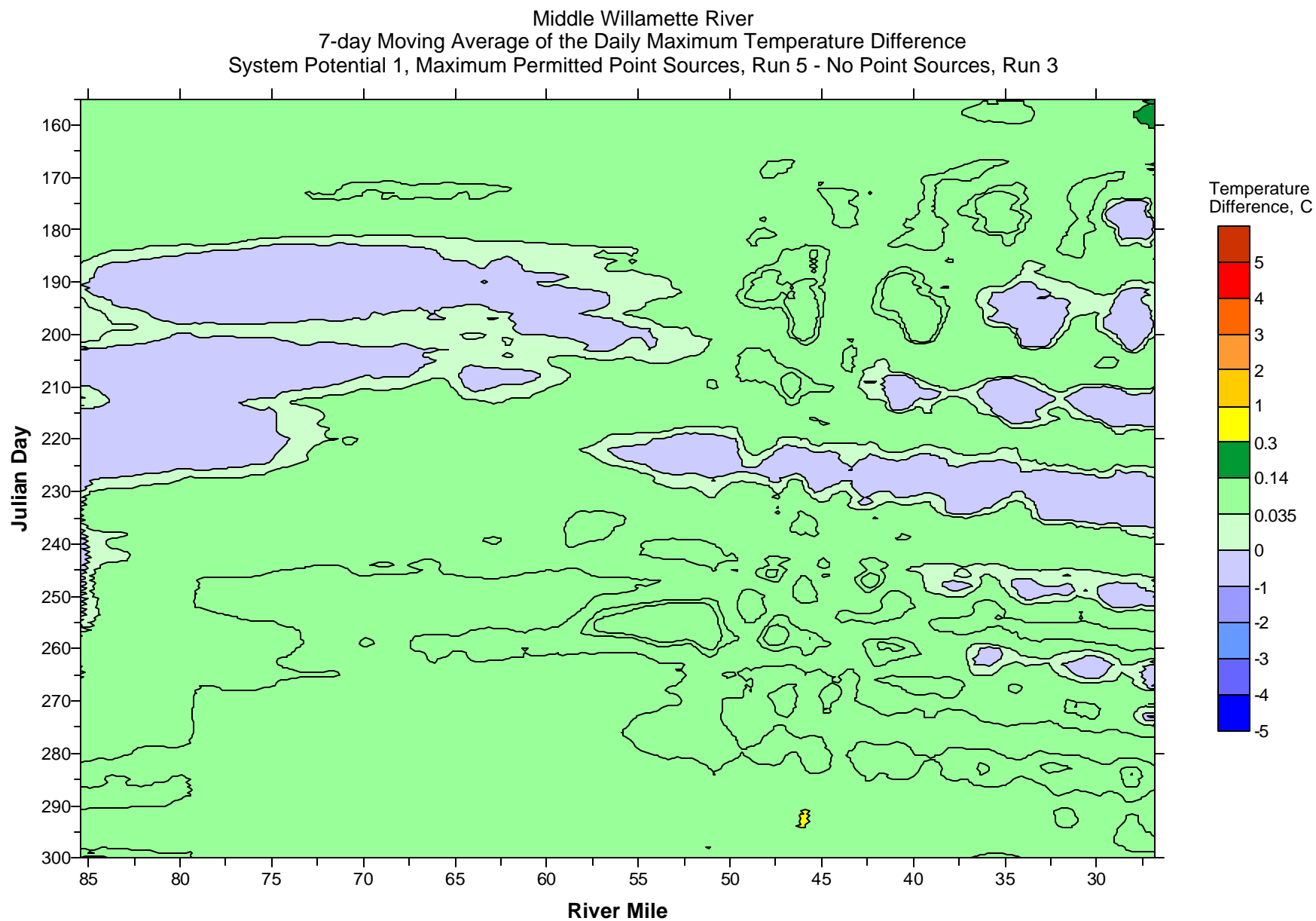


Figure 877: Maximum Permitted Point Sources vs. No Point Sources contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River

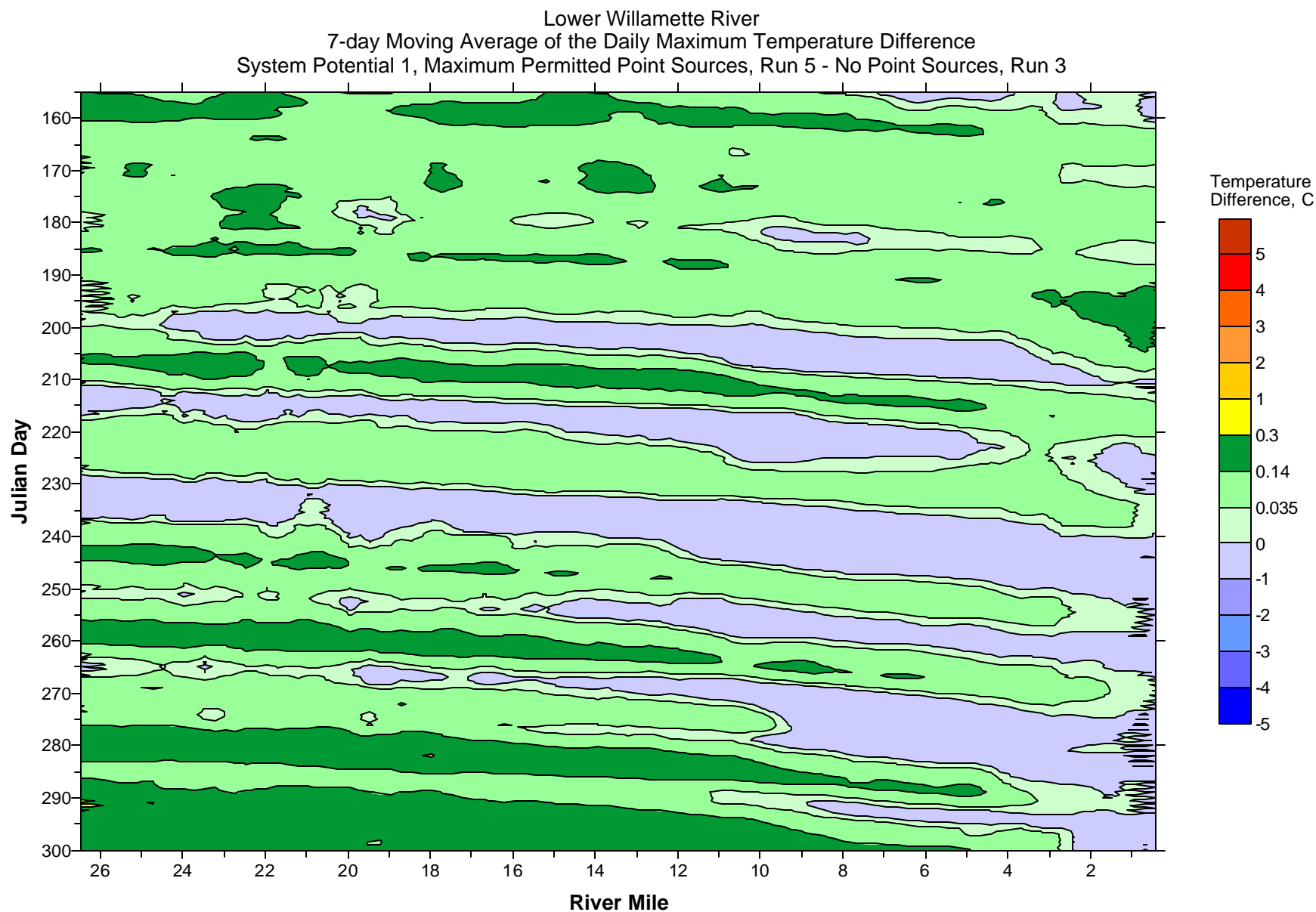


**Figure 878: Maximum Permitted Point Sources vs. No Point Sources contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 879: Maximum Permitted Point Sources vs. No Point Sources contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**

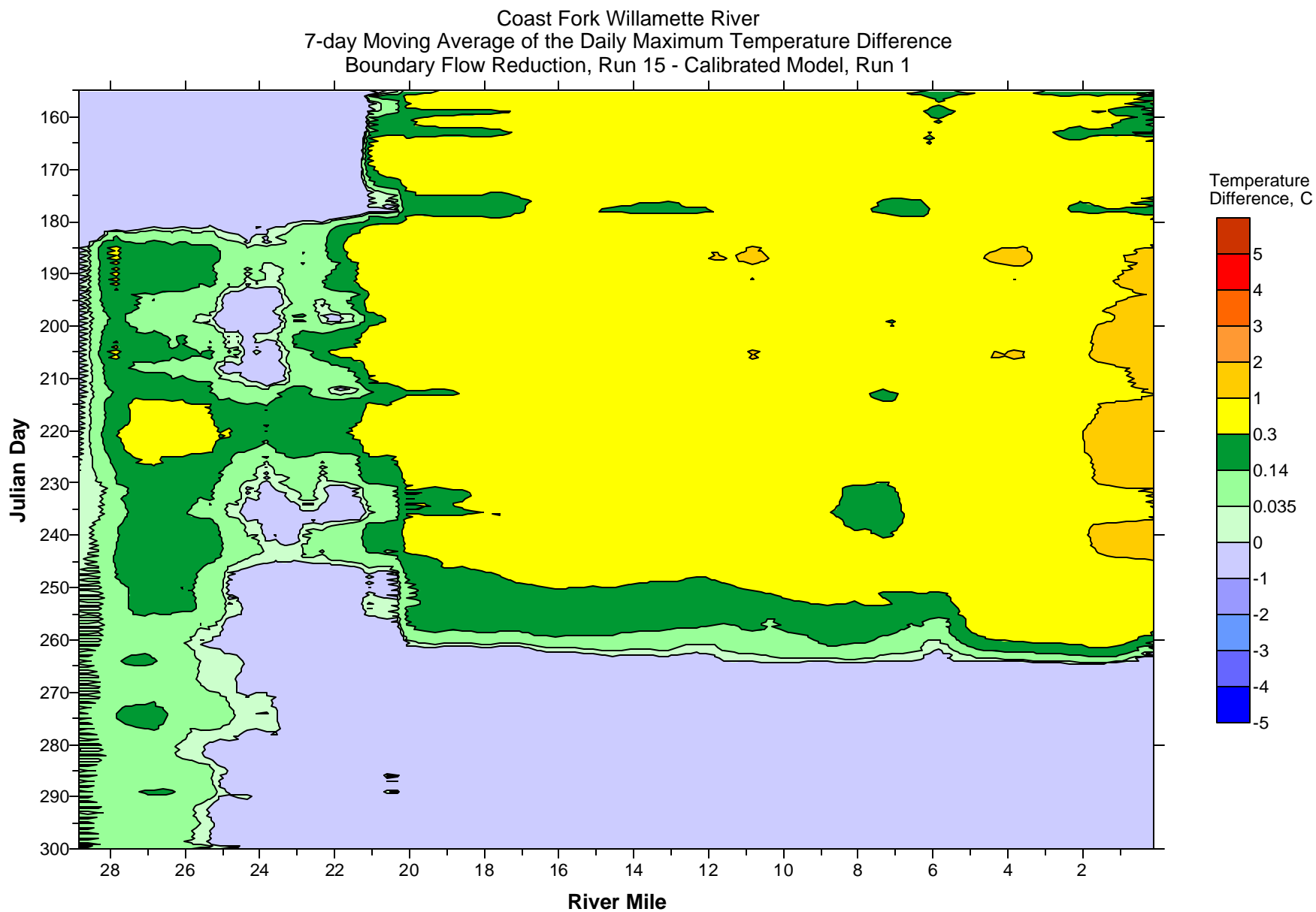




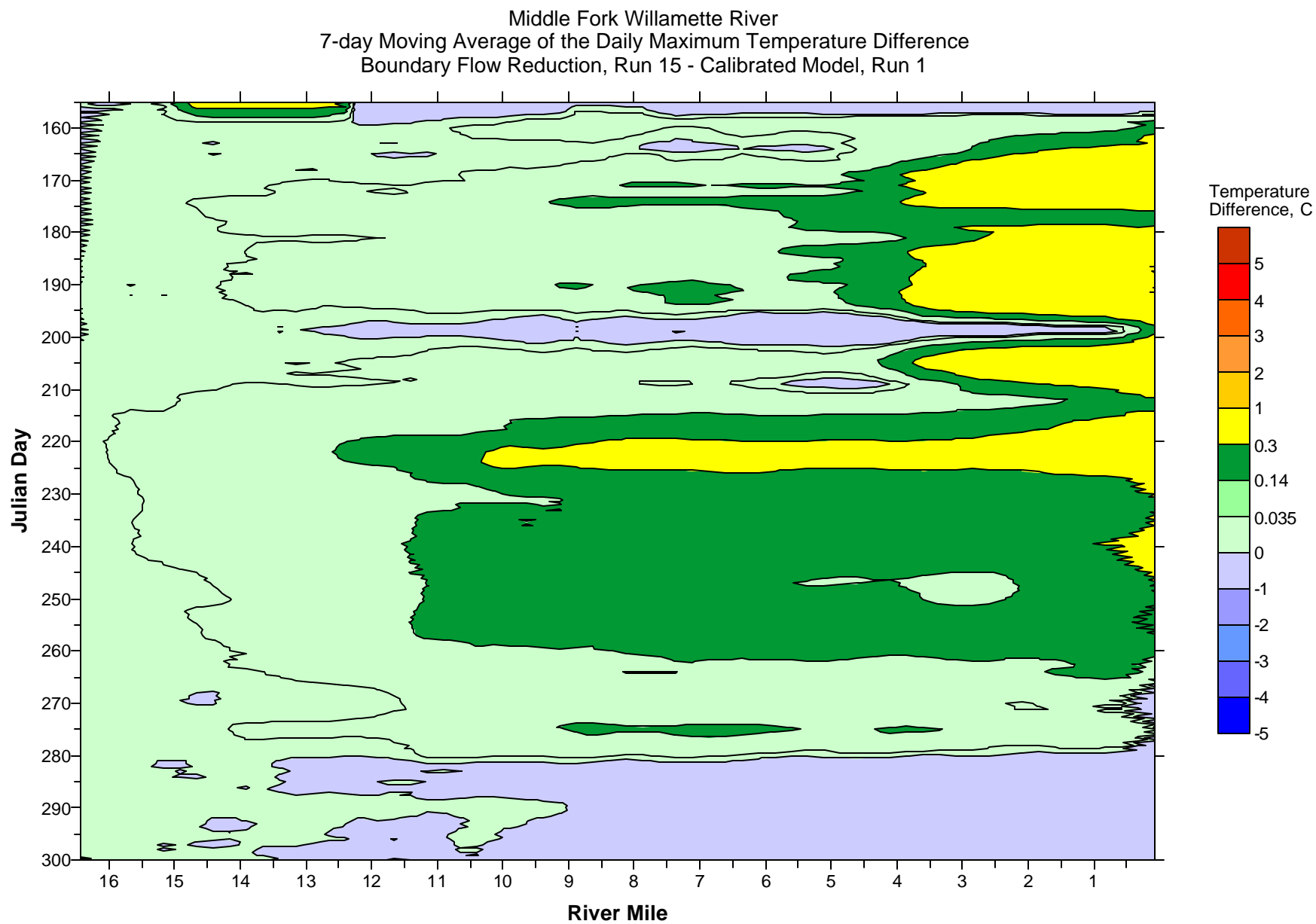
**Figure 880: Maximum Permitted Point Sources vs. No Point Sources contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

### ***Sensitivity to boundary flow rate reduction***

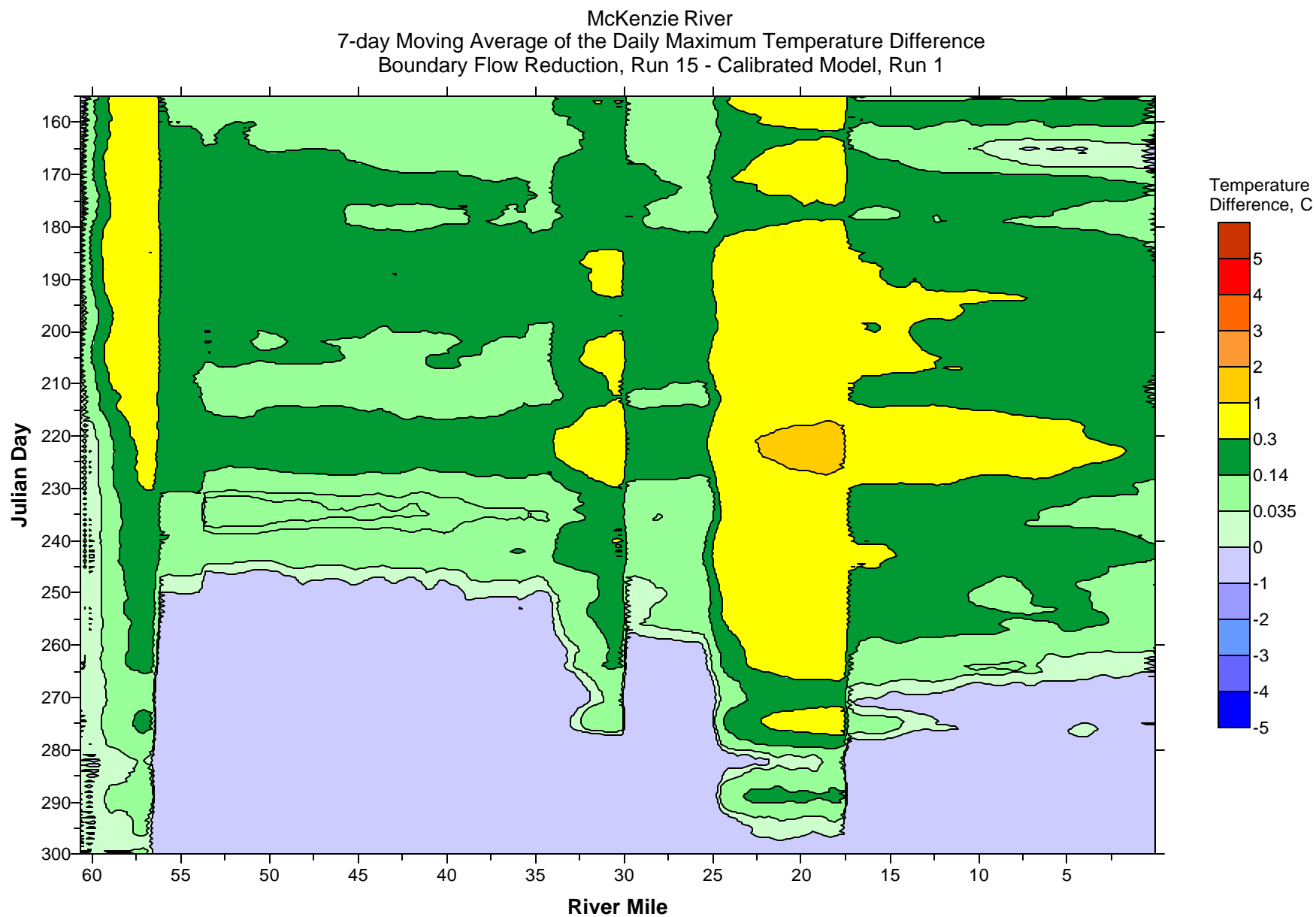
The sensitivity of the model to a 20% reduction in upstream boundary flows was examined by simulating the summer of 2001 and comparing it to the calibrated model. The difference between the seven-day moving average of the daily maximum temperature for each scenario was then taken and plotted as contour plot for each river reach modeled (ODEQ, 2003). The contour plots begin in the furthest upstream reaches of the watershed and move downstream.



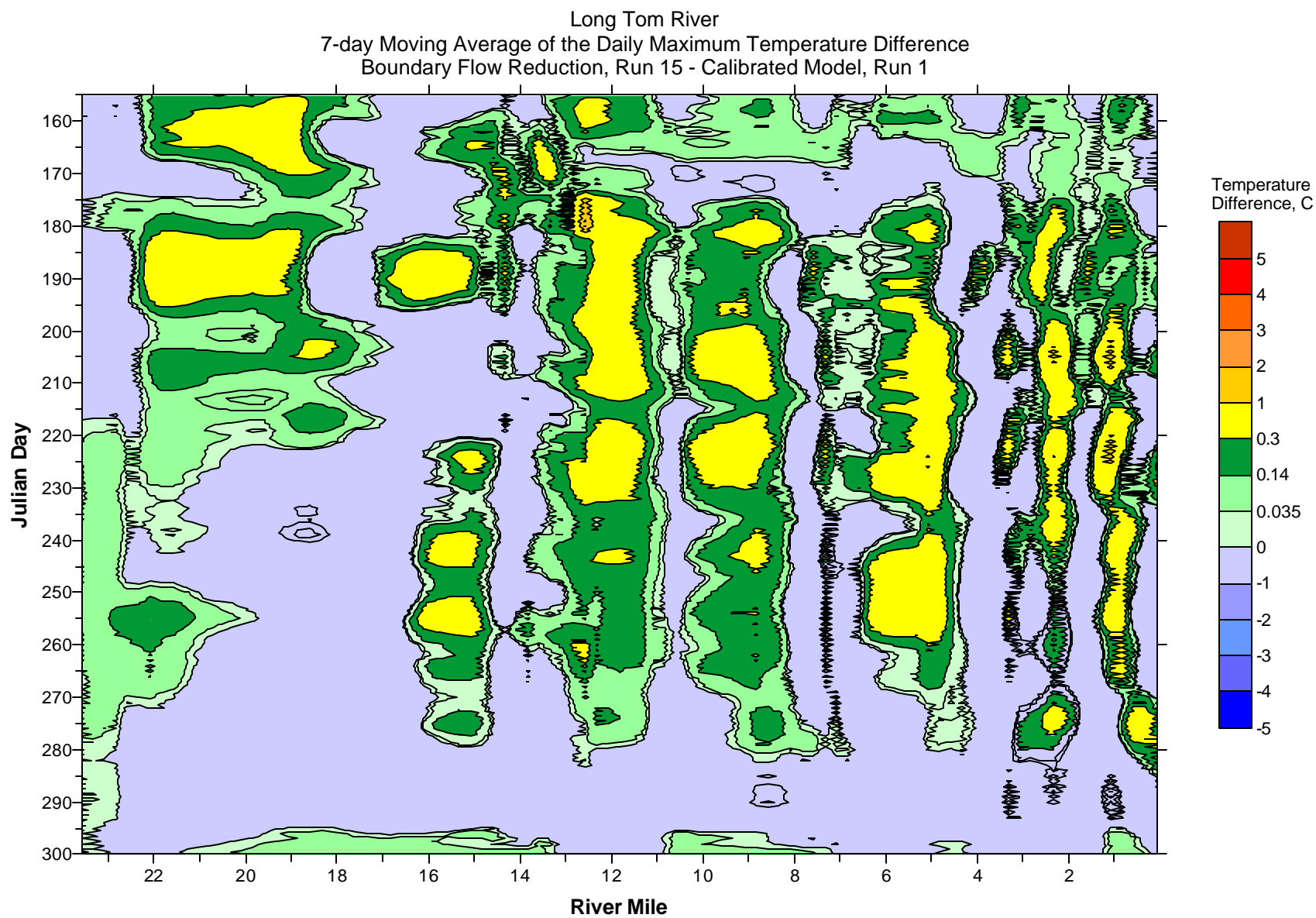
**Figure 881: Calibrated model vs. boundary flow reduction (- 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**



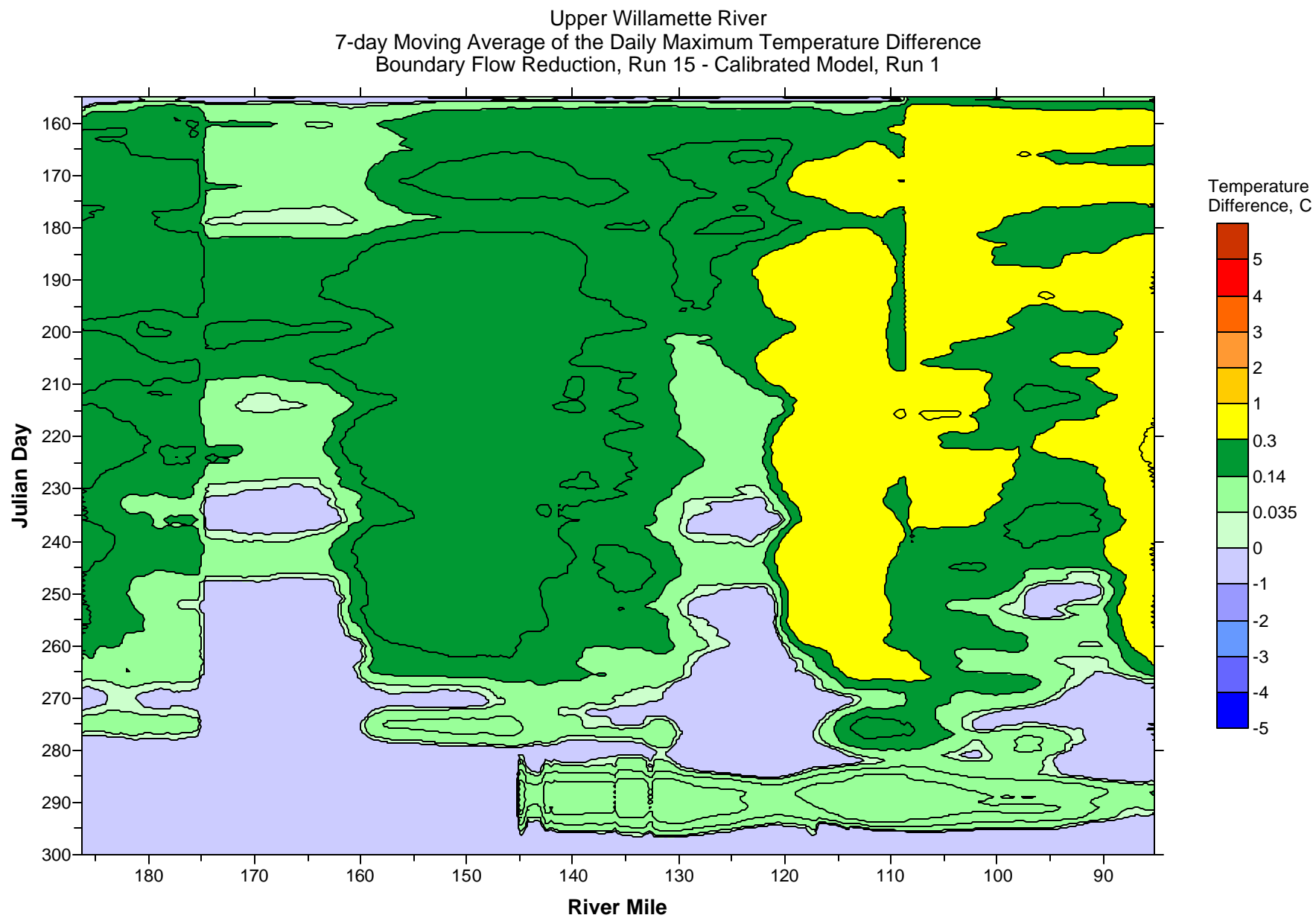
**Figure 882: Calibrated model vs. boundary flow reduction (- 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**



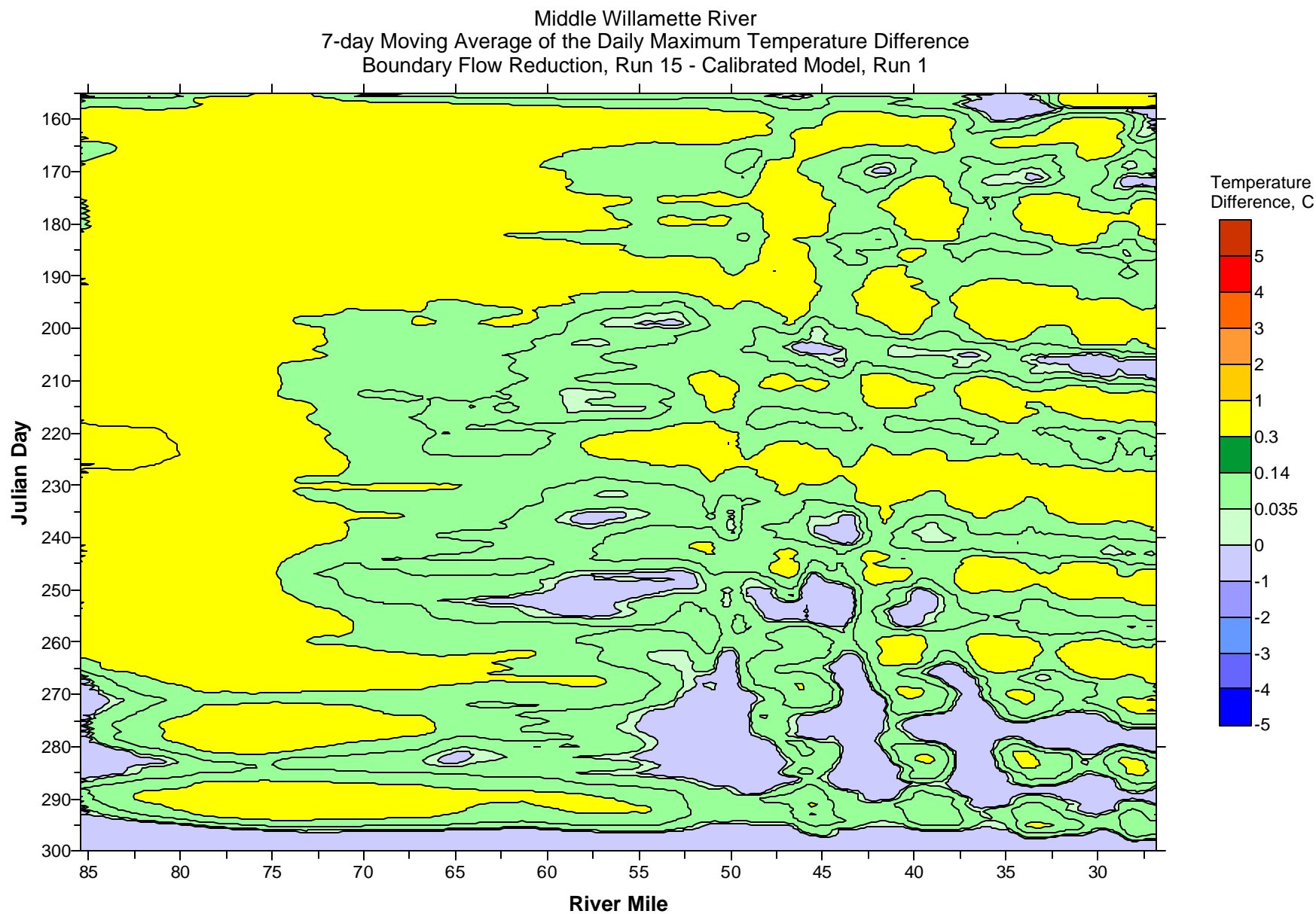
**Figure 883: Calibrated model vs. boundary flow reduction (- 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River**



**Figure 884: Calibrated model vs. boundary flow reduction (~ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River**



**Figure 885: Calibrated model vs. boundary flow reduction (- 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 886: Calibrated model vs. boundary flow reduction (- 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**



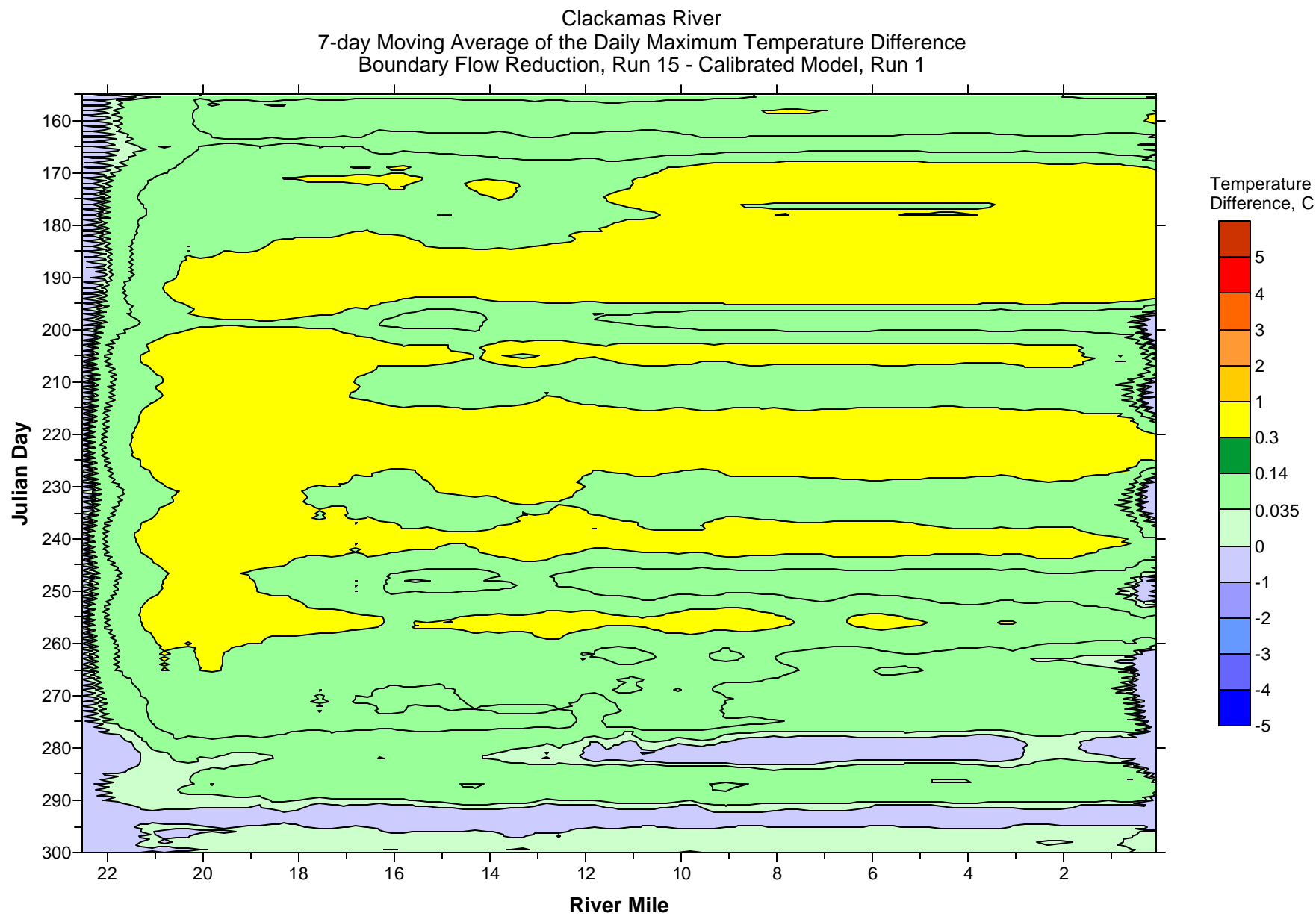
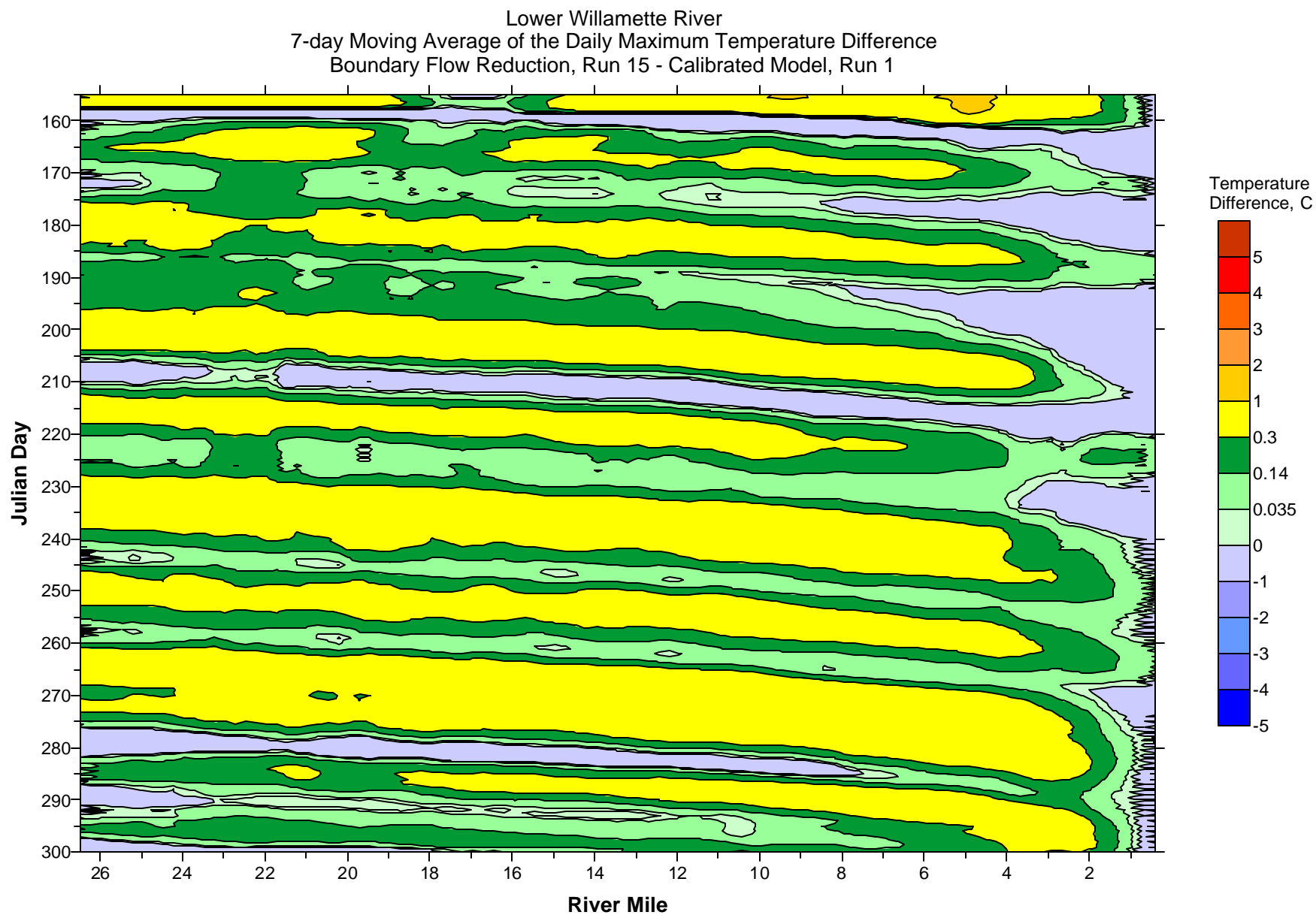


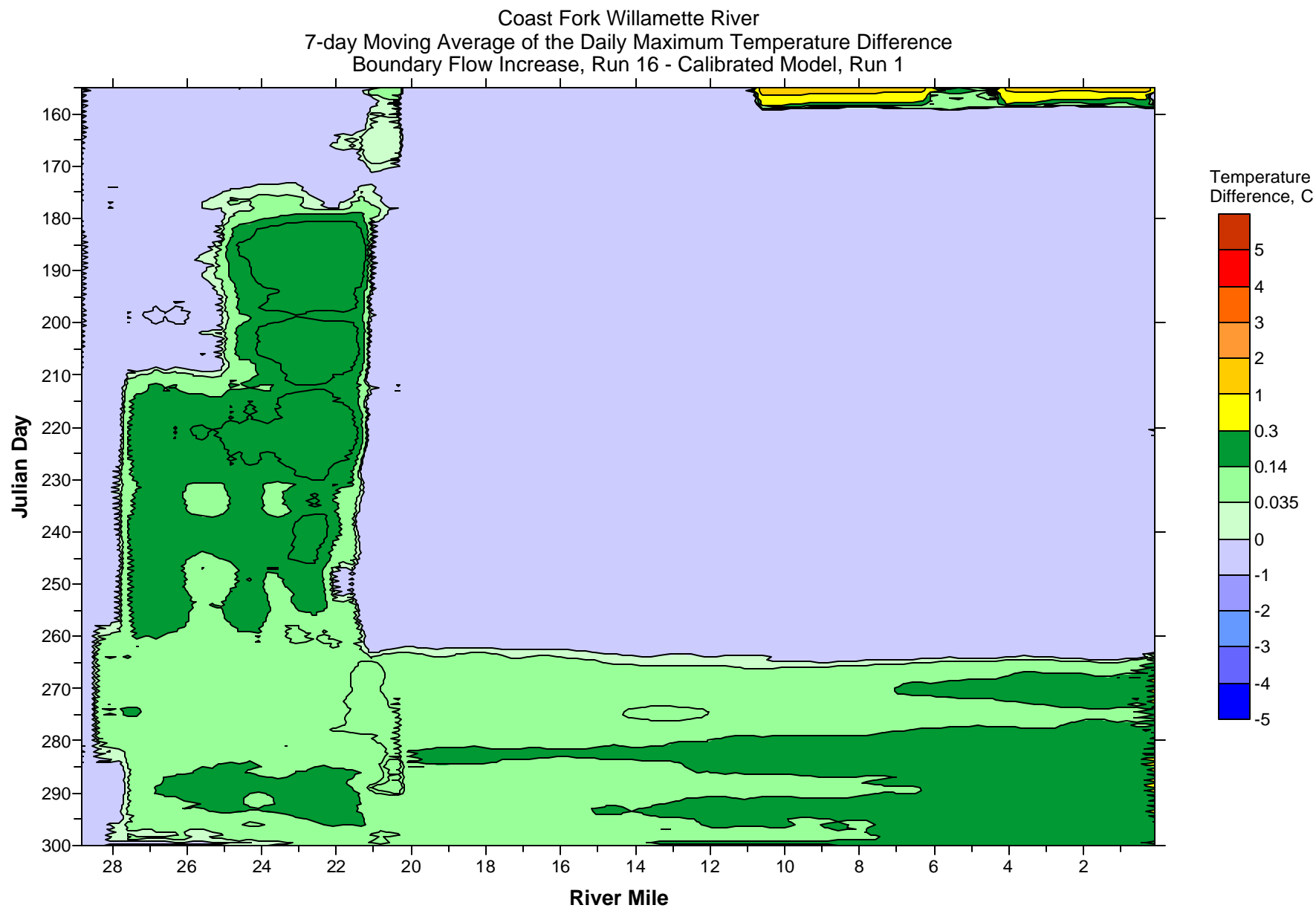
Figure 887: Calibrated model vs. boundary flow reduction (- 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River



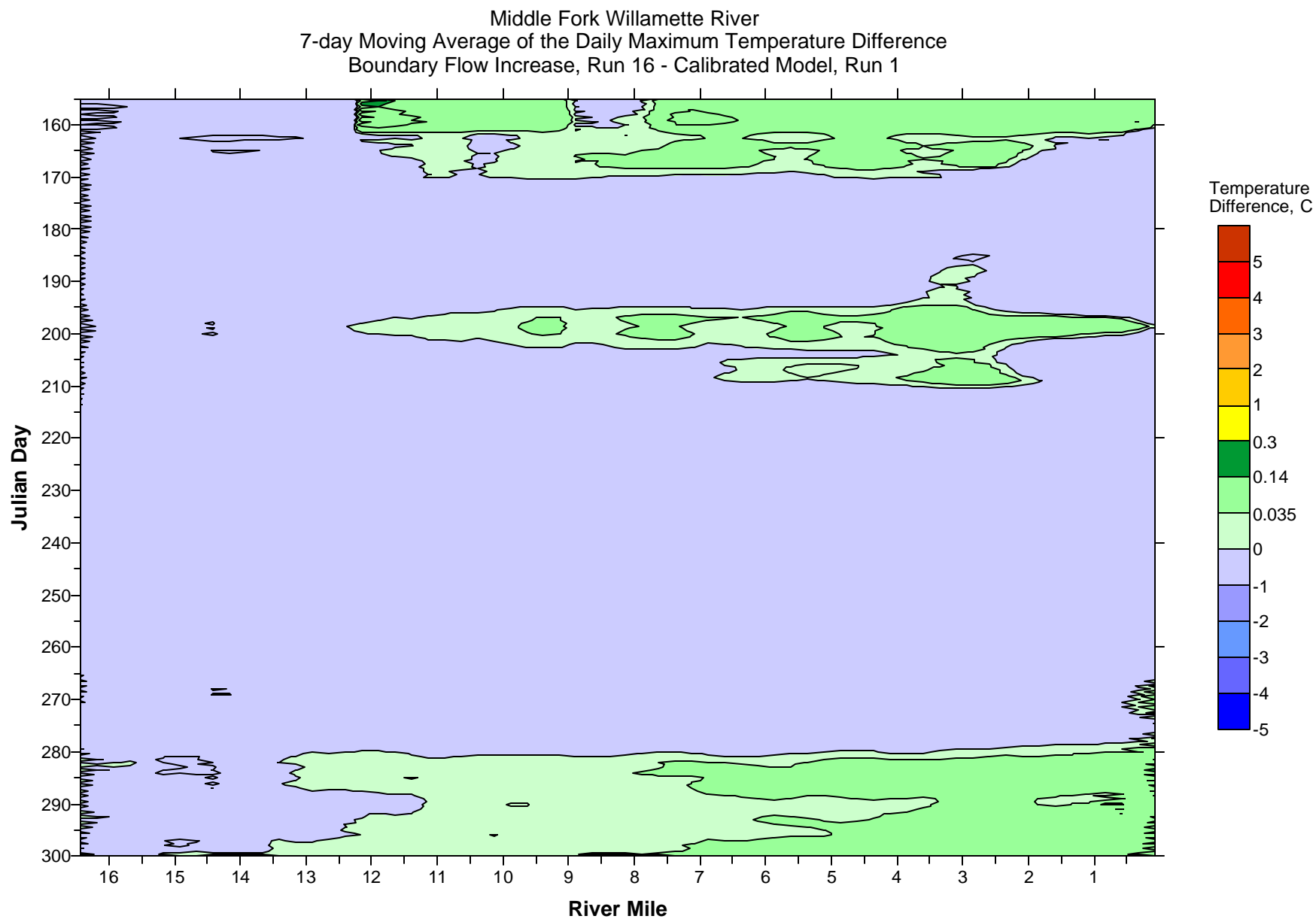
**Figure 888: Calibrated model vs. boundary flow reduction (~ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

### ***Sensitivity to boundary flow rate increase***

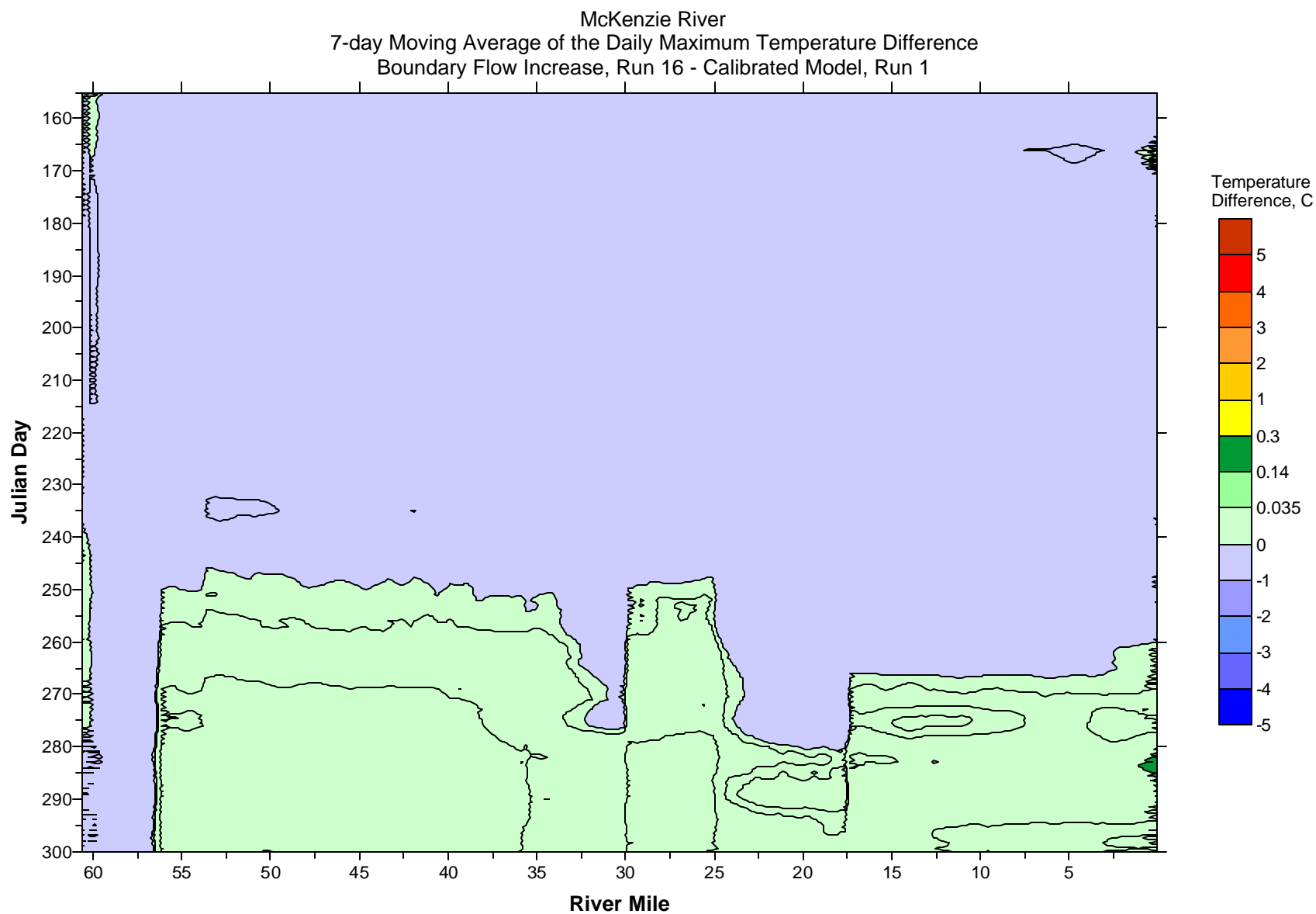
The sensitivity of the model to a 20% increase in upstream boundary flows was examined by simulating the summer of 2001 and comparing it to the calibrated model. The difference between the seven-day moving average of the daily maximum temperature for each scenario was then taken and plotted as contour plot for each river reach modeled (ODEQ, 2003). The contour plots begin in the furthest upstream reaches of the watershed and move downstream.



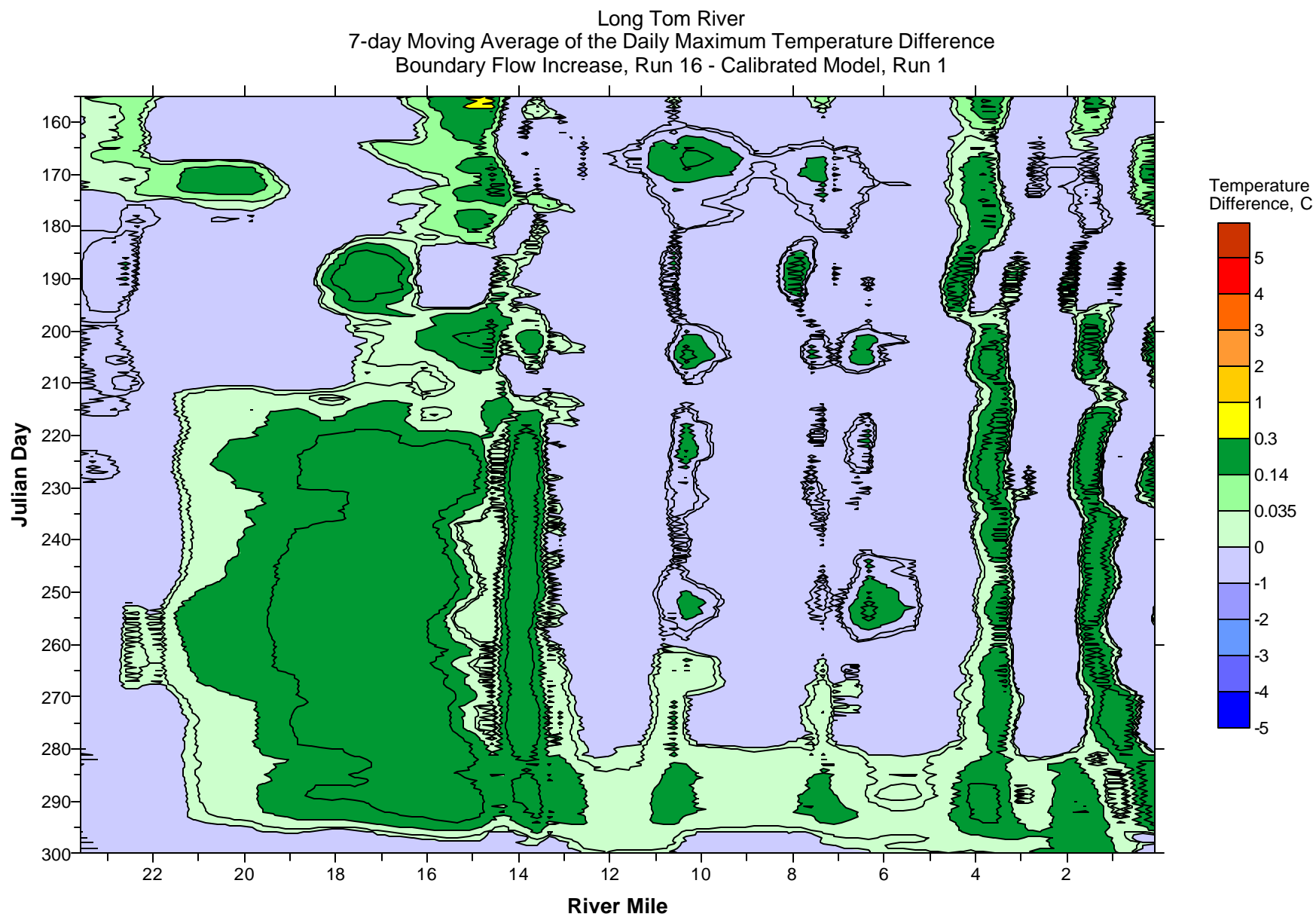
**Figure 889: Calibrated model vs. boundary flow increase (+ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**



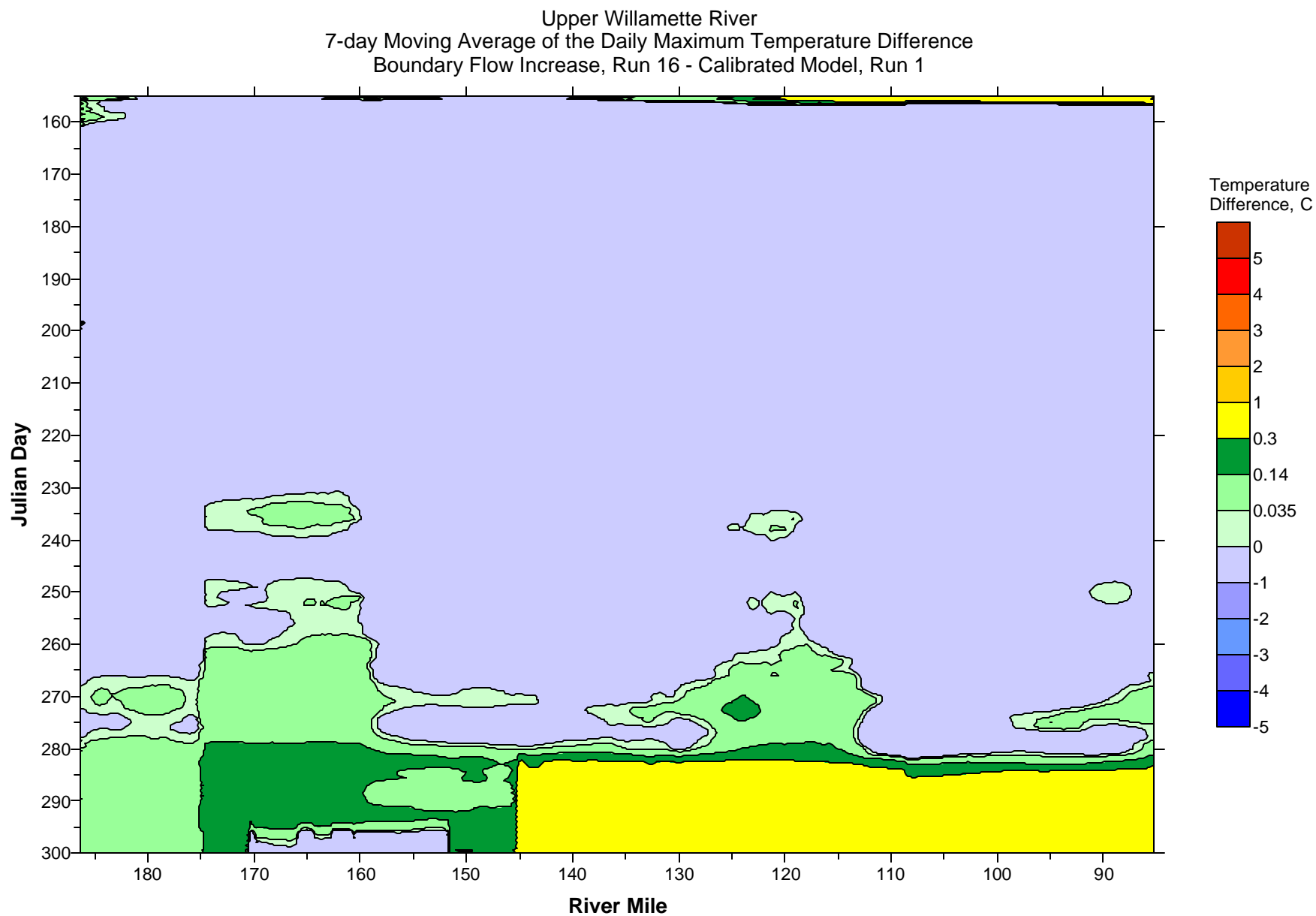
**Figure 890: Calibrated model vs. boundary flow increase (+ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**



**Figure 891: Calibrated model vs. boundary flow increase (+ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River**

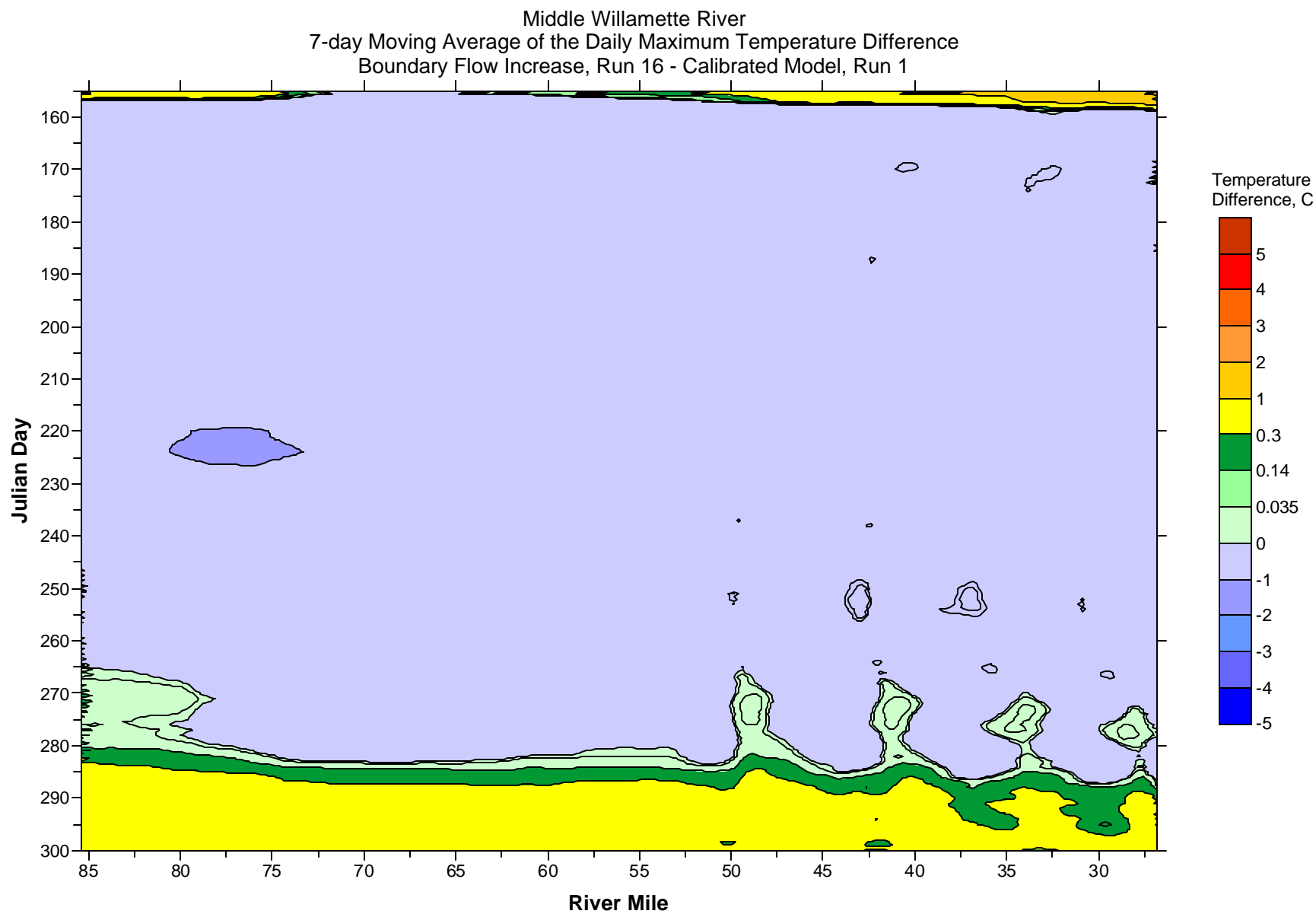


**Figure 892: Calibrated model vs. boundary flow increase (+ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River**

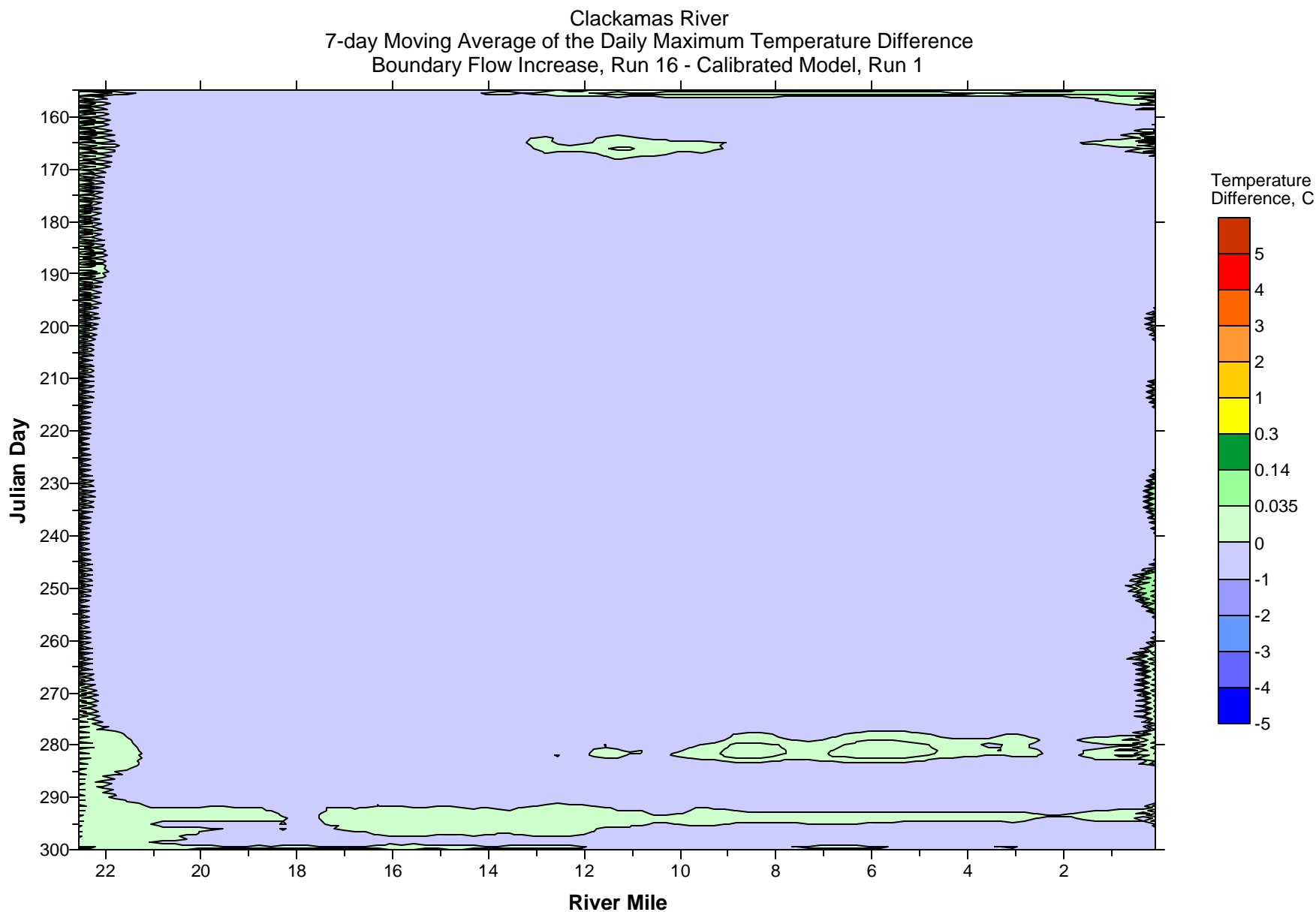


**Figure 893: Calibrated model vs. boundary flow increase (+ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**

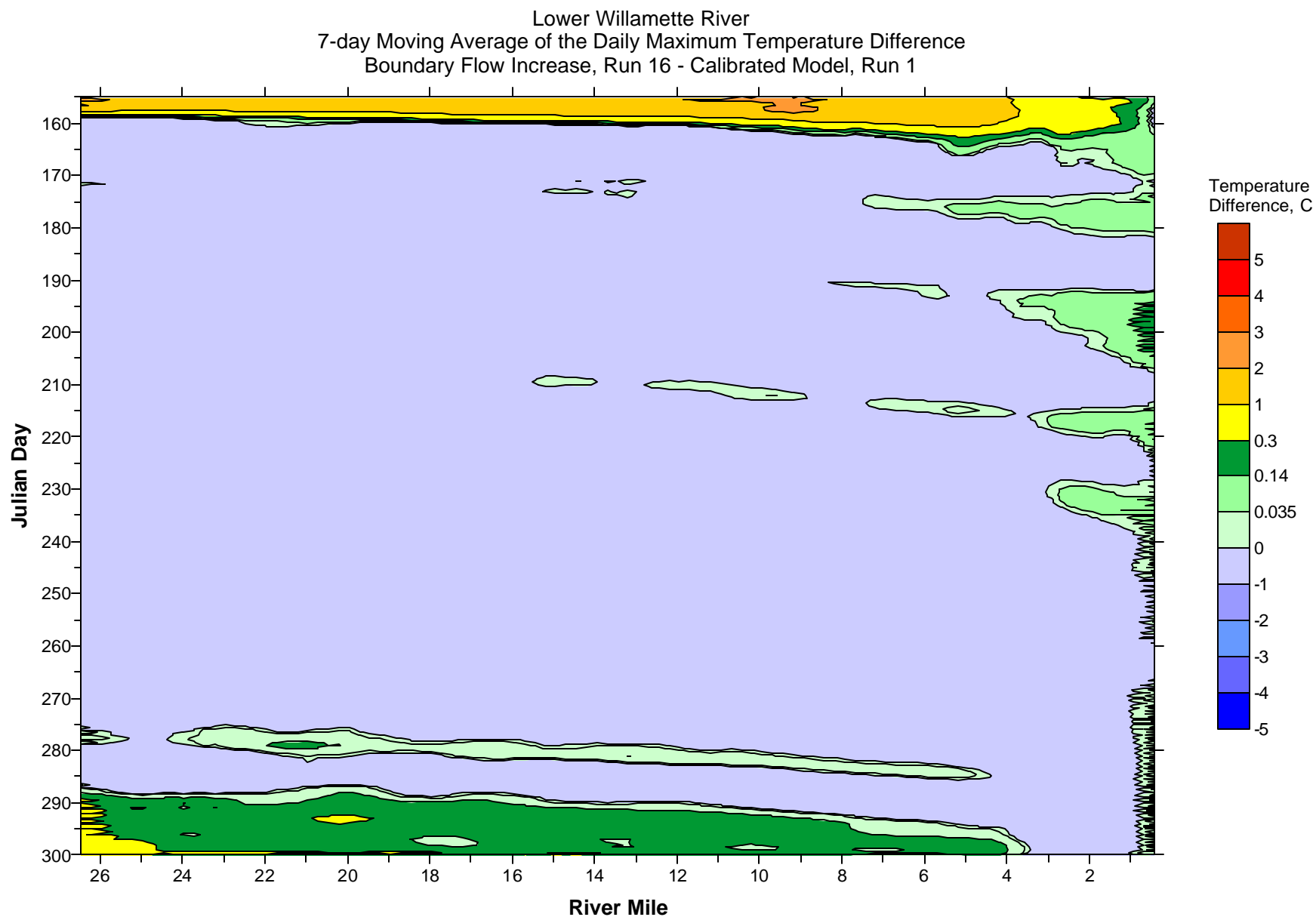




**Figure 894: Calibrated model vs. boundary flow increase (+ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**



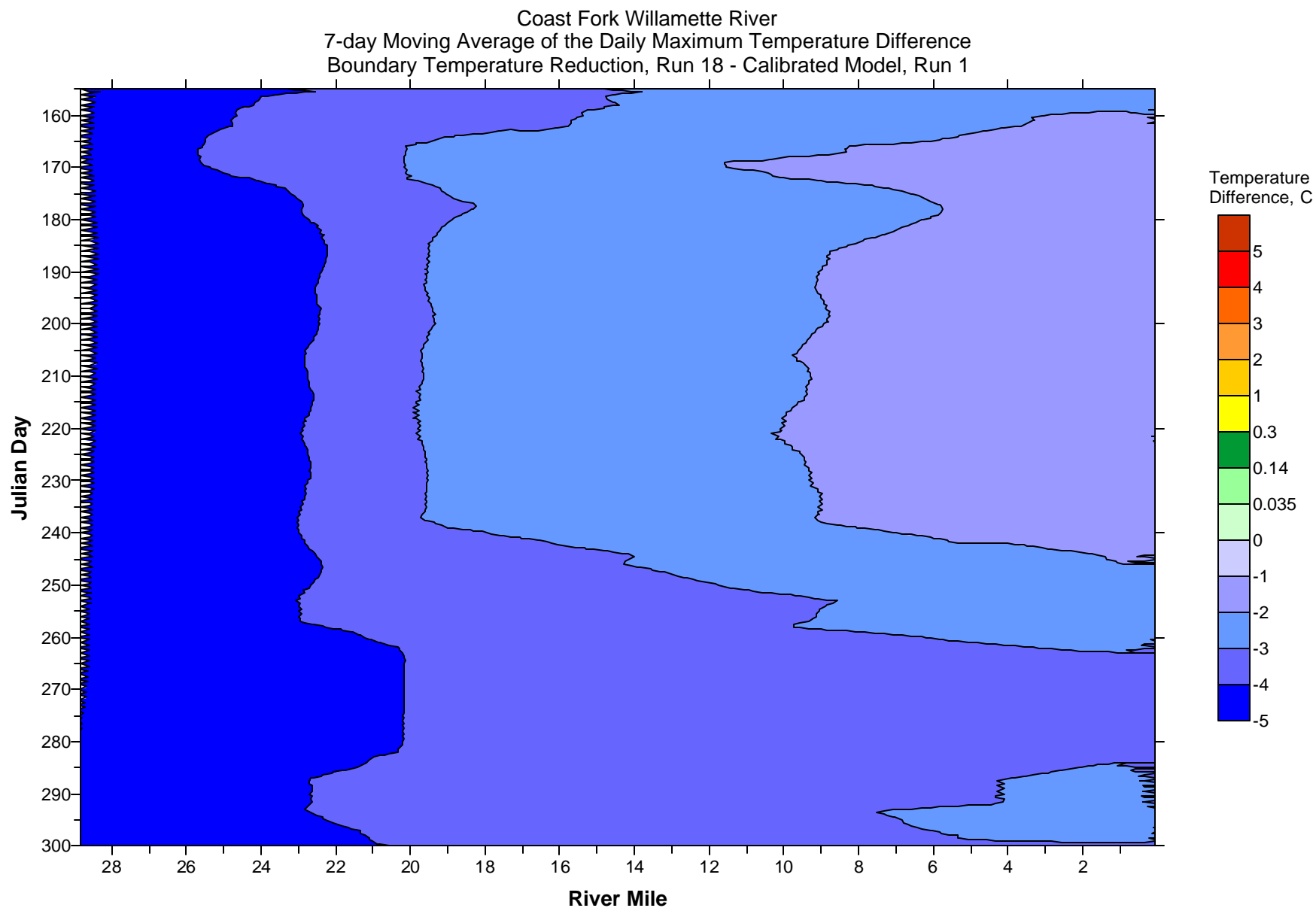
**Figure 895: Calibrated model vs. boundary flow increase (+ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River**



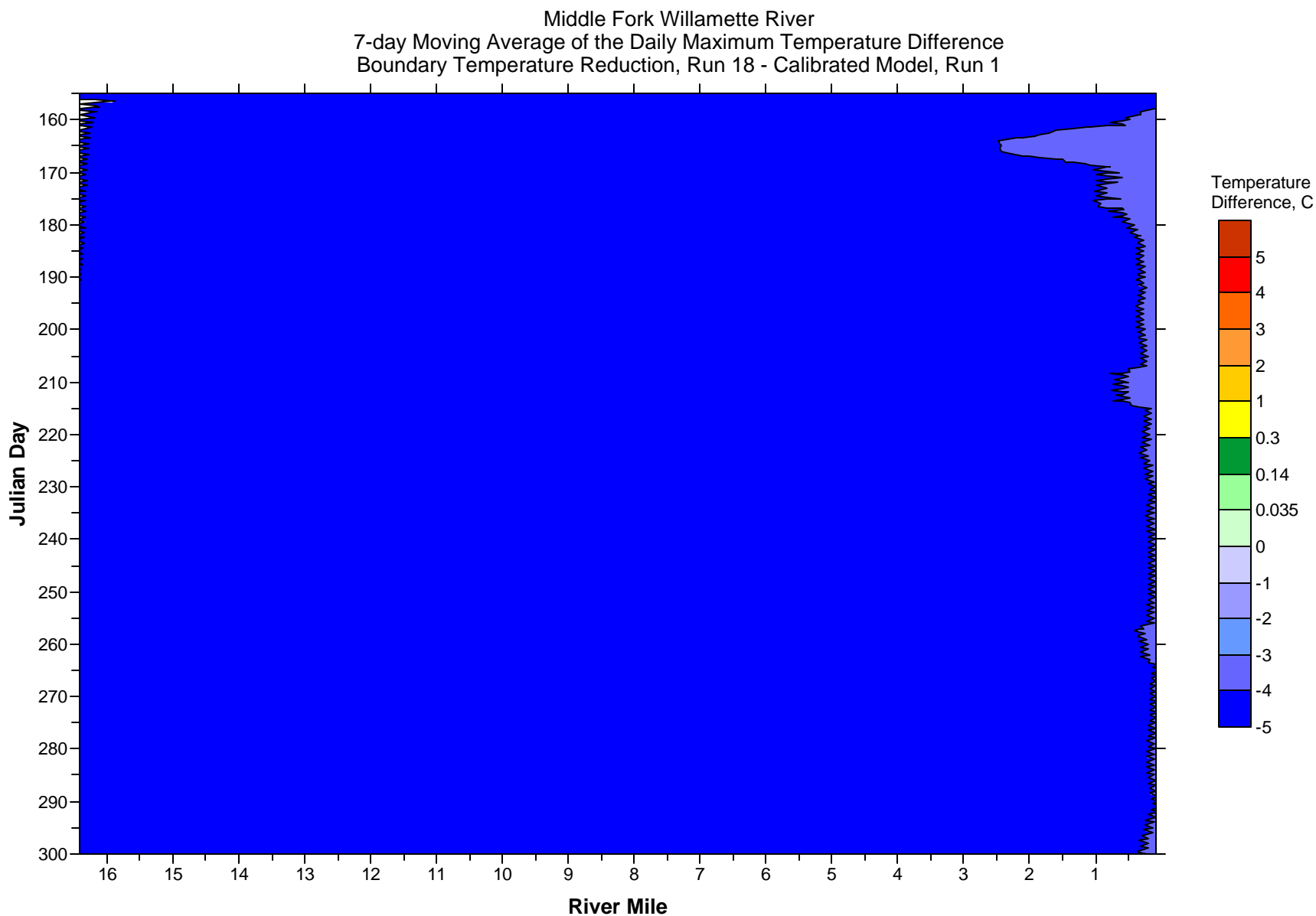
**Figure 896: Calibrated model vs. boundary flow increase (+ 20%) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

### ***Sensitivity to boundary temperature reduction***

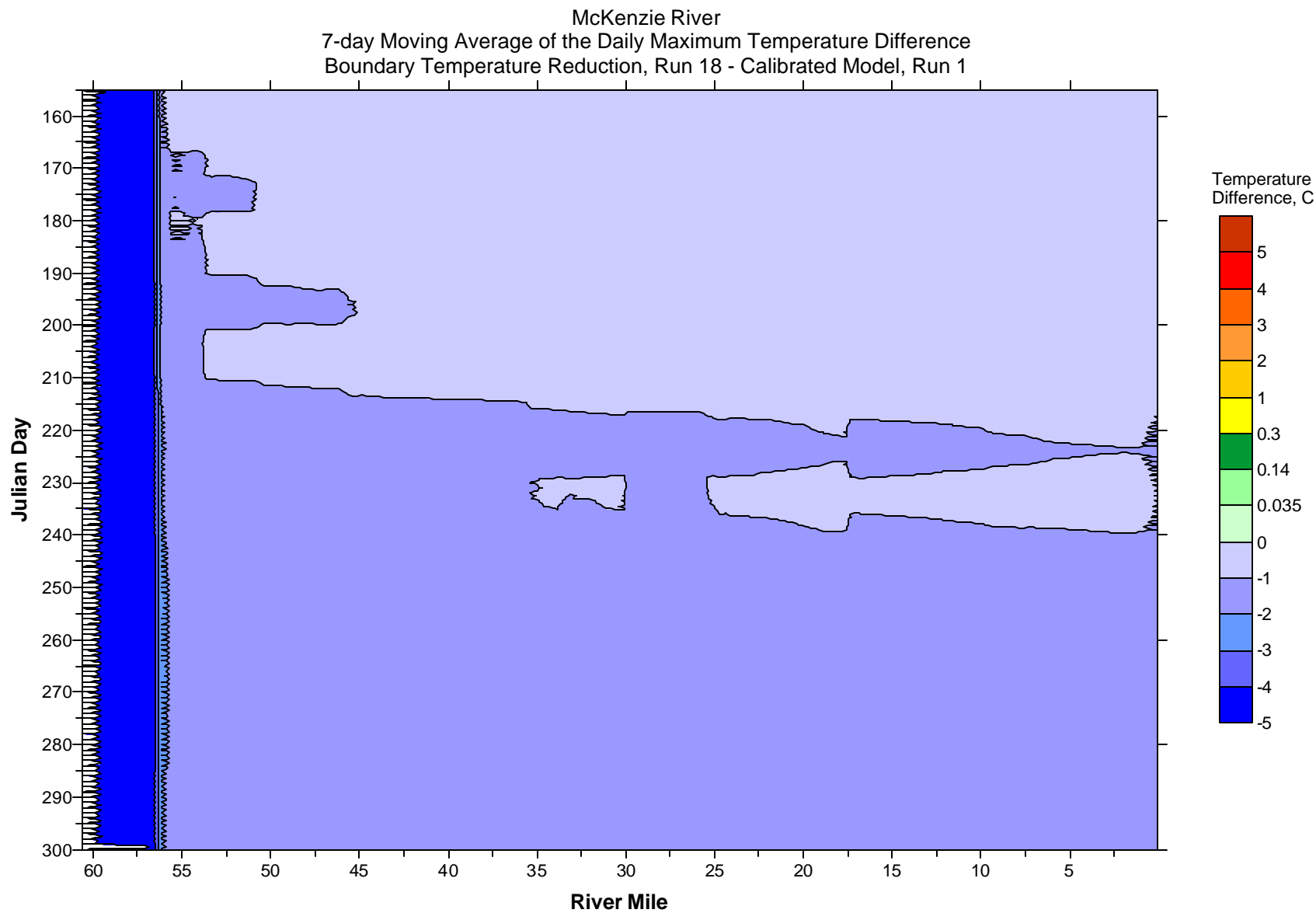
The sensitivity of the model to a 5 °C reduction in the upstream boundary temperature was examined by simulating the summer of 2001 and comparing it to the calibrated model. The difference between the seven-day moving average of the daily maximum temperature for each scenario was then taken and plotted as contour plot for each river reach modeled (ODEQ, 2003). The contour plots begin in the furthest upstream reaches of the watershed and move downstream.



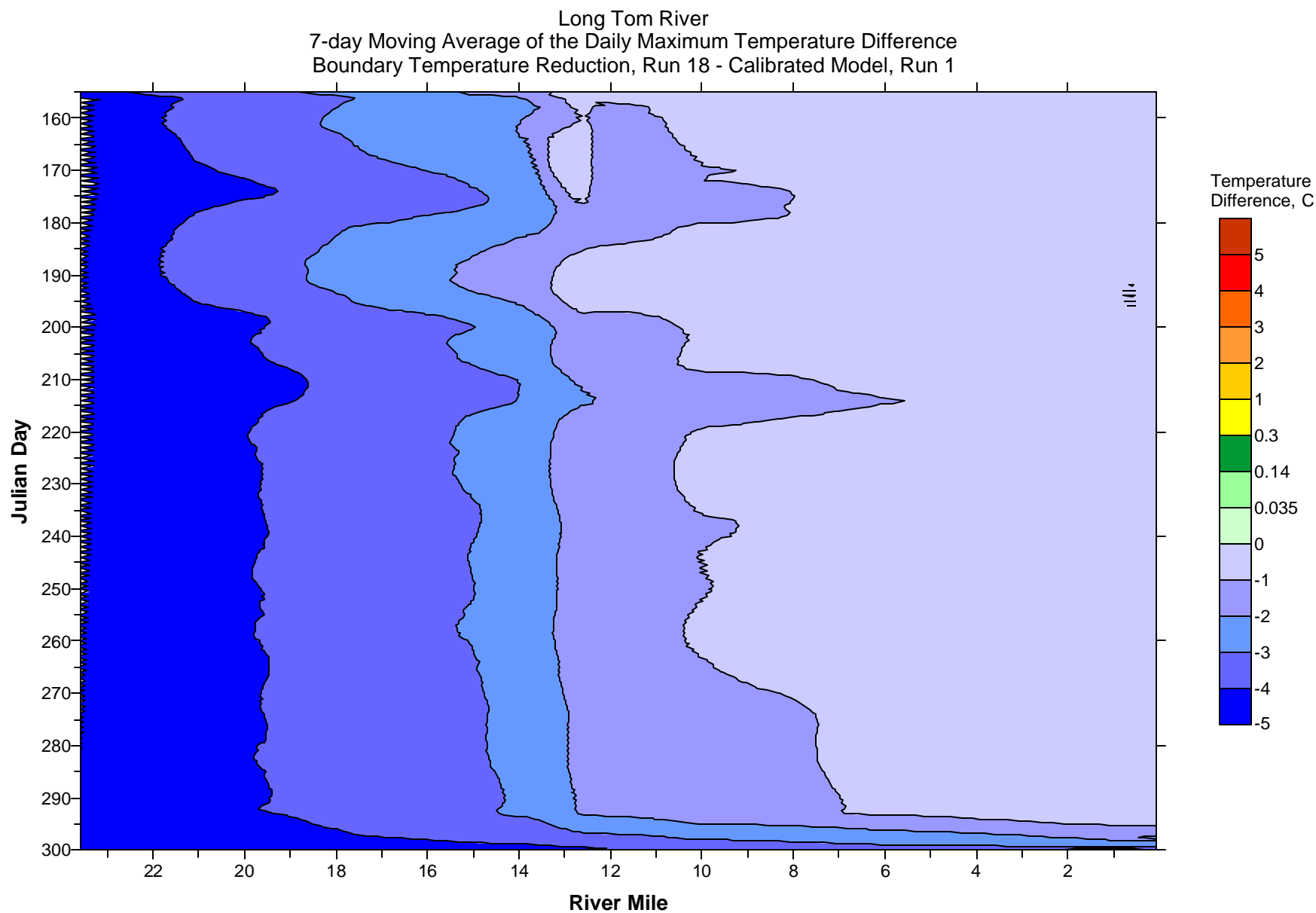
**Figure 897: Calibrated model vs. boundary temperature reduction ( $-5^{\circ}\text{C}$ ) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**



**Figure 898: Calibrated model vs. boundary temperature reduction (- 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**

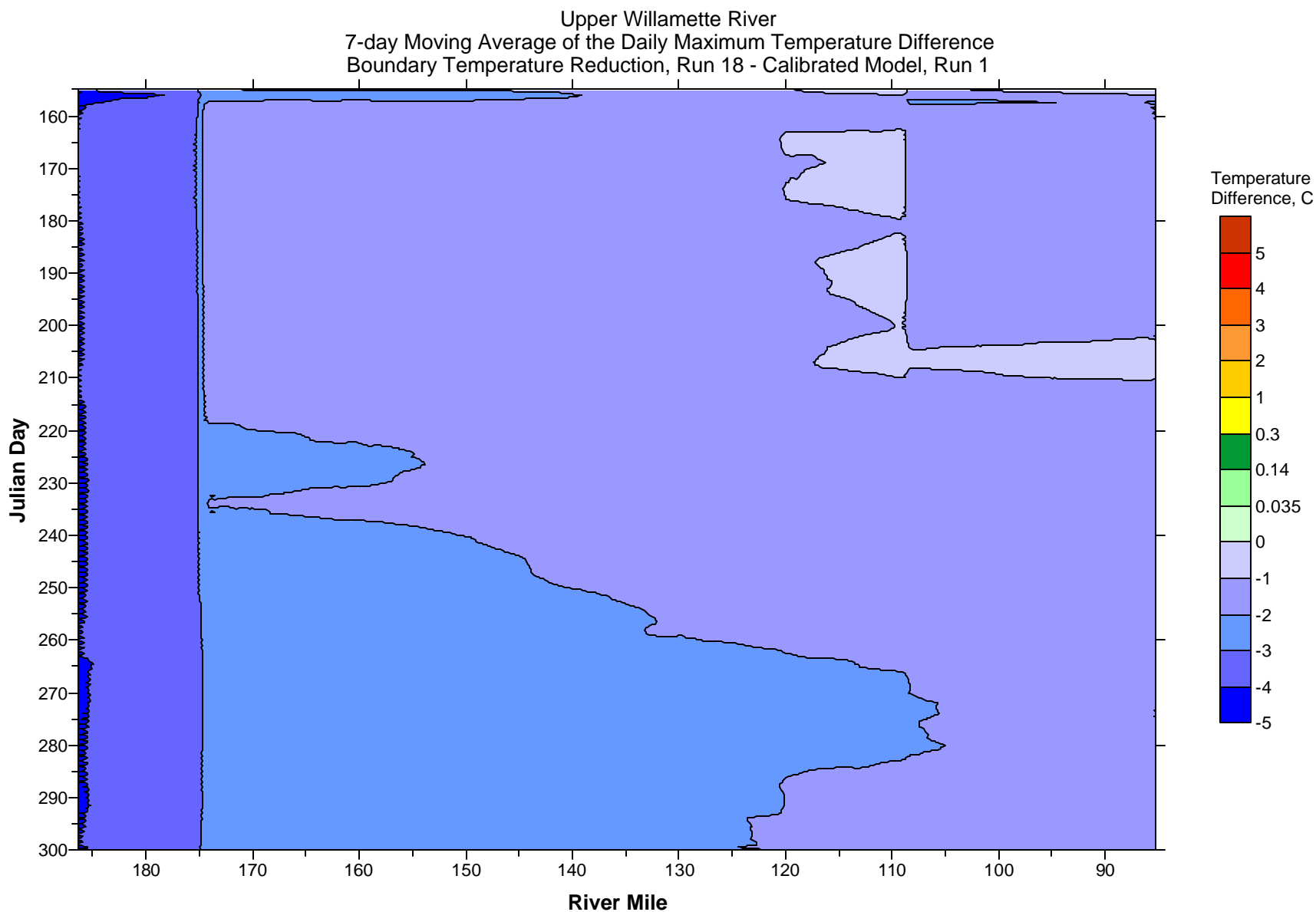


**Figure 899: Calibrated model vs. boundary temperature reduction (- 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River**

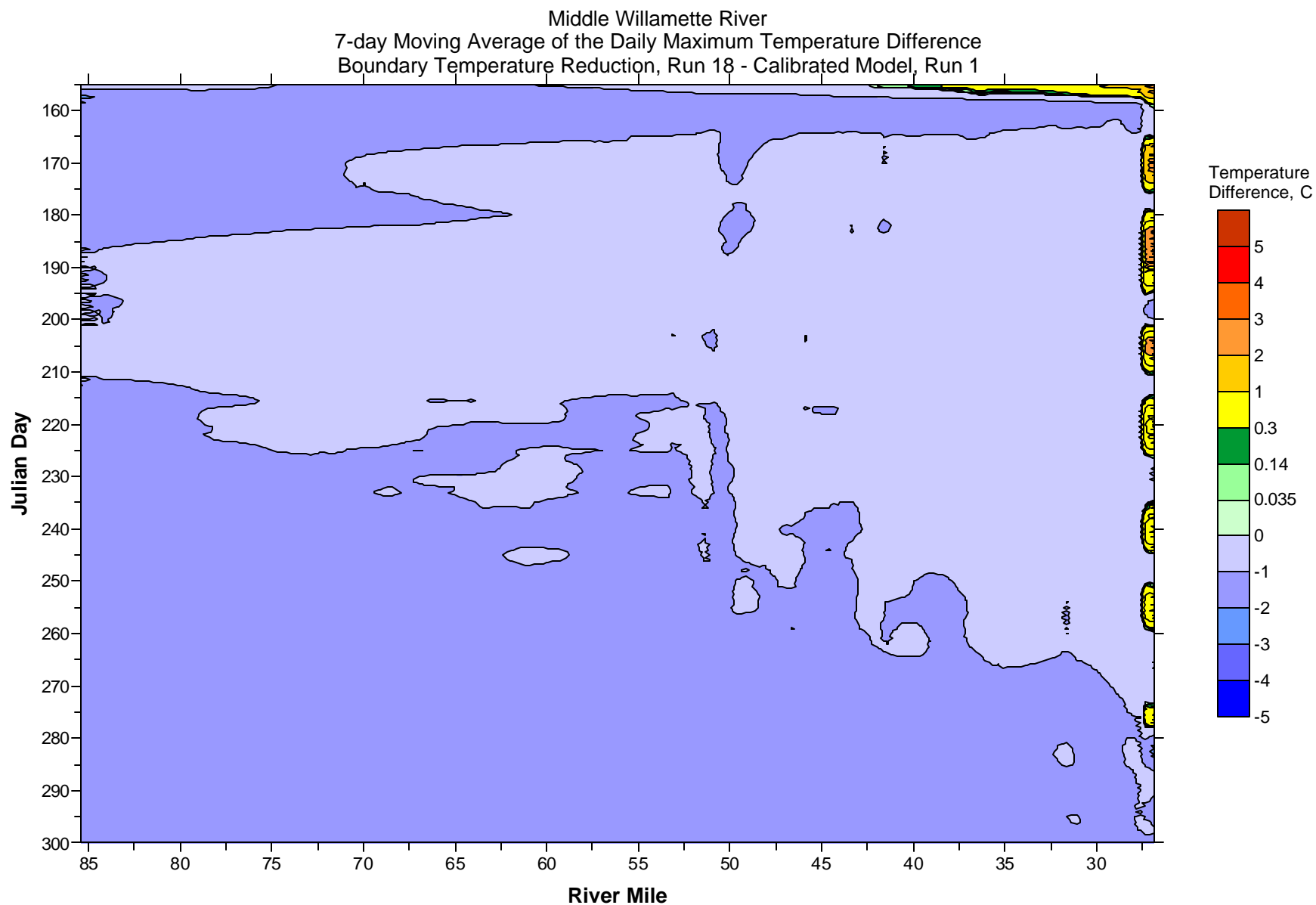


**Figure 900: Calibrated model vs. boundary temperature reduction (- 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**

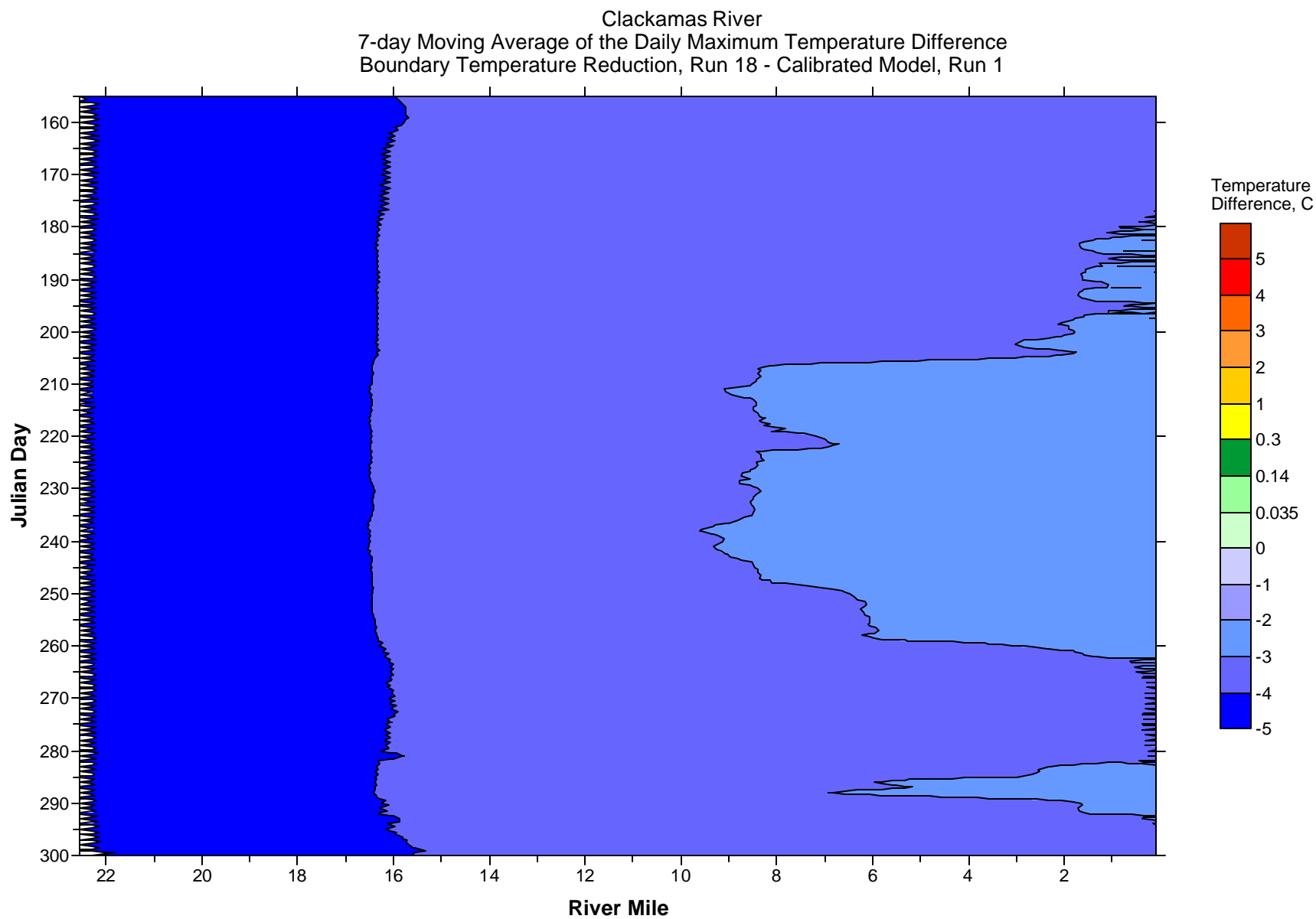




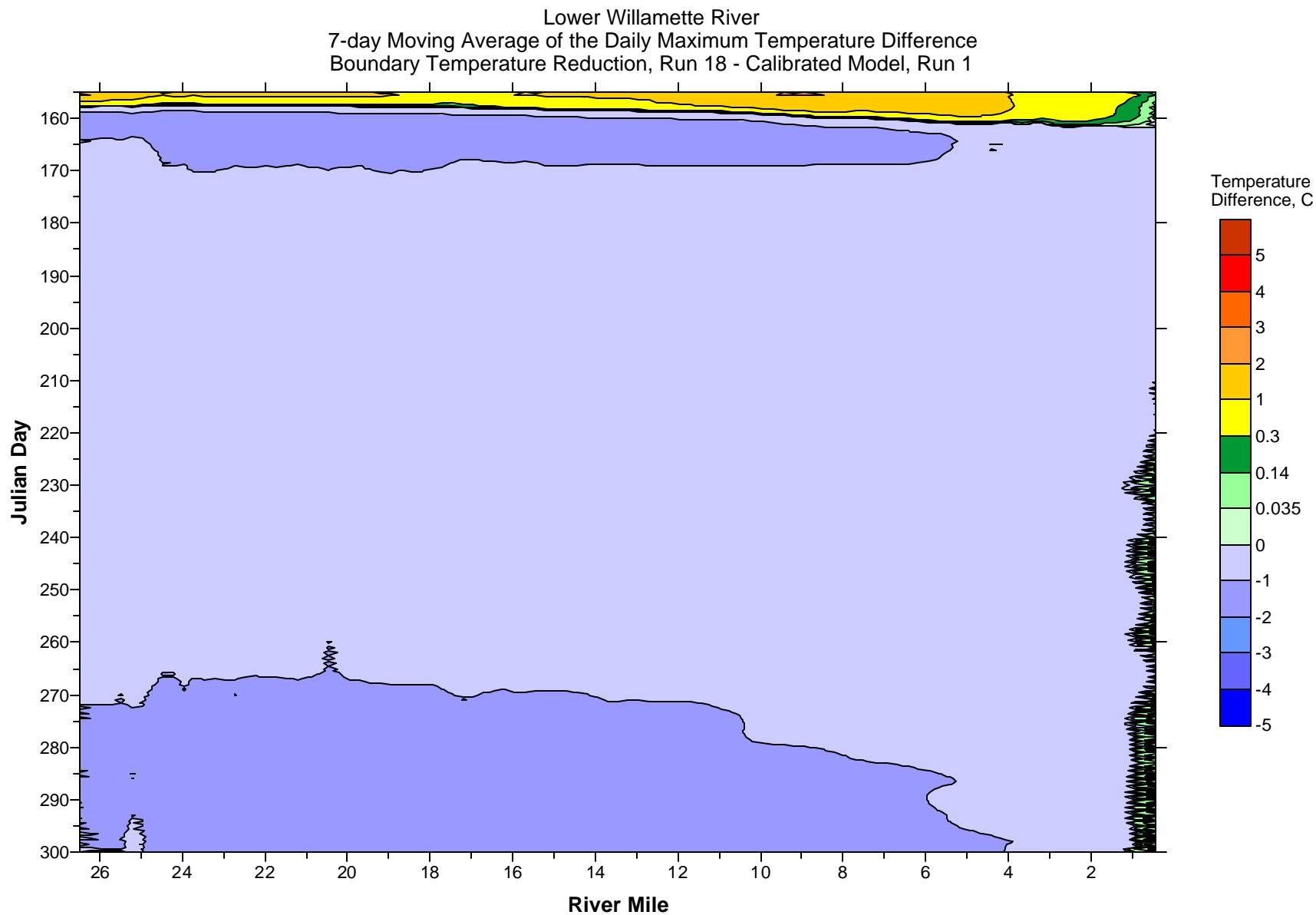
**Figure 901: Calibrated model vs. boundary temperature reduction (- 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 902: Calibrated model vs. boundary temperature reduction (- 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**



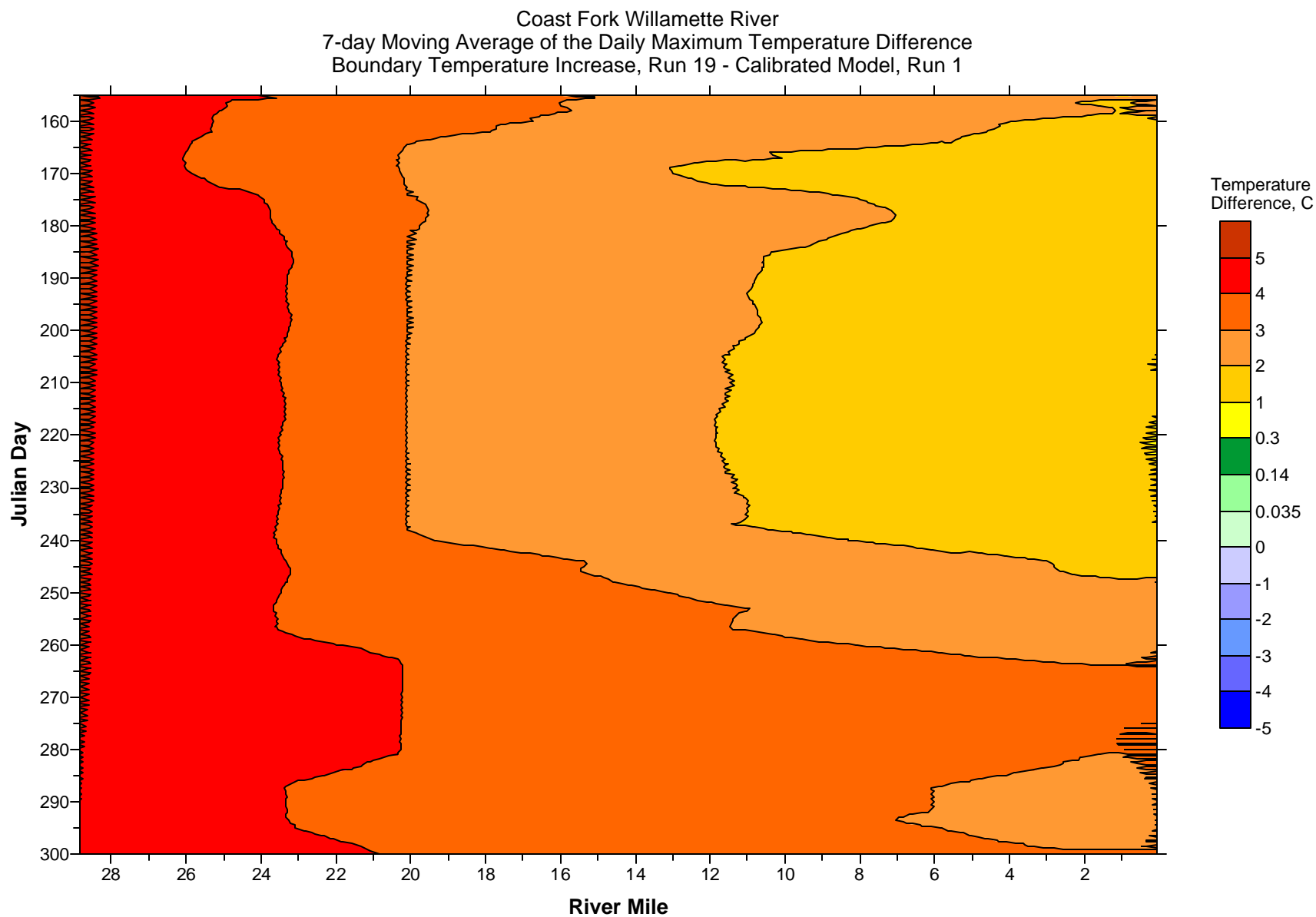
**Figure 903: Calibrated model vs. boundary temperature reduction (- 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River**



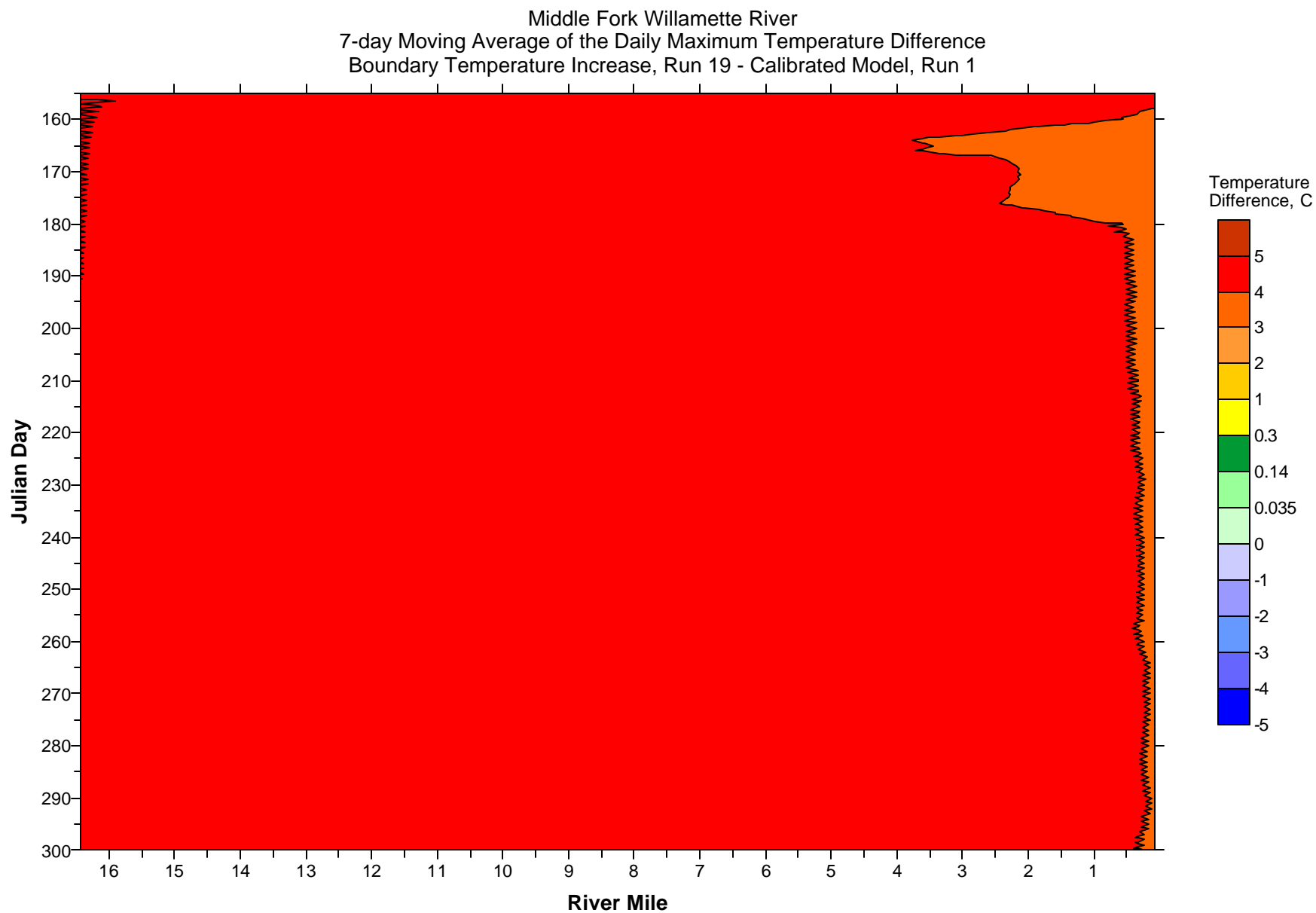
**Figure 904: Calibrated model vs. boundary temperature reduction (- 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

### ***Sensitivity to boundary temperature increase***

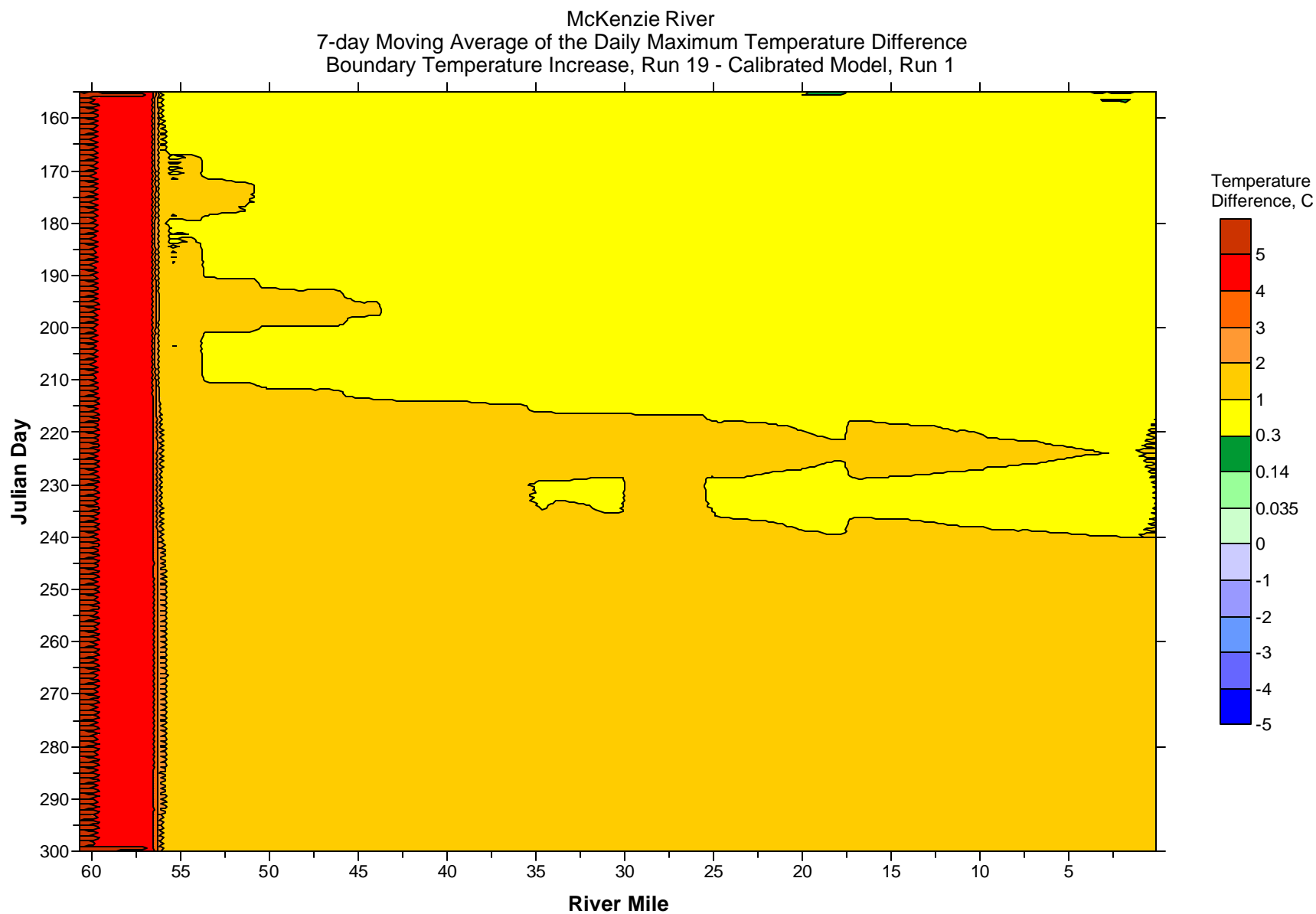
The sensitivity of the model to a 5 °C increase in the upstream boundary temperature was examined by simulating the summer of 2001 and comparing it to the calibrated model. The difference between the seven-day moving average of the daily maximum temperature for each scenario was then taken and plotted as contour plot for each river reach modeled (ODEQ, 2003). The contour plots begin in the furthest upstream reaches of the watershed and move downstream.



**Figure 905: Calibrated model vs. boundary temperature increase (+ 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**

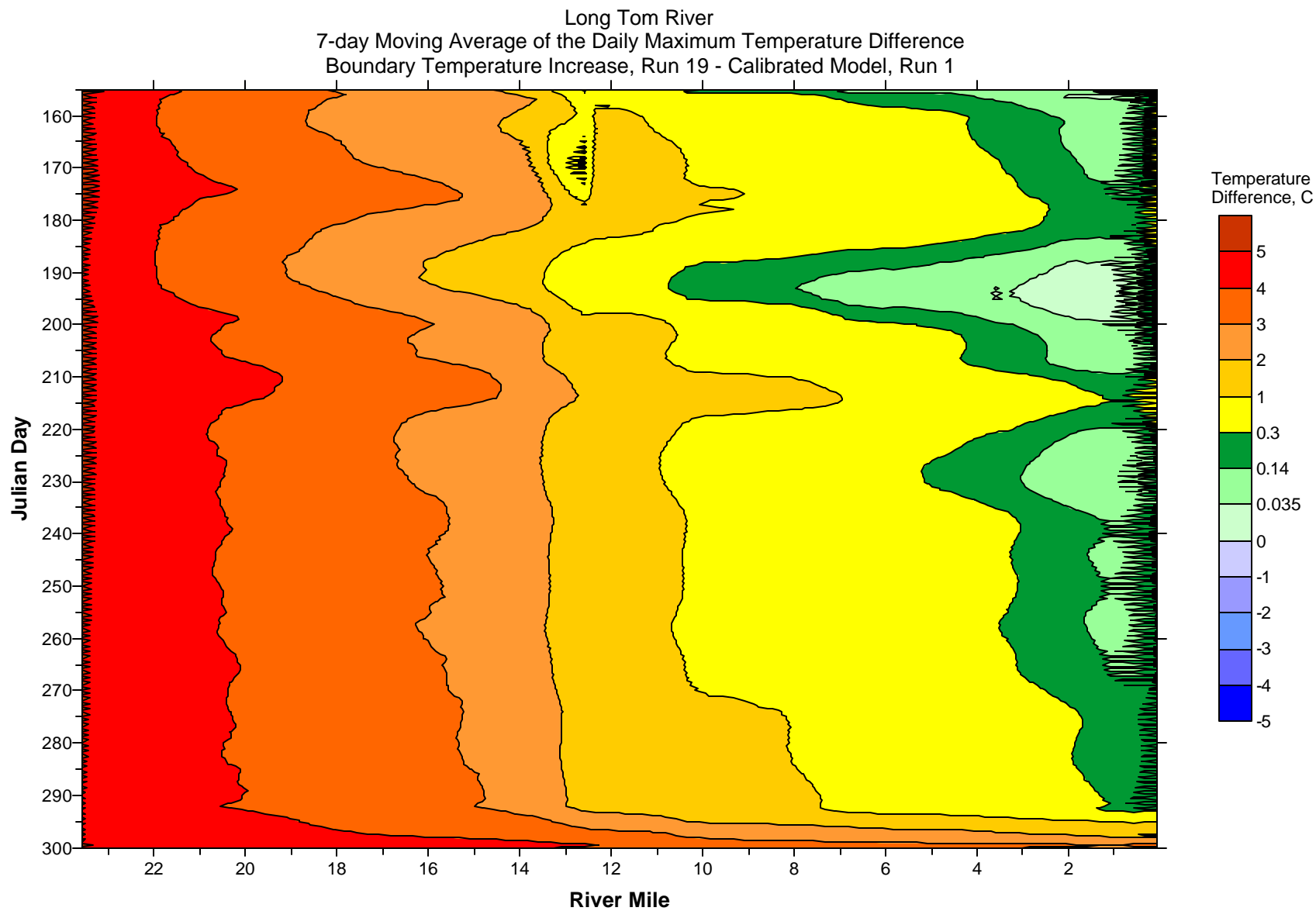


**Figure 906: Calibrated model vs. boundary temperature increase (+ 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**

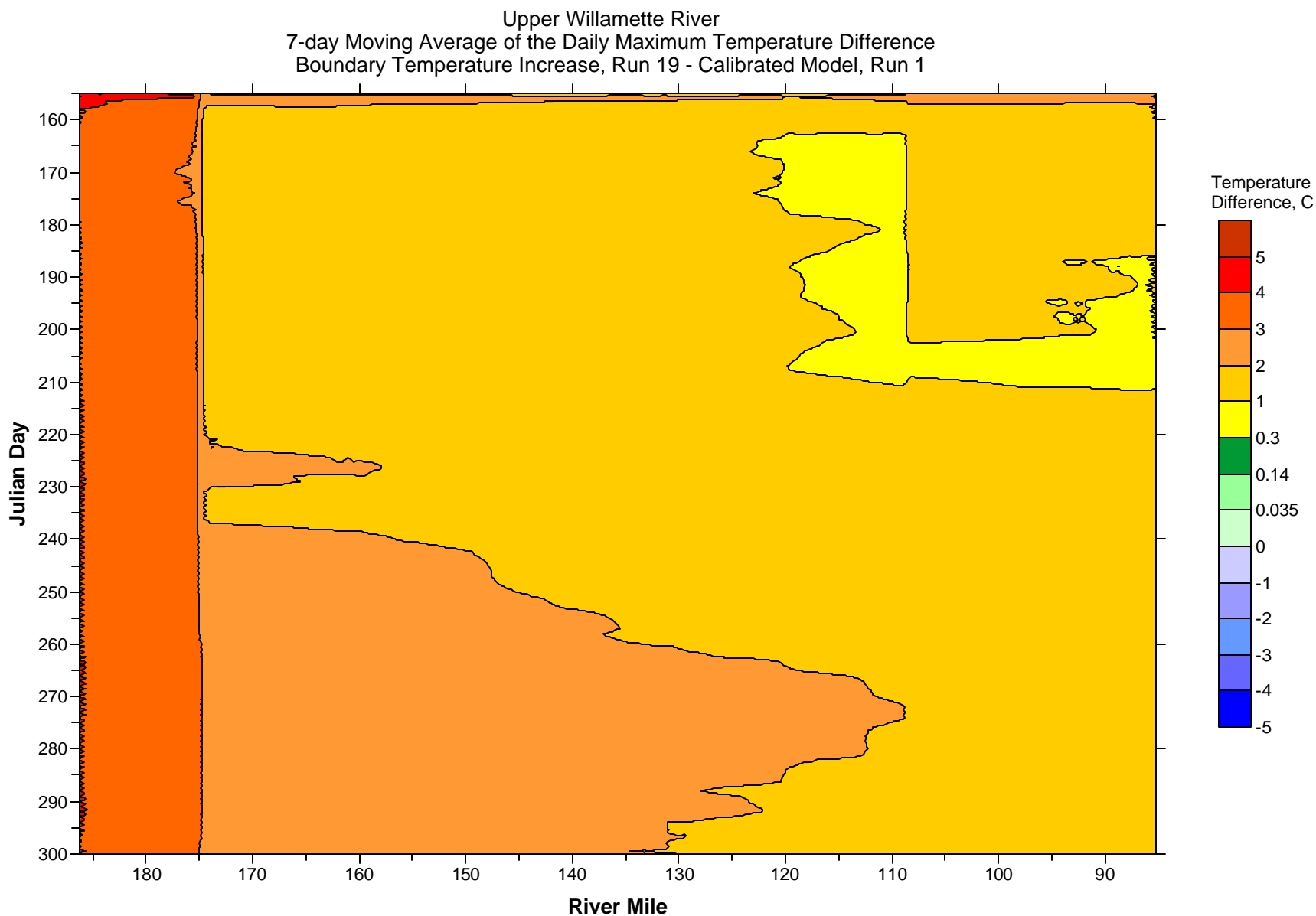


**Figure 907: Calibrated model vs. boundary temperature increase (+ 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River**

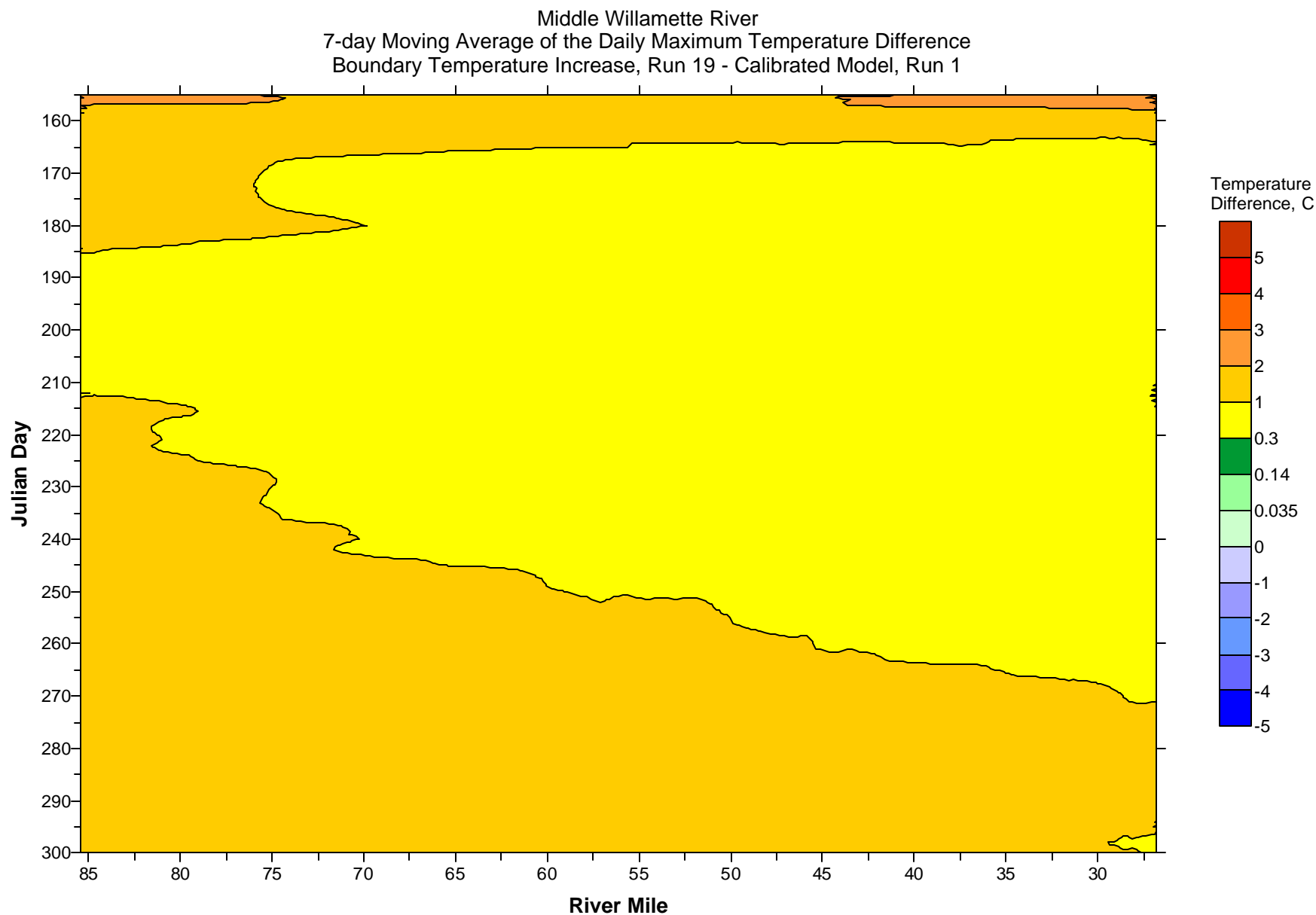




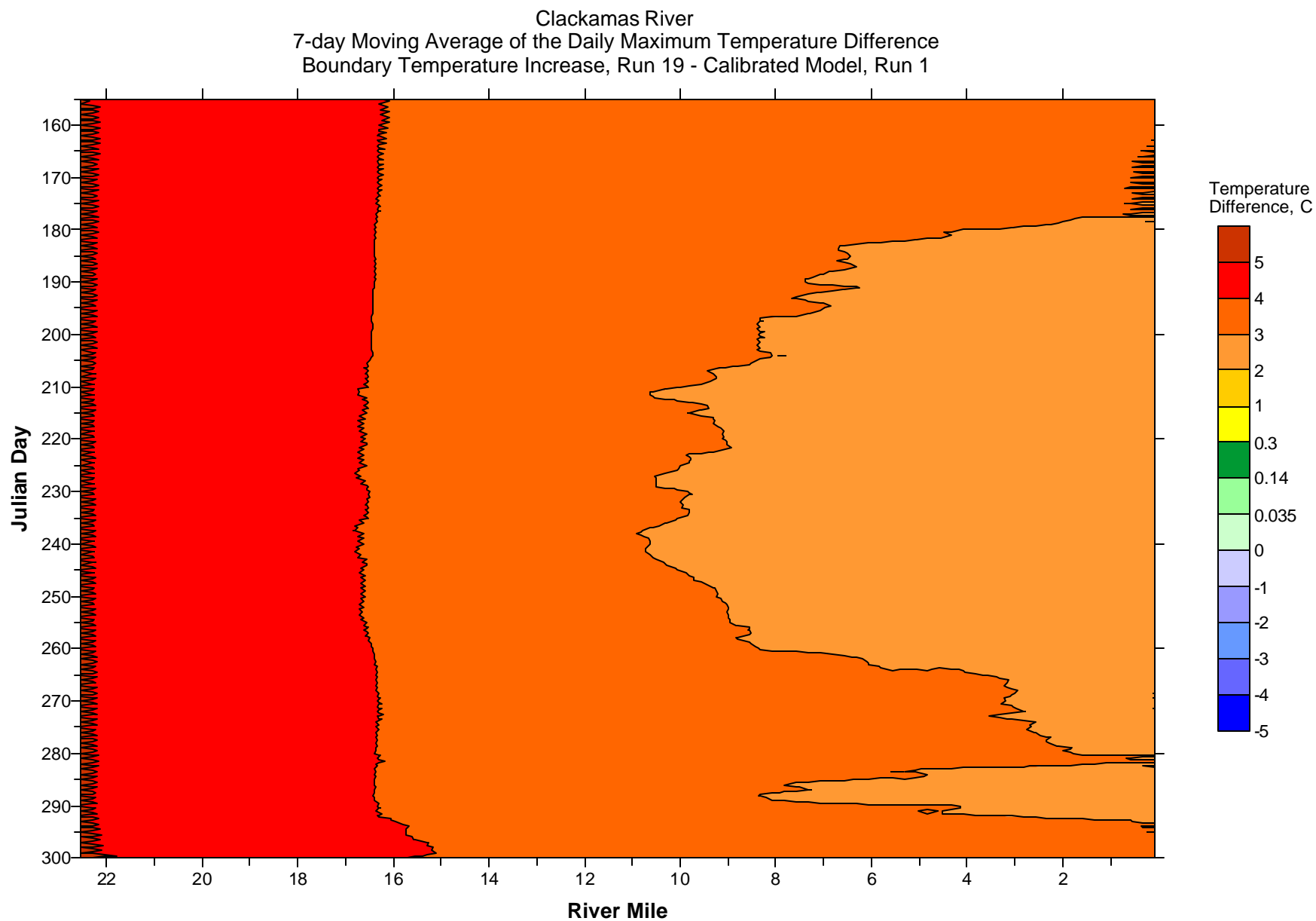
**Figure 908: Calibrated model vs. boundary temperature increase (+ 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River**



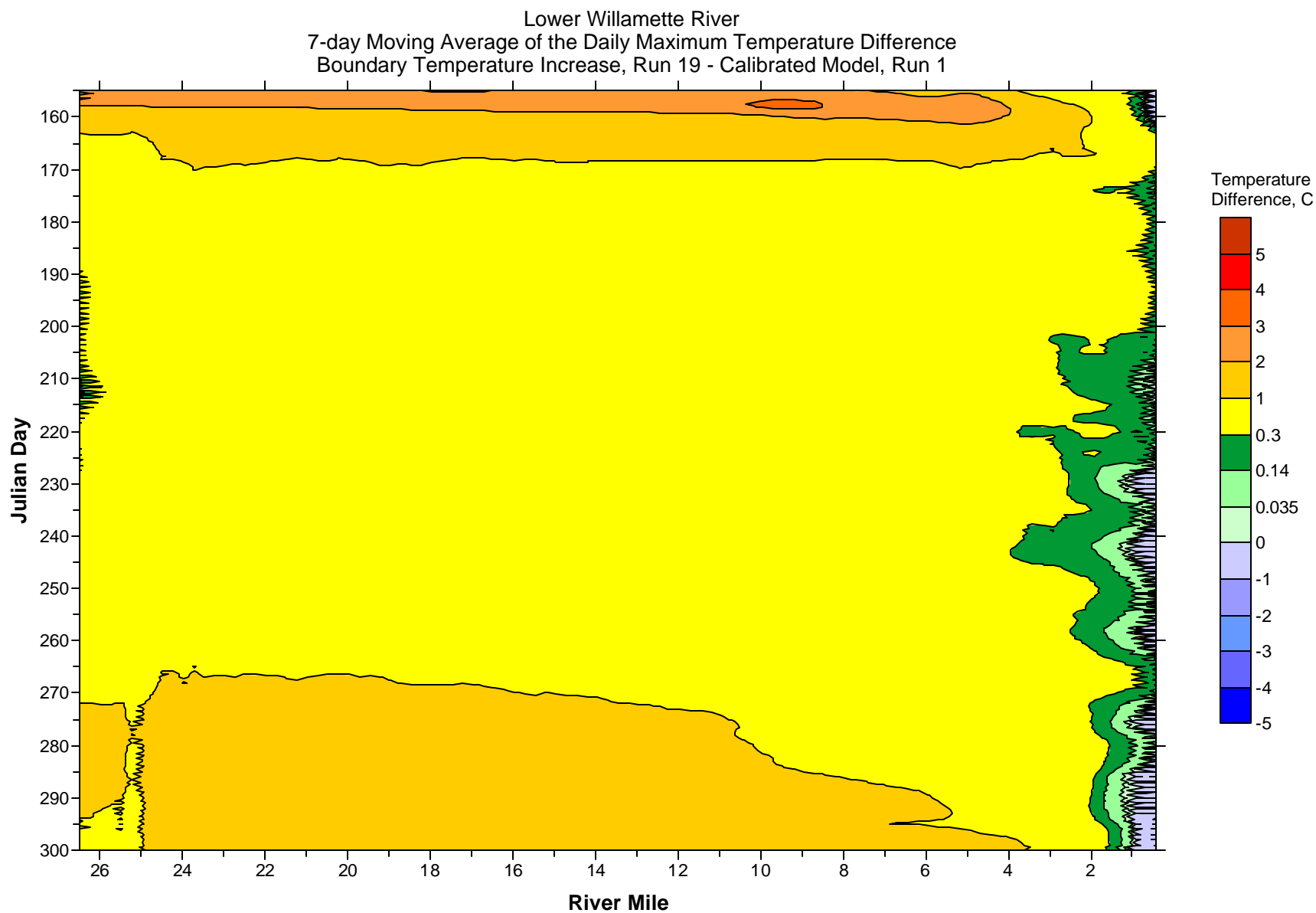
**Figure 909: Calibrated model vs. boundary temperature increase (+ 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 910: Calibrated model vs. boundary temperature increase (+ 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**



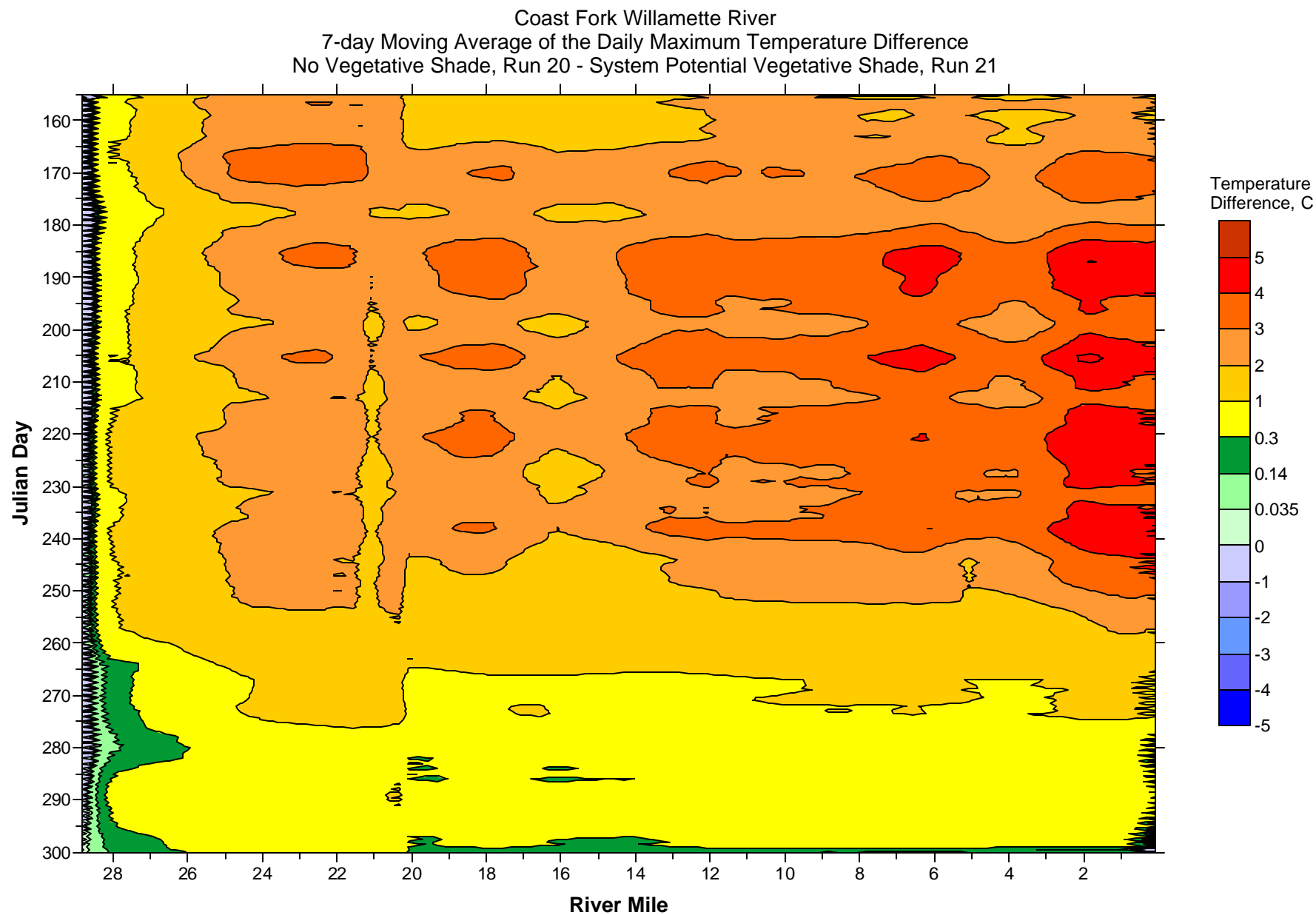
**Figure 911: Calibrated model vs. boundary temperature increase (+ 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River**



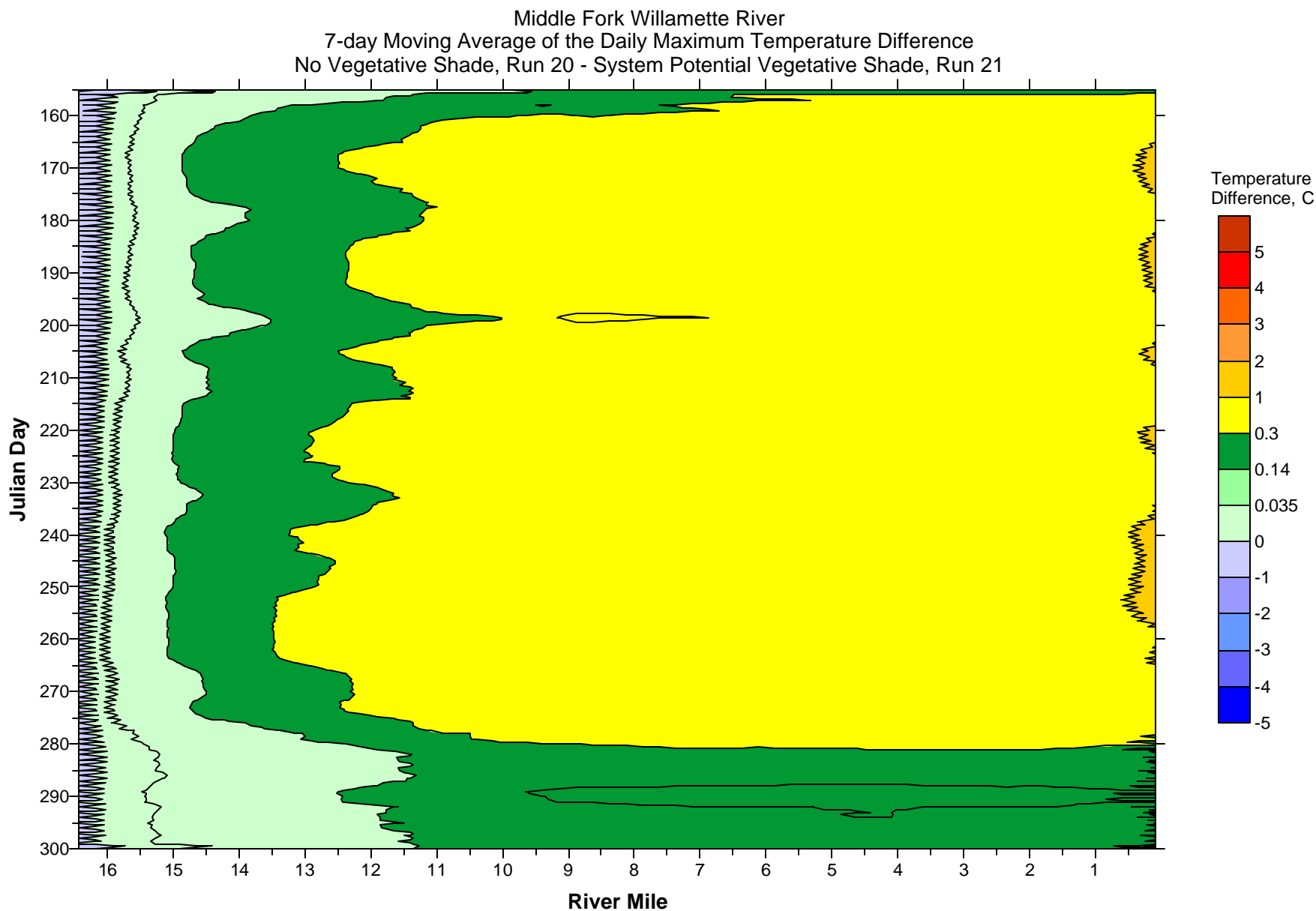
**Figure 912: Calibrated model vs. boundary temperature increase (+ 5 oC) contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

### ***Sensitivity to vegetative shade***

The sensitivity of the model to the varying vegetative shade was examined by simulating the summer of 2001 with no vegetative shade and System Potential vegetative shade. The difference between the seven-day moving average of the daily maximum temperature for each scenario was then taken and plotted as contour plot for each river reach modeled (ODEQ, 2003). The contour plots begin in the furthest upstream reaches of the watershed and move downstream.

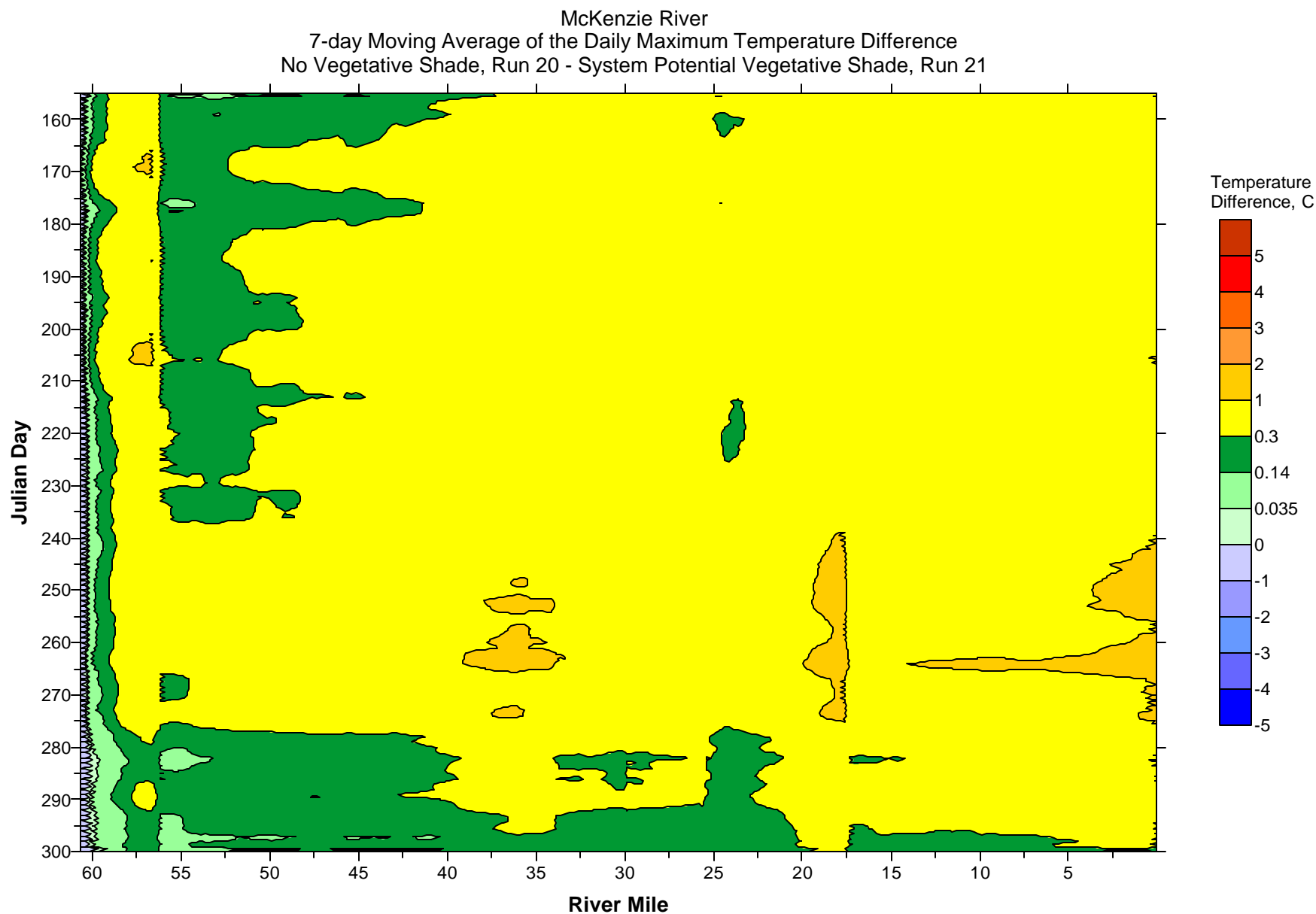


**Figure 913: No vegetative shade vs. System Potential vegetative shade contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**



**Figure 914: No vegetative shade vs. System Potential vegetative shade contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**





**Figure 915: No vegetative shade vs. System Potential vegetative shade contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River**

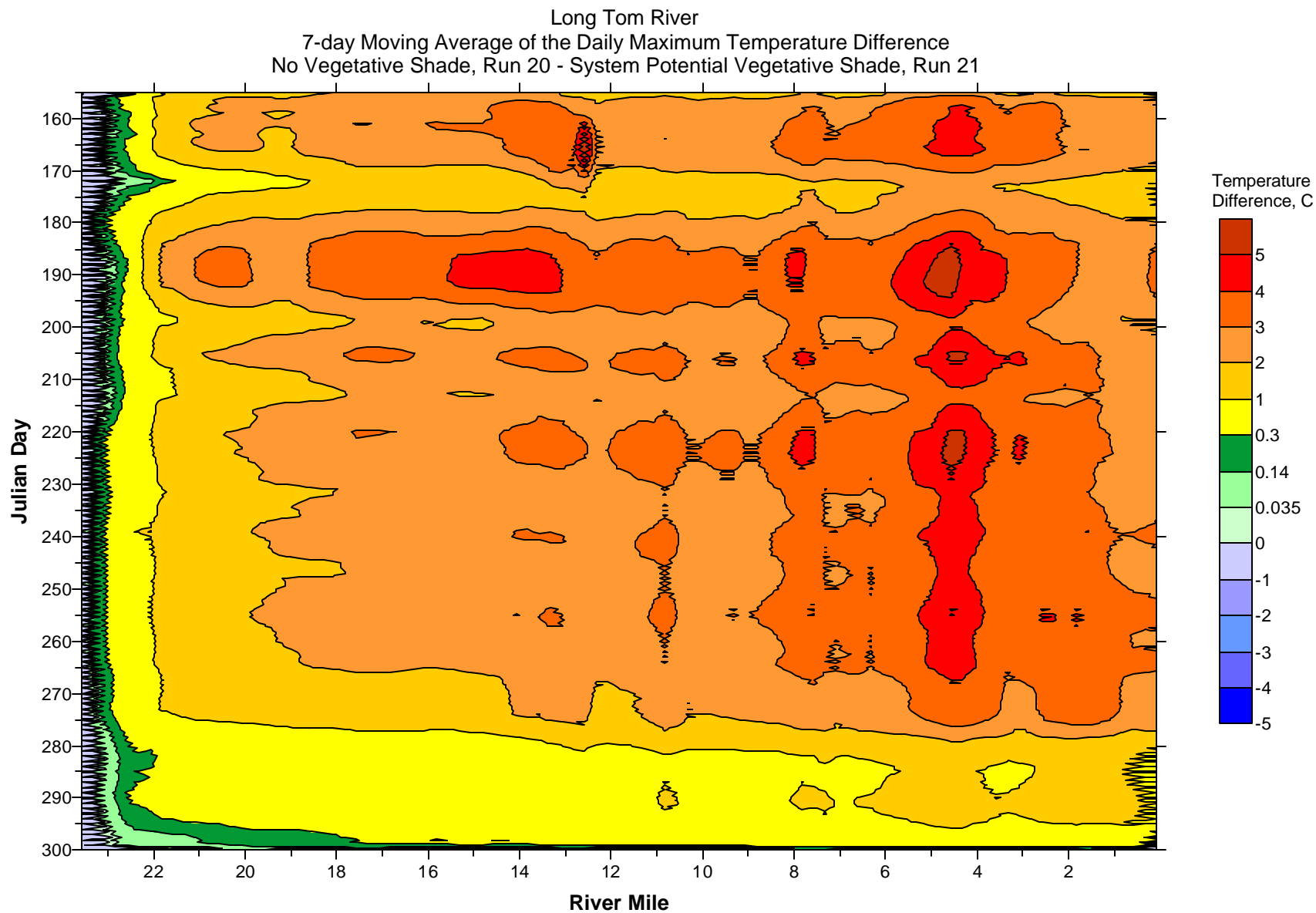
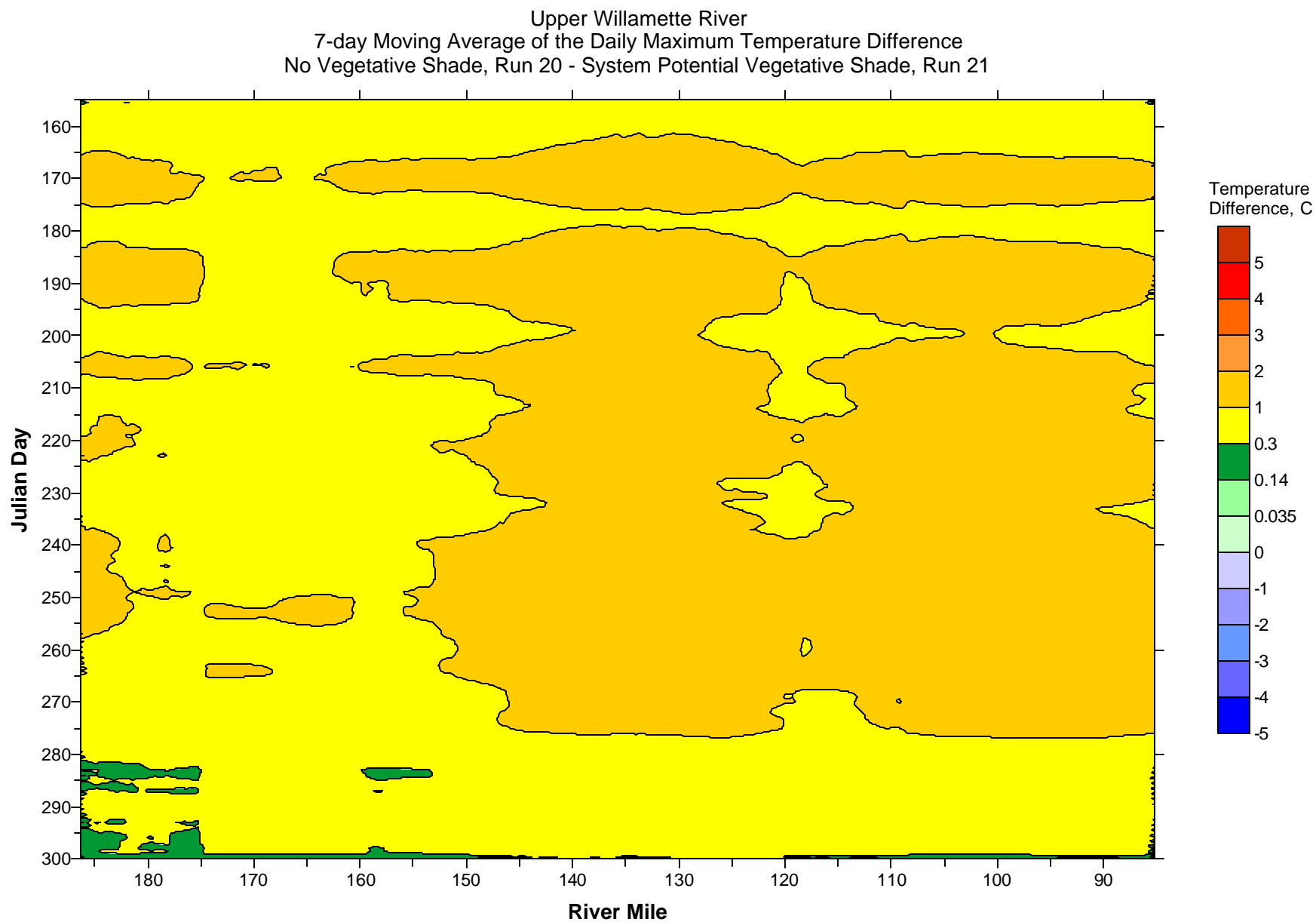
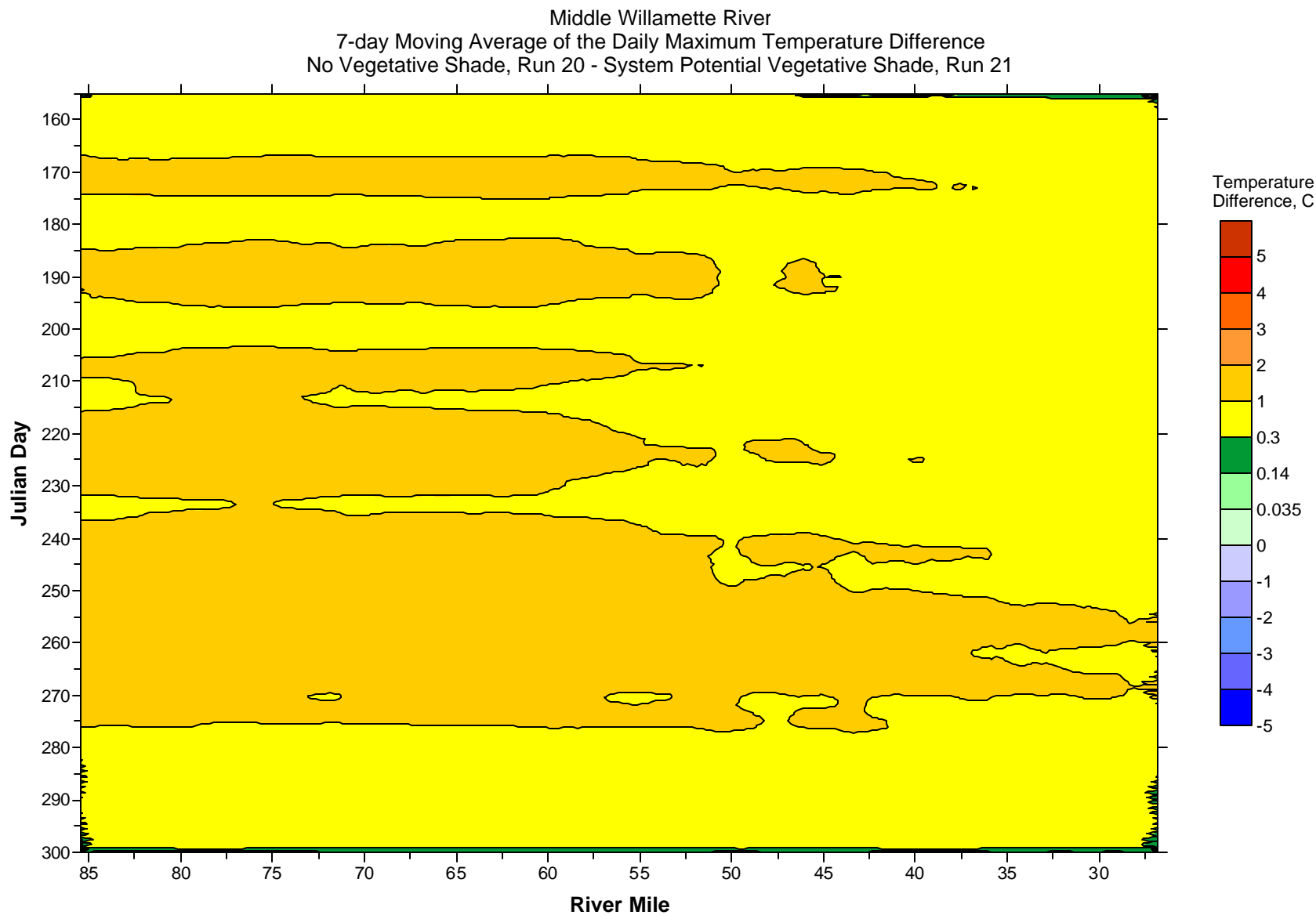


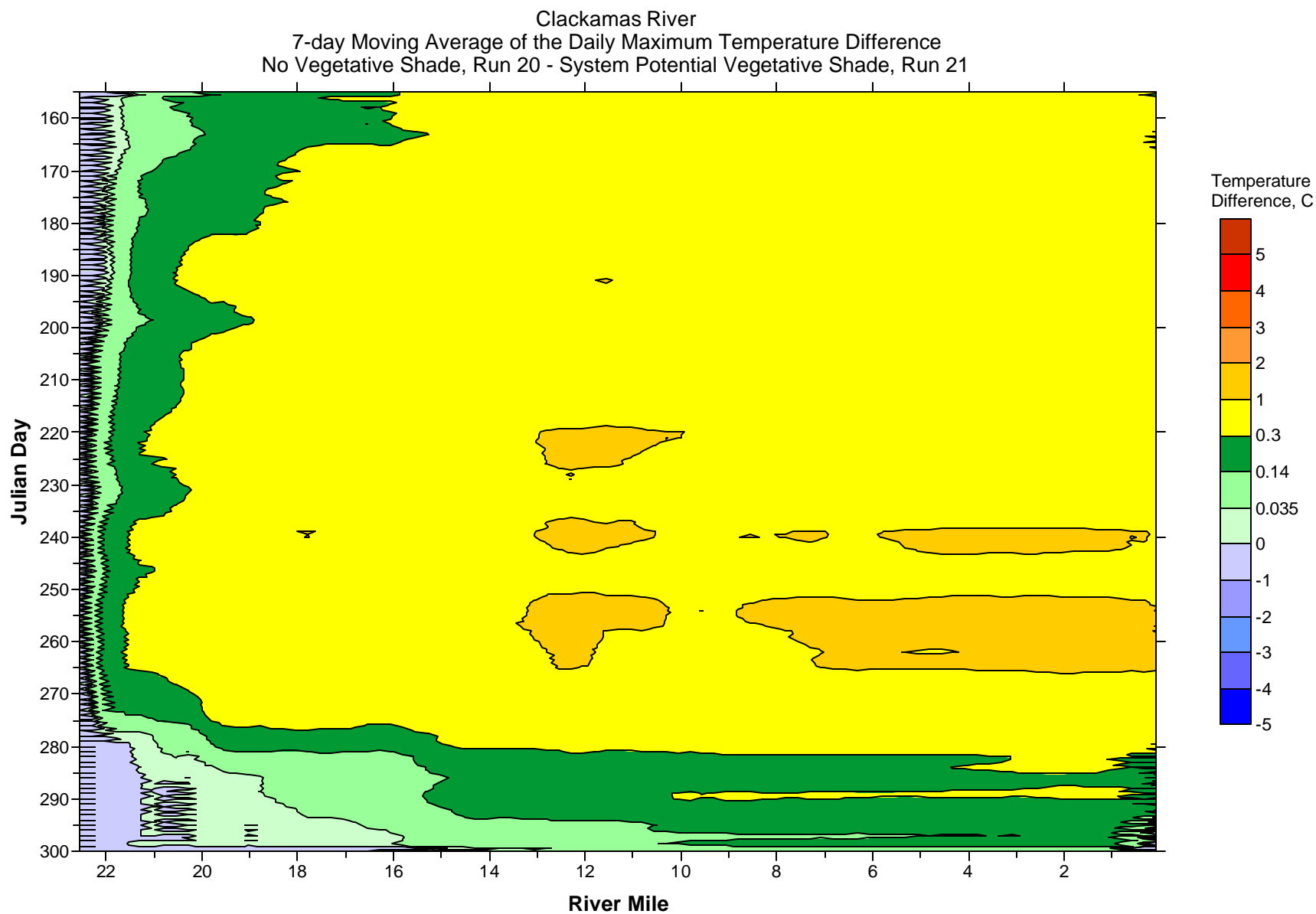
Figure 916: No vegetative shade vs. System Potential vegetative shade contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River



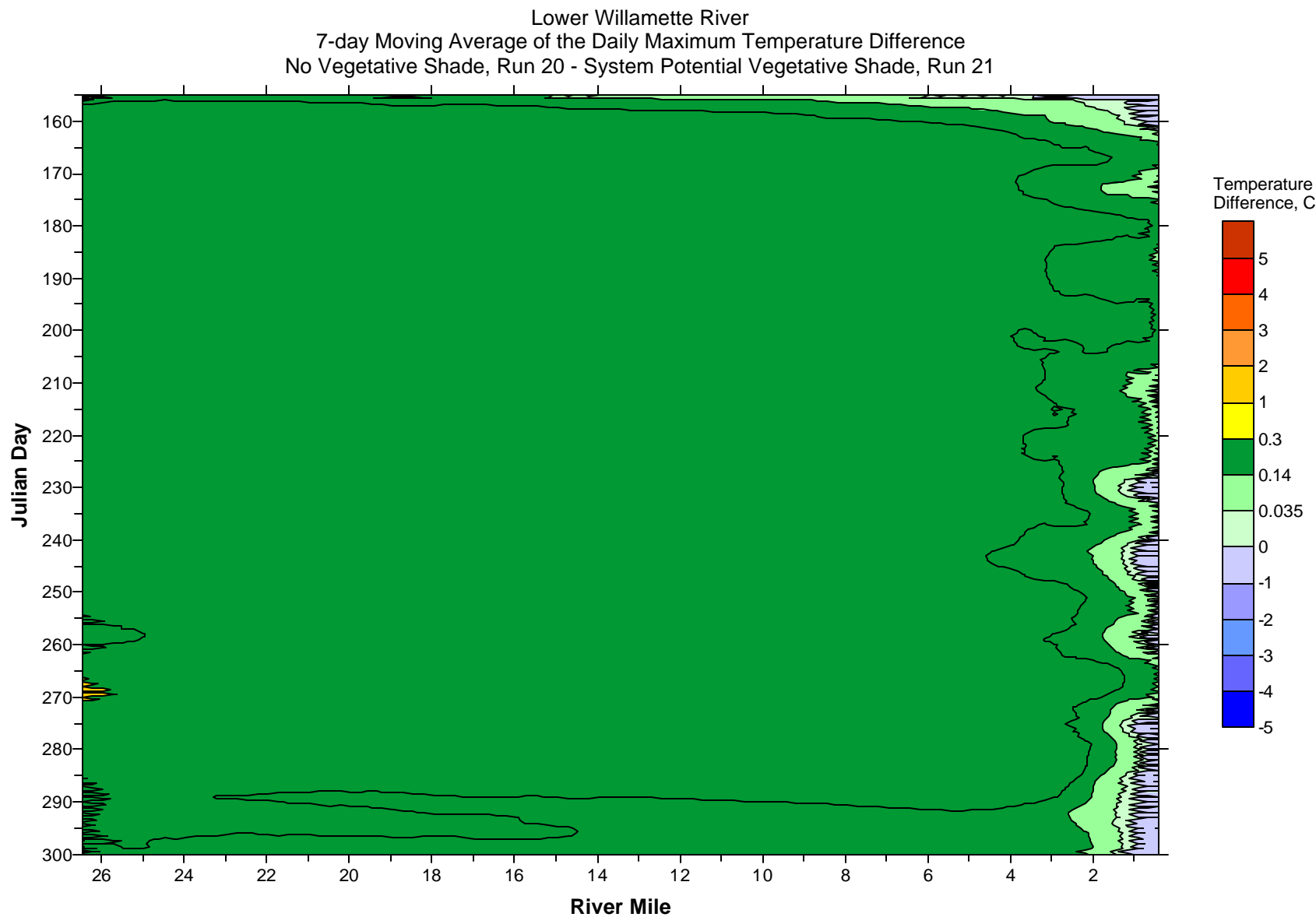
**Figure 917: No vegetative shade vs. System Potential vegetative shade contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 918: No vegetative shade vs. System Potential vegetative shade contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**



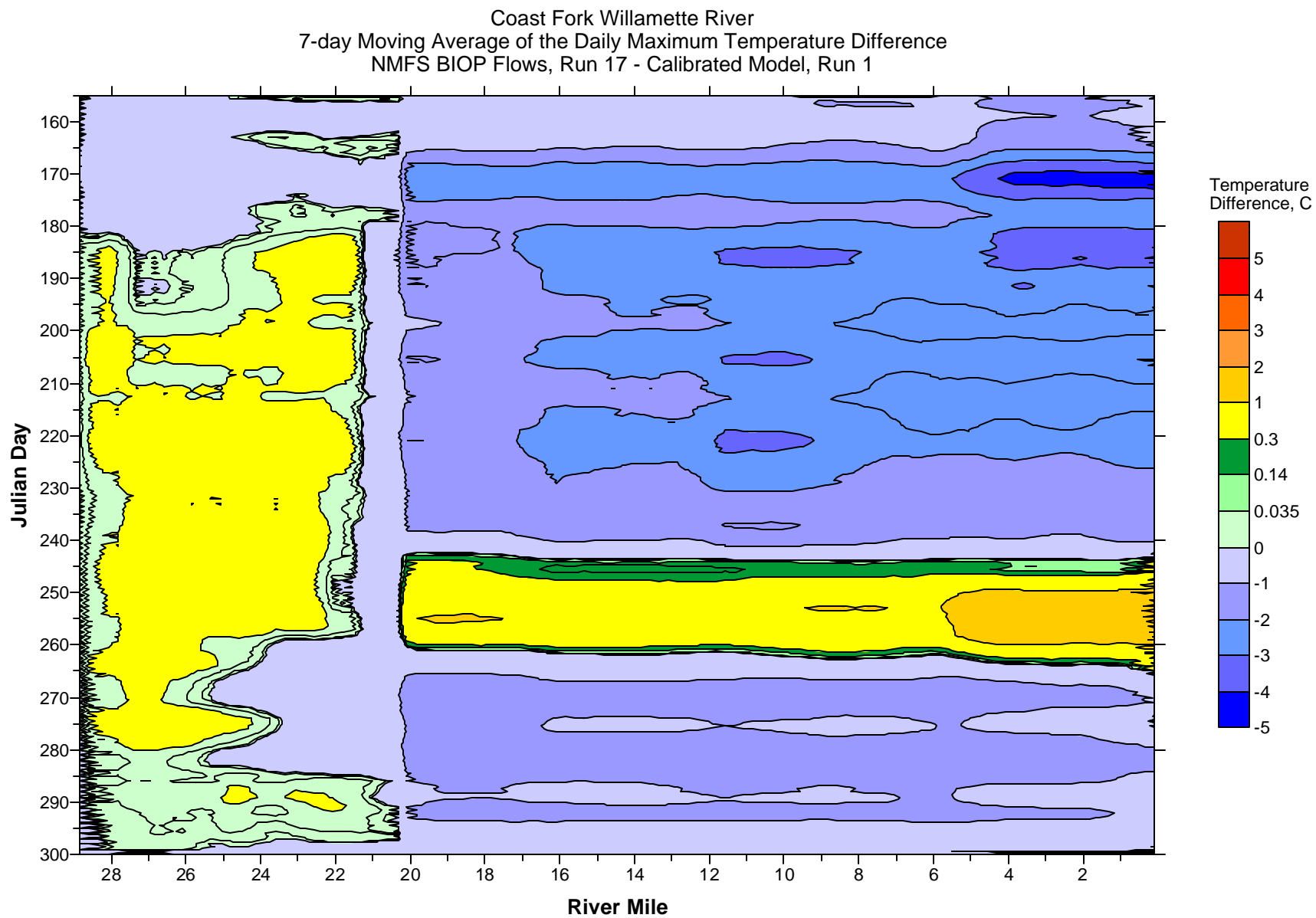
**Figure 919: No vegetative shade vs. System Potential vegetative shade contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Clackamas River**



**Figure 920: No vegetative shade vs. System Potential vegetative shade contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River**

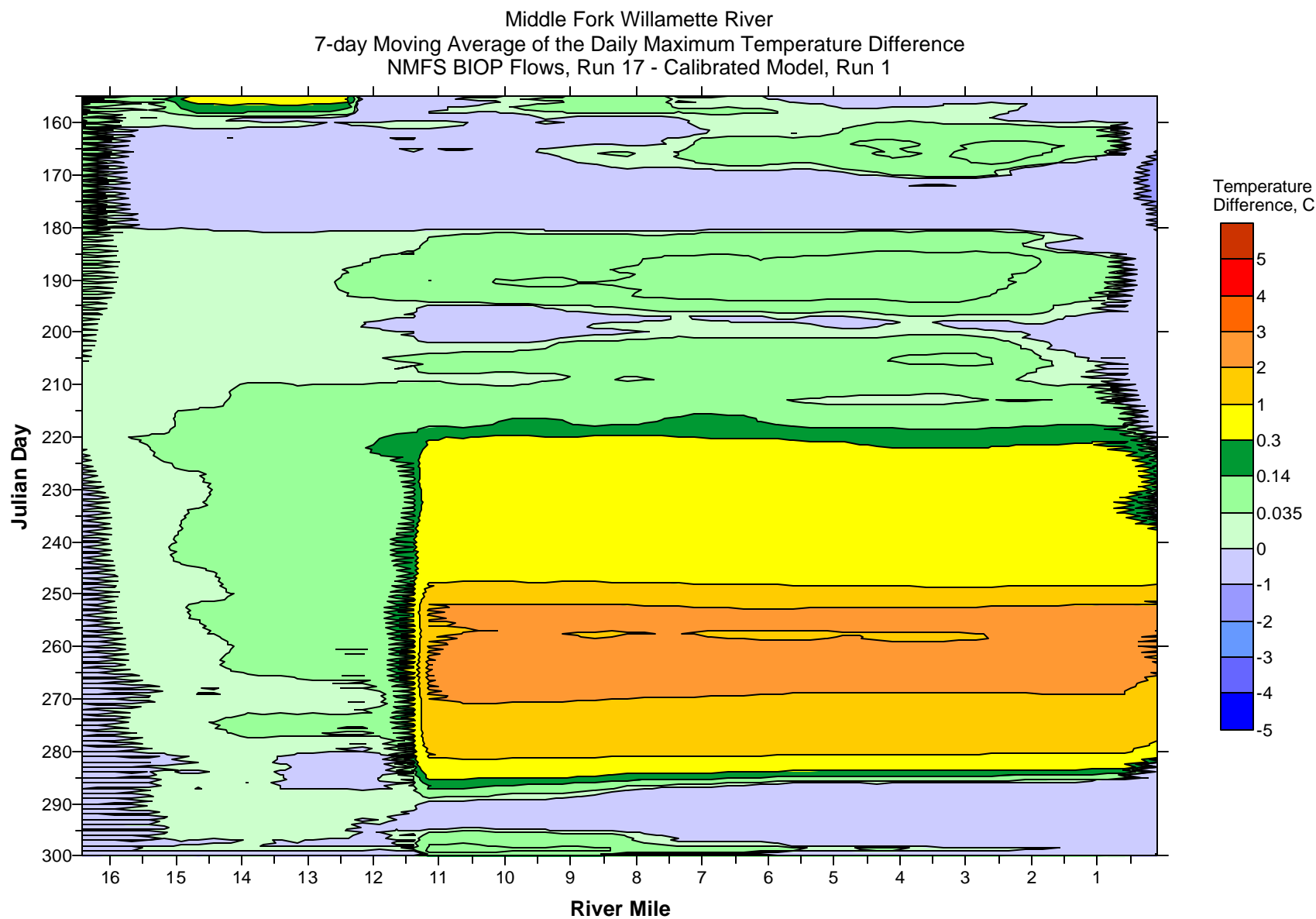
### ***Sensitivity to biological opinion flows***

The sensitivity of the model to using the National Marine Fisheries Service Biological Opinion (NMFS BIOP) flows for the upstream boundary flow condition was examined by simulating the summer of 2001. These results were then compared with the results of the calibrated model. The difference between the seven-day moving average of the daily maximum temperature for each scenario was then taken and plotted as contour plot for each river reach modeled (ODEQ, 2003). The contour plots begin in the furthest upstream reaches of the watershed and move downstream. Since there were no NMFS Biological Opinion flows for the Clackamas River model reach the difference between the two scenarios would be zero so no contour plots were generated.



**Figure 921: Calibrated model vs. Biological Opinion flow contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Coast Fork Willamette River**





**Figure 922: Calibrated model vs. Biological Opinion flow contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Fork Willamette River**

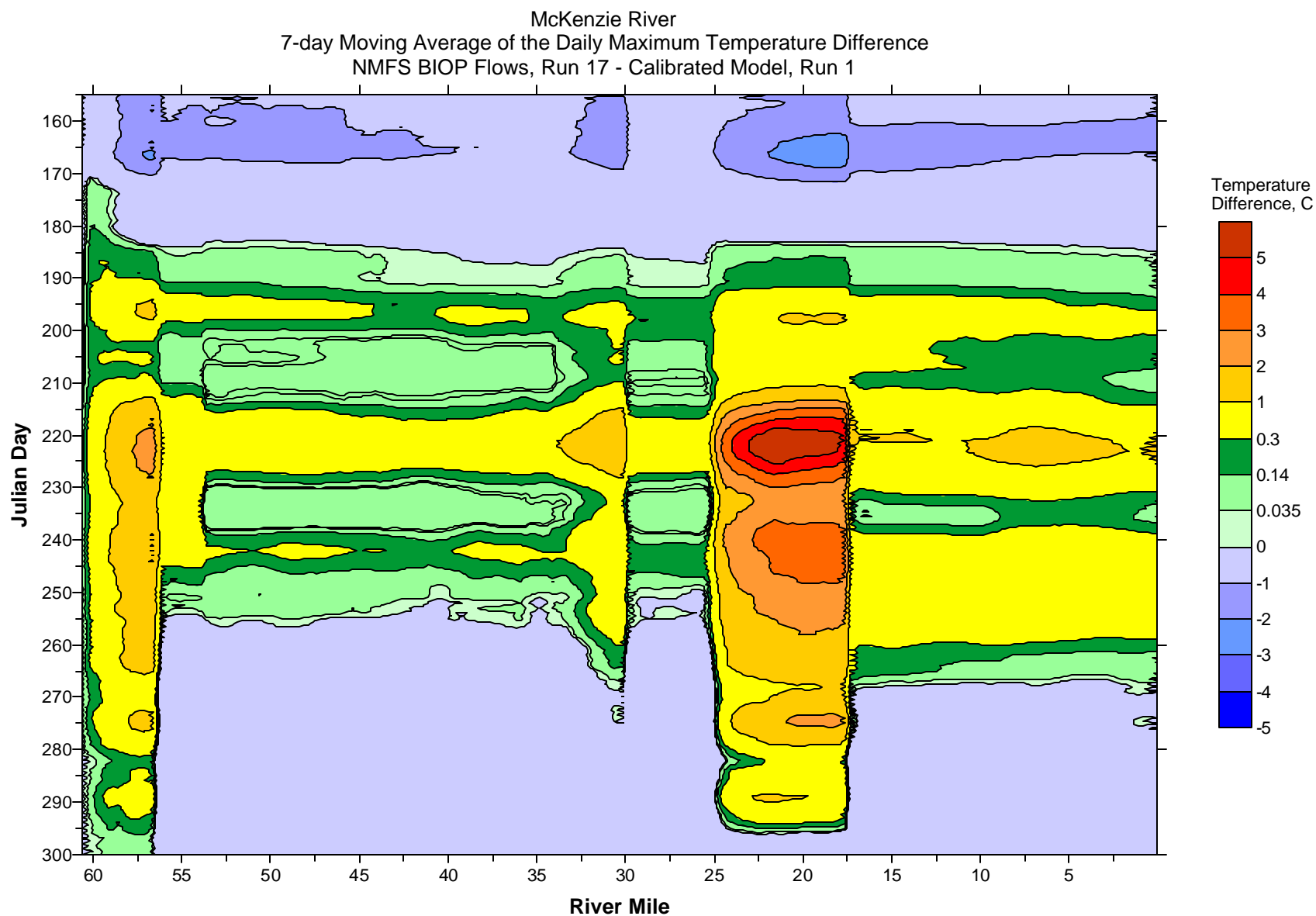
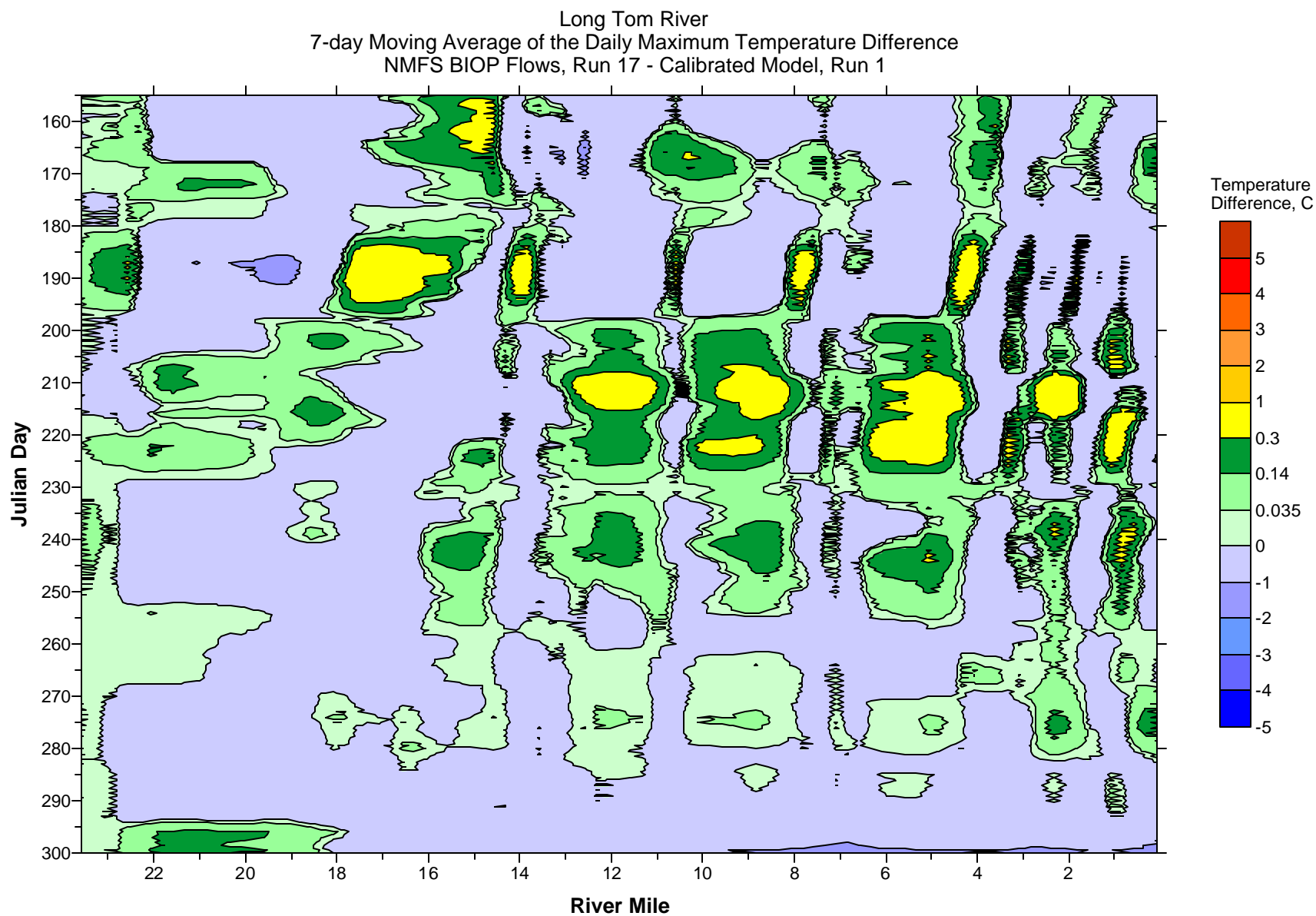
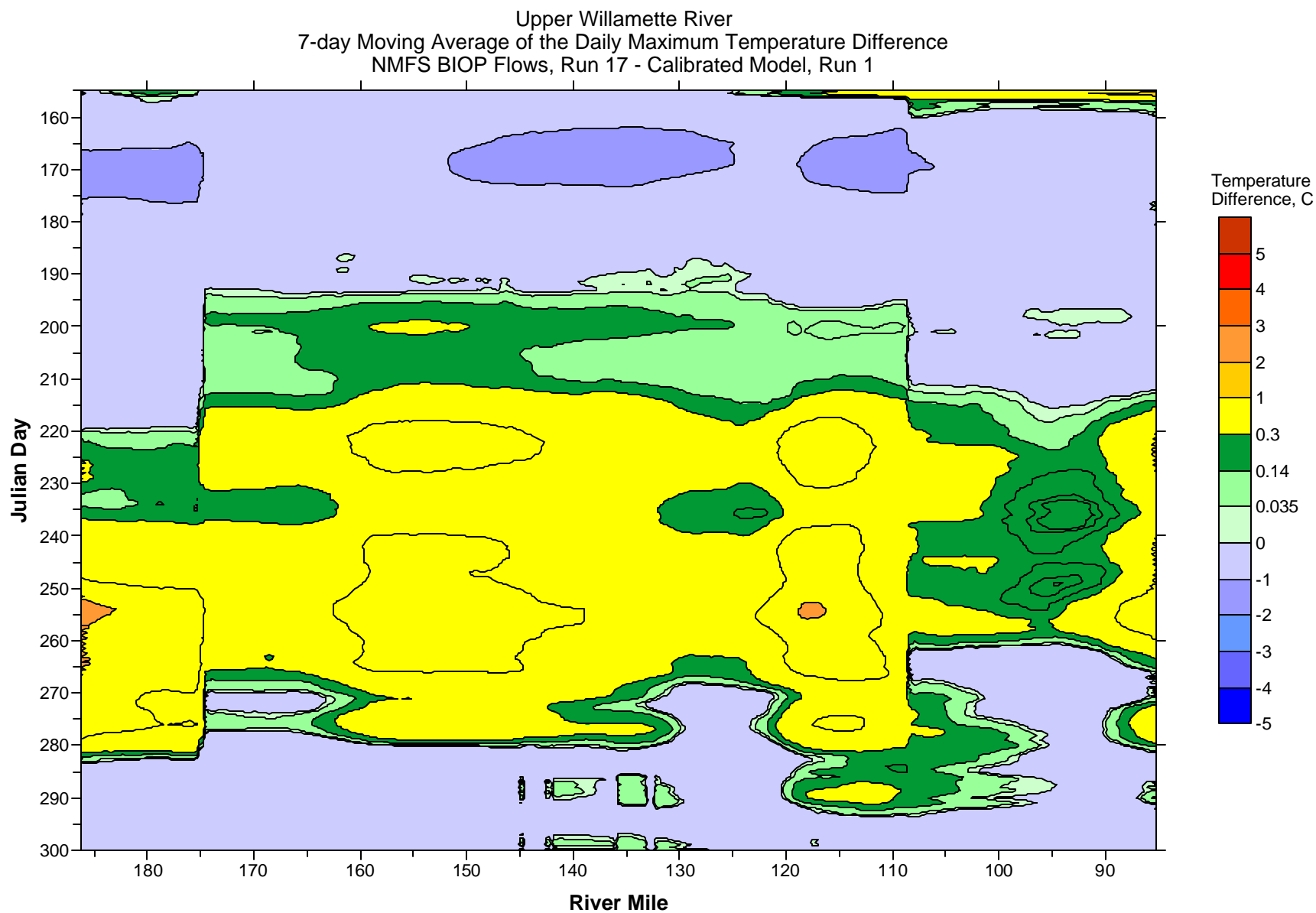


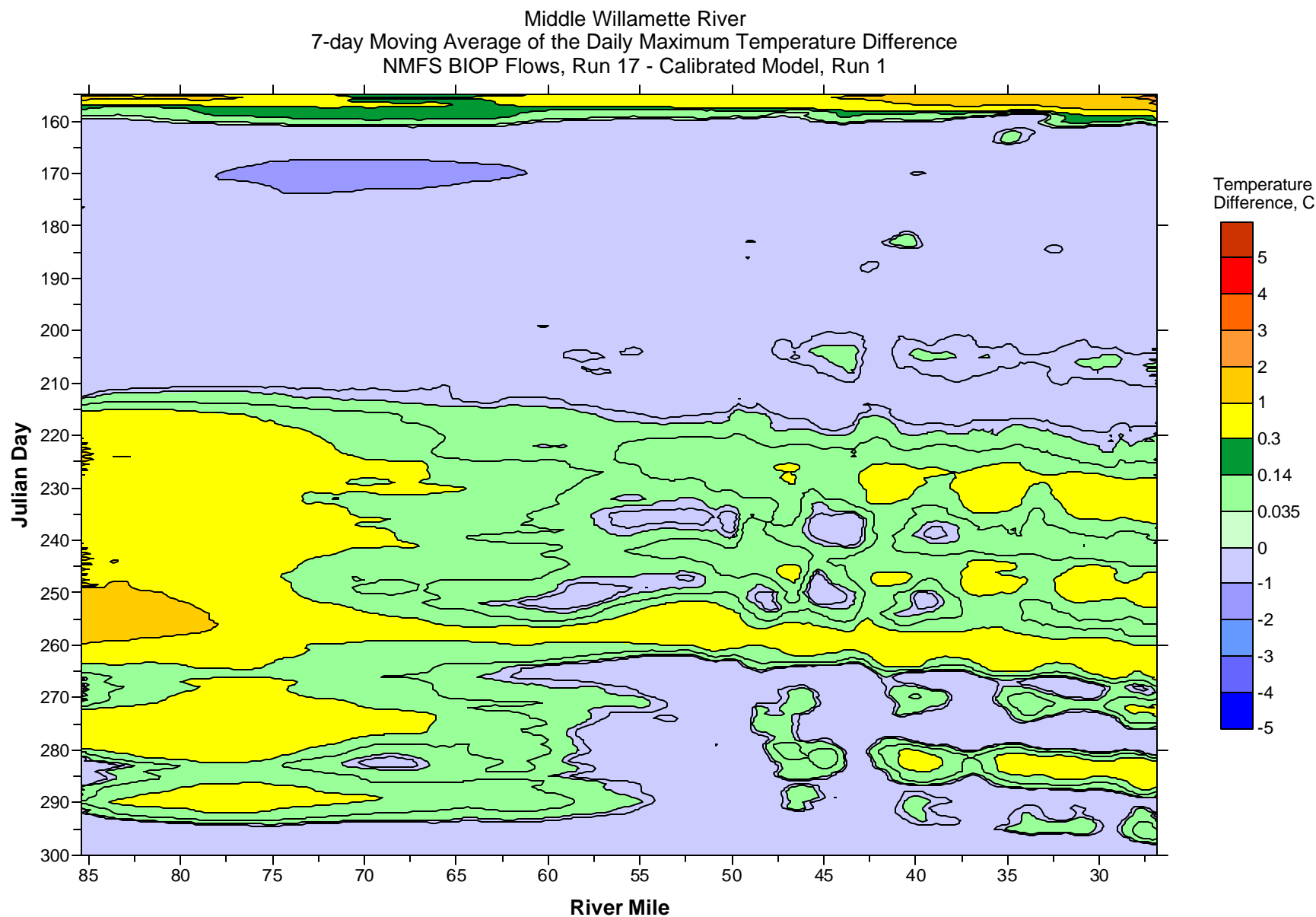
Figure 923: Calibrated model vs. Biological Opinion flow contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the McKenzie River



**Figure 924: Calibrated model vs. Biological Opinion flow contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Long Tom River**



**Figure 925: Calibrated model vs. Biological Opinion flow contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Upper Willamette River**



**Figure 926: Calibrated model vs. Biological Opinion flow contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Middle Willamette River**

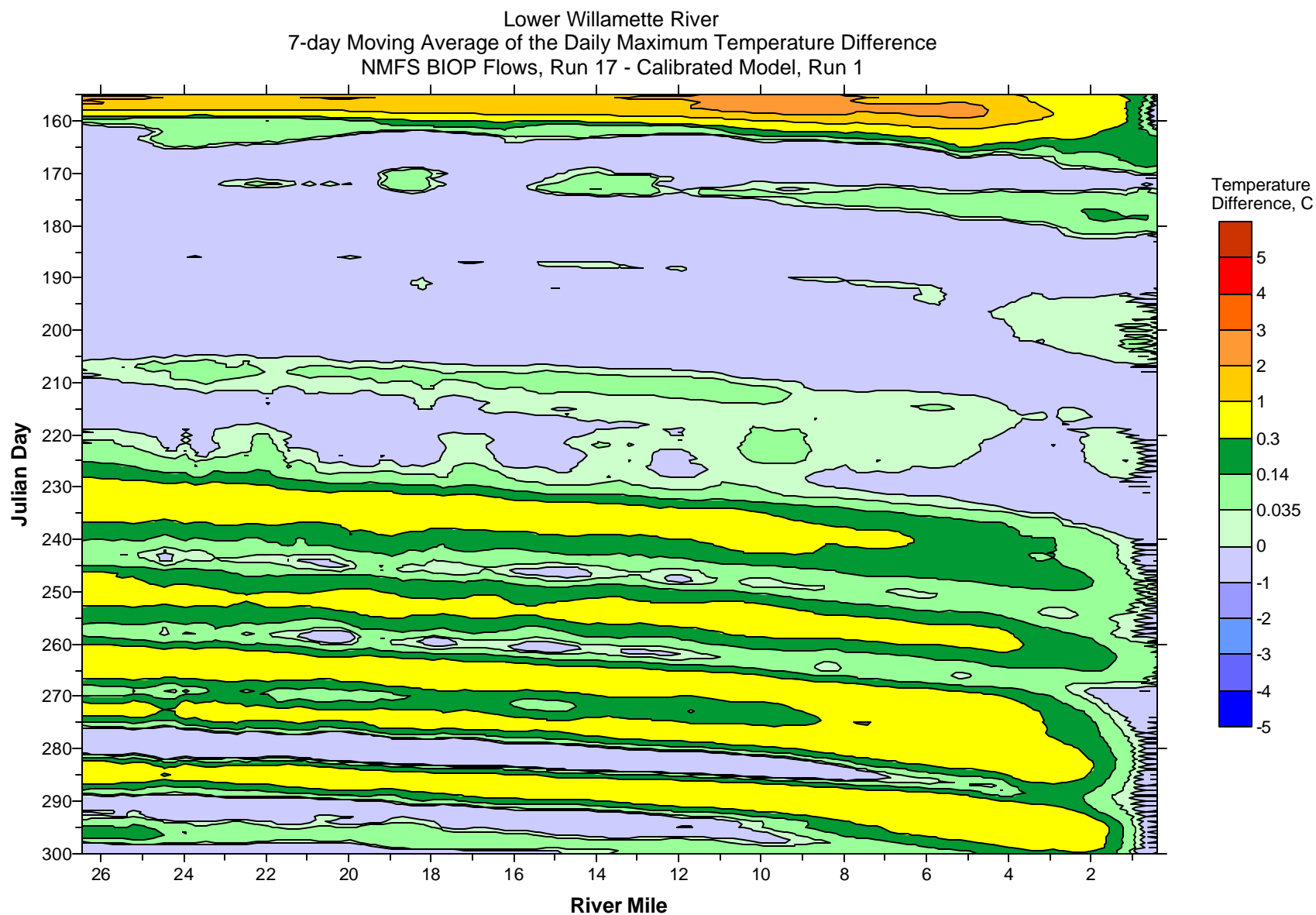


Figure 927: Calibrated model vs. Biological Opinion flow contour plot comparison, 7-day average of the daily maximum for August 10, 2001 for the Lower Willamette River

## Summary

## References

Annear, R. L.; McKillip, M. L.; Khan, Sher Jamal; Berger, C. J.; and Wells, S. A. (2004) "Willamette River Basin Temperature TMDL Model: Boundary Conditions and Model Setup," Technical Report EWR-01-04, Department of Civil and Environmental Engineering, Portland State University, Portland, OR.

Berger, C. J.; McKillip, M. L.; Annear, R. L.; Khan, Sher Jamal; and Wells, S. A. (2004) "Willamette River Basin Temperature TMDL Model: Model Calibration," Technical Report EWR-02-04, Department of Civil and Environmental Engineering, Portland State University, Portland, OR.

Oregon Department of Environmental Quality (2003) "Willamette River TMDLs Mainstem Modeling Scenarios," Draft, August 13, 2003. 8 pgs.