ORKUSTOFNUN
National Energy Authority

Markarfljót, calculated discharge with the WaSiM-ETH watershed model

Jóna Finndís Jónsdóttir

Prepared for the Icelandic Maritime Adiministration

Report JFJ-2006/001

ORKUSTOFNUN
National Energy Authority

Key page

Report no.:	**Date:**	**Distribution:** Open ☒ Closed ☐
JFJ-2006/001	June 2006	**Conditions:**

Report name / Main and subheadings:	**Number of copies:**
Markarfljót, calculated discharge with the WaSiM-ETH watershed model	10
	Number of pages: 14
Authors: Jóna Finndís Jónsdóttir	**Project manager:** Jórunn Harðardóttir
Classification of report: Modelling results	**Project number:** 7-649000

Prepared for:
Icelandic Maritime Adiministration

Cooperators:

Abstract:
The discharge of river Markarfljót in south Iceland was modelled with the distributed watershed model WaSiM-ETH and calculated meteorological data from the PSU/NCAR MM5 mesoscale meteorological model. Data from the discharge gauge, vhm 218, at Markarfljót by Emstrubrú were used for calibration of the model and discharge at the mouth of the river for the time period 1.9.1961 – 31.5.2003 was calculated with the model.

Keywords:
Markarfljót, WaSiM-ETH, MM5, watershed model, discharge.

Project manager's signature
Jórunn Harðardóttir

Reviewed by:
PJ, JHa

1 INTRODUCTION

Markarfljót is a river in south Iceland with a watershed area of 1226 km^2 at its mouth by the ocean. One discharge gauging station has been operated by the Hydrological Service of the National Energy Authority for the National Energy Authority, vhm 218, Markarfljót at Emstrubrú since June 1982. The gauging station is approximately 50 km upstream from the mouth of the river, at an elevation of 425 m a.s.l. and with a watershed area of 514 km^2 or 42% of the watershed area at the mouth of the river.

The discharge of Markarfljót at its mouth was modelled using the distributed watershed model WaSiM-ETH and calculated meteorological data from the PSU/NCAR MM5 mesoscale meteorological model. The data from the discharge gauging station were used for calibration. The watershed of the river and watershed outlets used in the model are shown in Fig. 1.

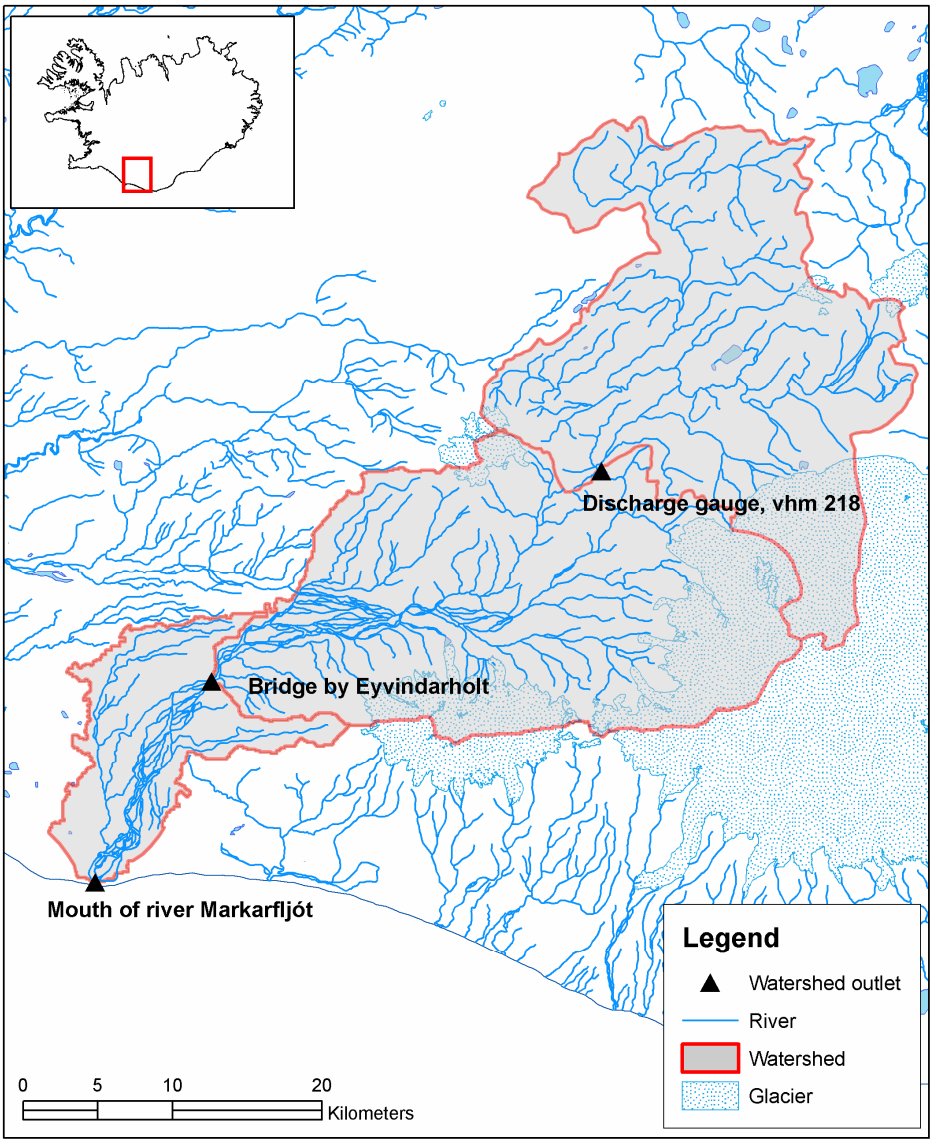

Figure 1: *Watershed outlines and watershed outlets at river Markarfljót.*

2 DATA

Average daily discharge data from vhm 218 were extracted from the database of the Hydrological Service of the National Energy Authority for calibration of the model. Additionally, discrete estimated values of disharge at the old bridge on the Highway by the farm Eyvindarholt were used for evaluation of the model (Pálsson and Vigfússon, 1996). The discrete discharge estimations at the Highway were made 150 times during the time period of 1973–1995. The estimations were, however, not done with regular discharge measurements and the values are very uncertain, particulary the first half of the series.

The climate data are from the PSU/NCAR MM5 mesoscale meteorological model which has been applied by the Institute of Meteorological Research to calculate precipitation and other meteorological variables over Iceland (Rögnvaldsson et al., 2004). The model uses input data from ECHMWF and calculates the weather in Iceland on a 6 hourly time resolution and 8x8 km spatial resolution. The climate information consists of data series of precipitation, temperature, wind, radiation, and humidity.

The outlines of the watershed at the gauging station was extracted from the database of the Hydrological Service. The watershed at the bridge by Eyvindarholt as well as the watershed of Markarfljót at its mouth were evaluated using a figure showing watershed divides on Mýrdalsjökull by Björnsson et al. (2000) and a 90 m digital elevation cover and a river network from the database of the Hydrological Service.

3 THE WATERSHED MODEL

WaSiM-ETH is a fully distributed catchment model using physically based algorithms and parameters for most of the process descriptions (Schulla and Jasper, 2001). Input data for the model consist of various grids and time series, describing the surface of watersheds and its climate. The grids describe the watersheds elevation, shade, flow direction, land use and soil types on a 1x1 km spatial resolution. The algorithms used for calculation of different links in the hydrology are selected according to the available input data. The use of the model for evaluation of runoff in Iceland has been described by Jónsdóttir (2006).

The model was calibrated for the time period 1982–1990 and run for the time period 1960–2003.

4 RESULTS

The fit of the model may be judged by on one hand the water balance and on the other hand by the R2 and R2log, Nash efficiency criterion. R2 is defined in the following way:

$$R2 \equiv \frac{\sum (Q_{meas} - \overline{Q}_{meas})^2 - \sum (Q_{calc} - \overline{Q}_{meas})^2}{\sum (Q_{meas} - \overline{Q}_{meas})^2}$$

Where Q_{meas} is measured discharge, $\overline{Q}_{meas}$ is measured mean discharge and Q_{calc} is calculated discharge during the days where data on measured discharge exist. R2 log is defined in the same way except a logarithm of the discharge is used instead of the discharge in order to give low discharge values relatively higher value than in R2.

Table 1 shows the waterbalance and the R2 and R2 log values for the measured versus calculated discharge at the gauge vhm 218. Furthermore, in Appendix I are figures comparing calculated and measured discharge at the gauging station vhm 218. There are also figures comparing estimations of discharge and calculated discharge at the bridge by Eyvindarholt and calculated discharge at the mouth of the river.

Table 1: *Waterbalance and R2, R2 log values. Q_{tot} is the calculated discharge for the whole water year.*

Wateryear	Q_{meas} [m^3/s]	Q_{calc} [m^3/s]	Proportional difference	Q_{tot} [m^3/s]	R2	R2log
1981/82	63	67	6%	40	0.77	0.77
1982/83	39	46	20%	41	0.36	0.64
1983/84	43	48	14%	45	0.81	0.79
1984/85	51	43	-16%	37	0.75	0.81
1985/86	46	44	-4%	34	0.82	0.77
1986/87	54	48	-11%	38	0.61	0.64
1987/88	43	33	-22%	33	0.74	0.78
1988/89	53	56	6%	46	0.32	0.67
1989/90	69	67	-3%	44	0.73	0.33
1990/91	48	48	-1%	45	0.87	0.85
1991/92	53	60	13%	50	0.25	0.58
1992/93	54	66	22%	52	0.67	0.75
1993/94	62	64	3%	47	0.67	0.72
1994/95	54	63	18%	43	-0.03	0.21
1995/96	42	44	5%	40	0.56	0.55
1996/97	67	64	-4%	42	0.40	0.57
1997/98	49	41	-16%	37	0.22	0.21
1998/99	42	40	-4%	35	0.71	0.78
1999/00	76	59	-23%	38	0.25	0.20
2000/01	51	34	-34%	32	-0.30	-0.63
2001/02	54	44	-19%	39	0.22	0.46
2002/03	54	51	-6%	47	0.21	0.35

According to the model the average discharge for the water years 1961–2001 at the mouth of river Markarfljót is 96 m^3/s. The calibrated model was not able to simulate the large flood in January 2002 with the same model parameters as for other periods. This is because, at the time of the flood the ground within the watershed was frosen and, therefore, not as permeable as it is during non-frozen periods. Another set of model parameters was therefore used for the winter 2000–2001 in order to evaluate the flood at the mouth of the river. This wintertime model was calbrated using evaluations of flood peak at the bridge by Eyvindarholt and average daily discharge at the discharge gauge vhm 218. The resulting calculated discharge at the mouth of the river over a five day period is shown in Table 2. The peak at the bridge by Eyvindarholt may have occured at around 11 AM January 10th (Ingólfsson, 2002) and the maximum discharge may have reached up to 1500 m^3/s (Zóphóníasson and Jónsdóttir, 2002).

Table 2: *Calculated daily discharge at the mouth of river Markarfljót during a winter flood in January 2002.*

Date	Discharge [m3/s]
8/1/2002	90
9/1/2002	780
10/1/2002	880
11/1/2002	60
12/1/2002	70

5 CONCLUSIONS

The average daily discharge of the river Markarfljót in south Iceland has been evaluated using the WaSiM-ETH model with calculated meteorological data from the PSU/NCAR MM5 mesoscale meteorological model.

The comparison between the calculated discharge shows that the model catches the main characteristics of the river fairly well. The main problem that arose was that the model cannot account for different chararteristics of the watershed during periods when the ground is frozen and therefore impermeable. Therefore, winter floods are difficult to model correctly, except when discrete events are seperated from the continuous modelling period.

6 REFERENCES

Björnsson, Helgi, Finnur Pálsson, Magnús T. Guðmundsson. (2000). Surface and bedrock topography of the Mýrdalsjökull ice cap, Iceland: The Katla caldera, eruption sites and routes of jökulhlaups. *Jökull 49*, 29-49.

Ingólfsson, Sigurgeir. (2002). Personal communication.

Jónsdóttir, Jóna Finndís. (2006). *A runoff map of Iceland based on numerically simulated precipitation*. European Conference on Impacts of Climate Change on Renewable Energy Sources. Abstract volume. Reykjavik, Iceland, June 5–9. ISBN 9979-68-189-6.

Pálsson, Svanur and Guðmundur H. Vigfússon. (1996). Gagnasafn aurburðarmælinga 1963–1995. Orkustofnun report nr. OS-96032/VOD-05 B.

Rögnvaldsson, Ólafur, Philippe Crochet and Haraldur Ólafsson. (2004). Mapping of precipitation in Iceland using numerical simulations and statistical modeling, *Meteorologische Zeitschrift, 13*(3), 209-219.

Schulla, Jörg and Karsten Jasper. (2001). *Model description WaSiM-ETH*. Web address: http://www.iac.ethz.ch/staff/verbunt/Down/WaSiM.pdf.

Zóphóníasson, Snorri and Jóna Finndís Jónsdóttir. (2002). *Rennsli í flóðtoppum í Markarfljóti*. Orkustofnun report nr. SZ/JFJ 2002/02.

APPENDIX I

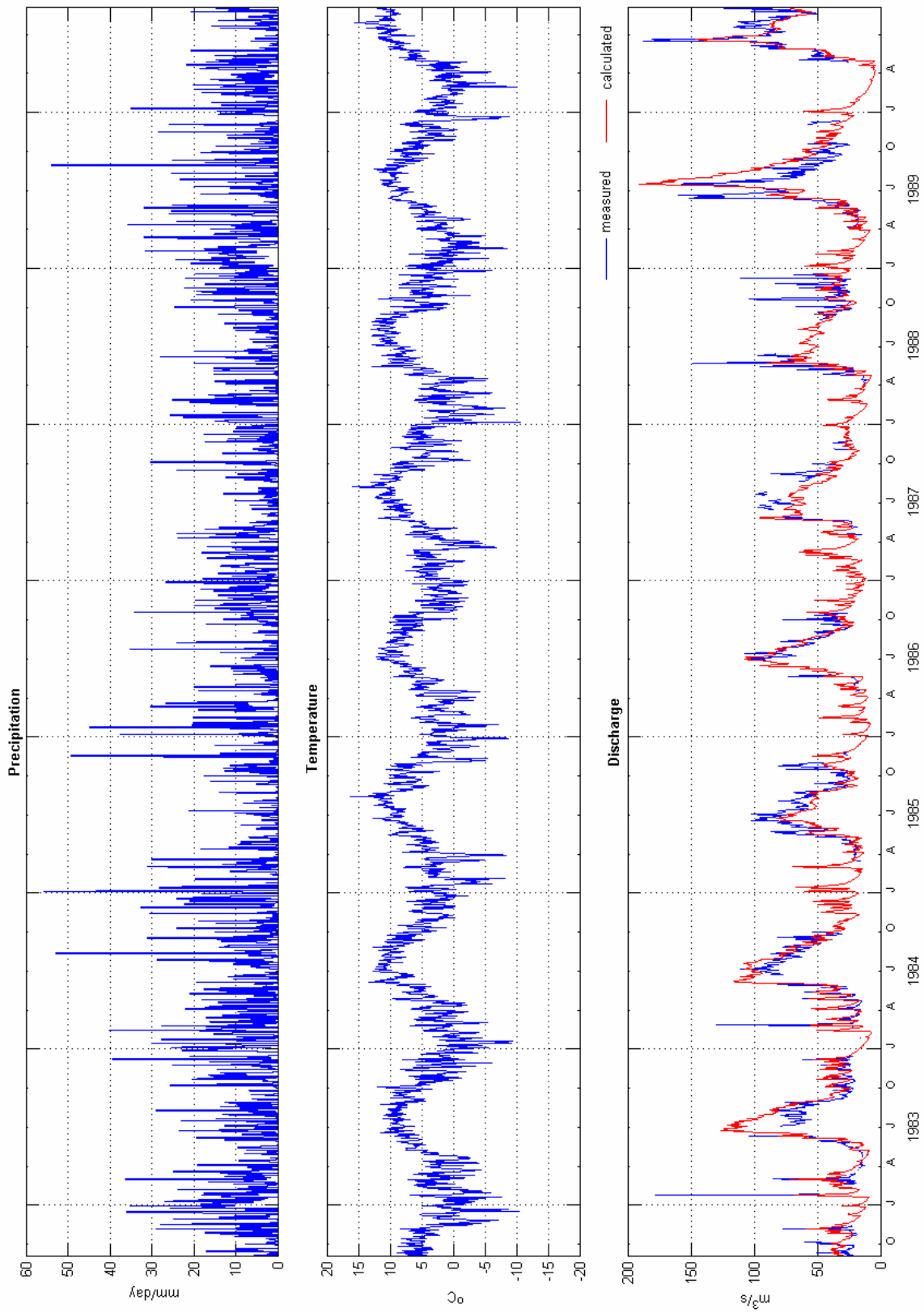

Figure 1: *Measured and calculated discharge at the discharge gauge vhm 218, 1982–1990.*

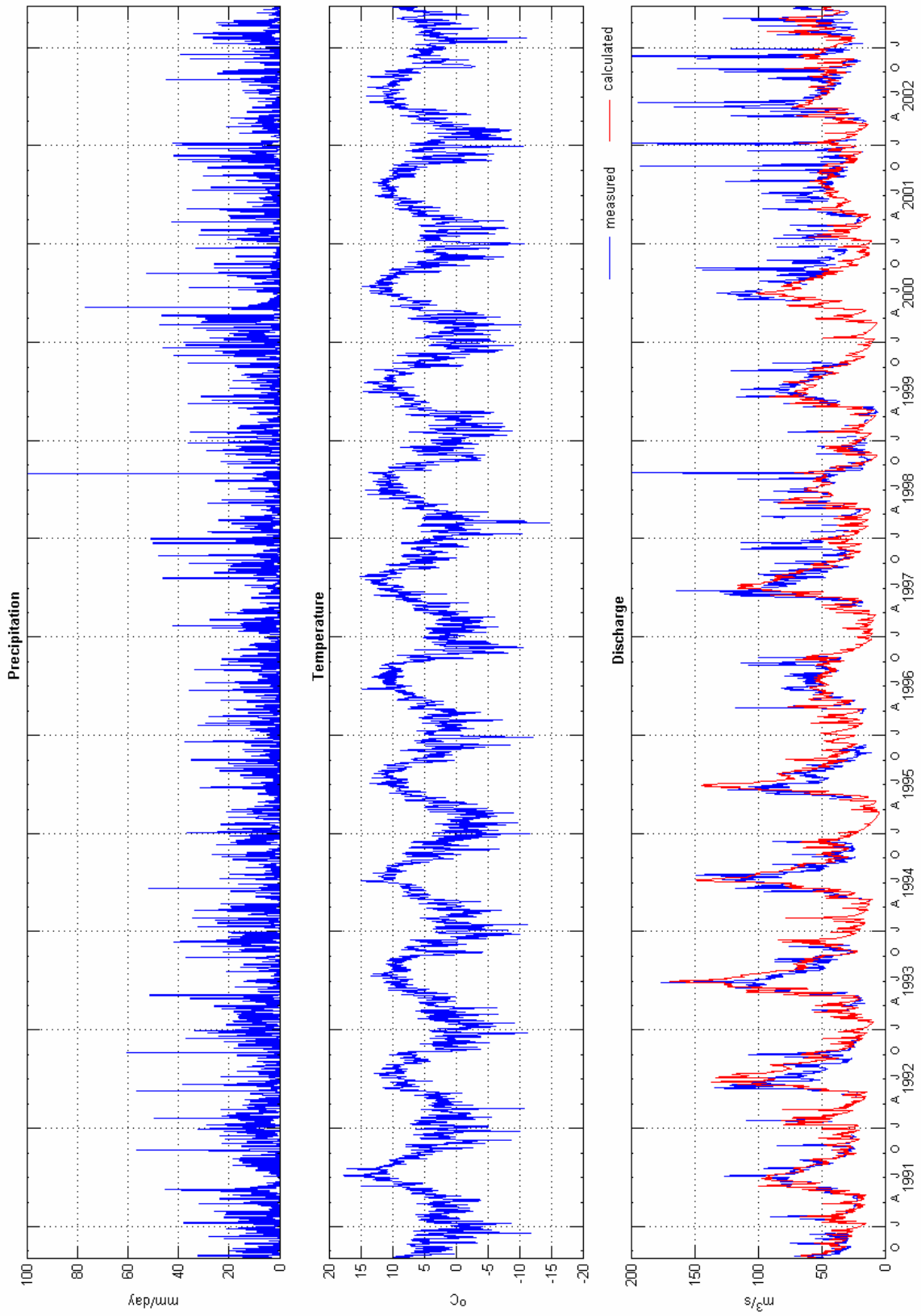

Figure 2: *Measured and calculated discharge at the discharge gauge vhm 218, 1990–2003.*

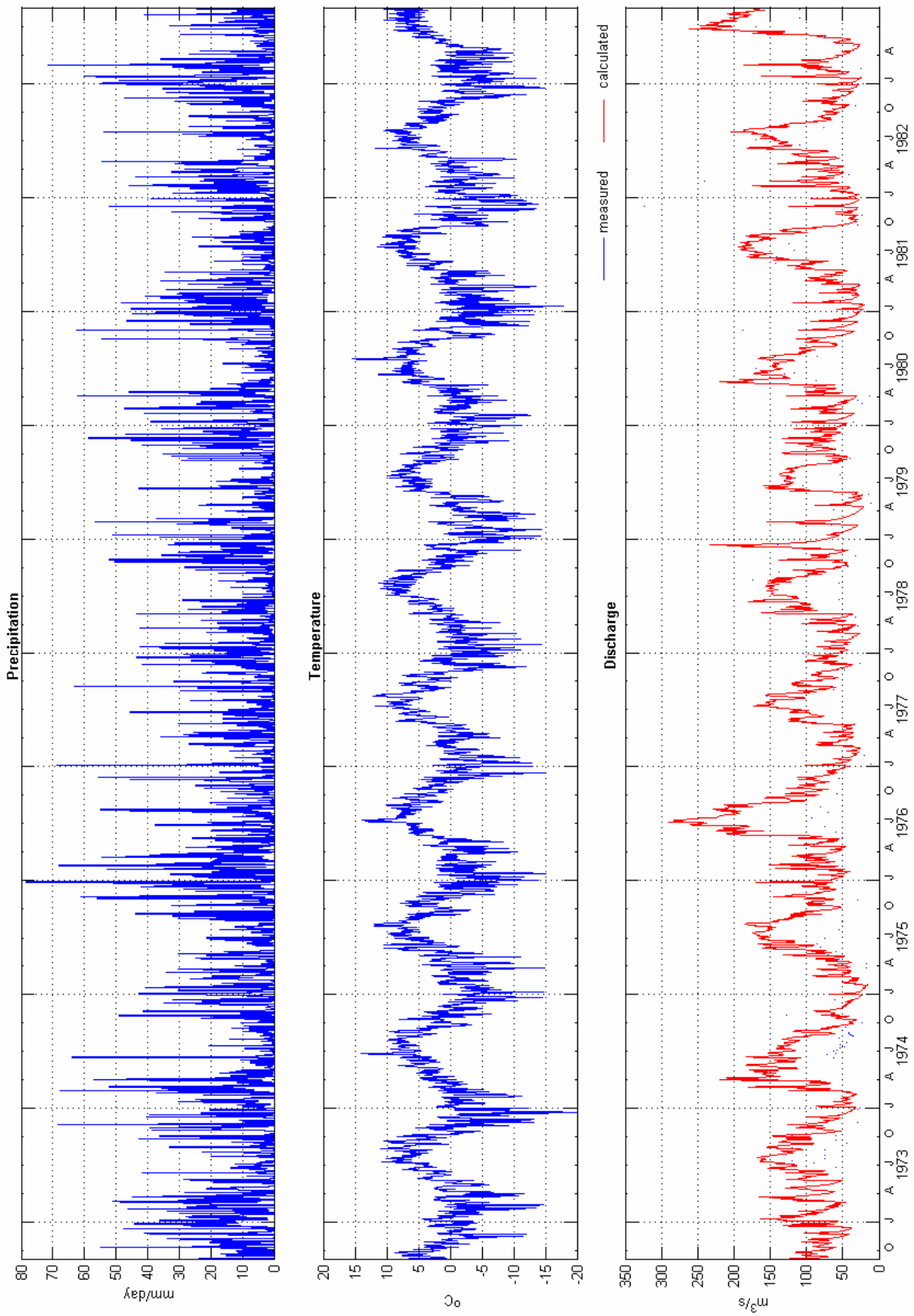

Figure 3: *Discrete estimations and calculated discharge at the bridge by Eyvindarholt, 1972–1983.*

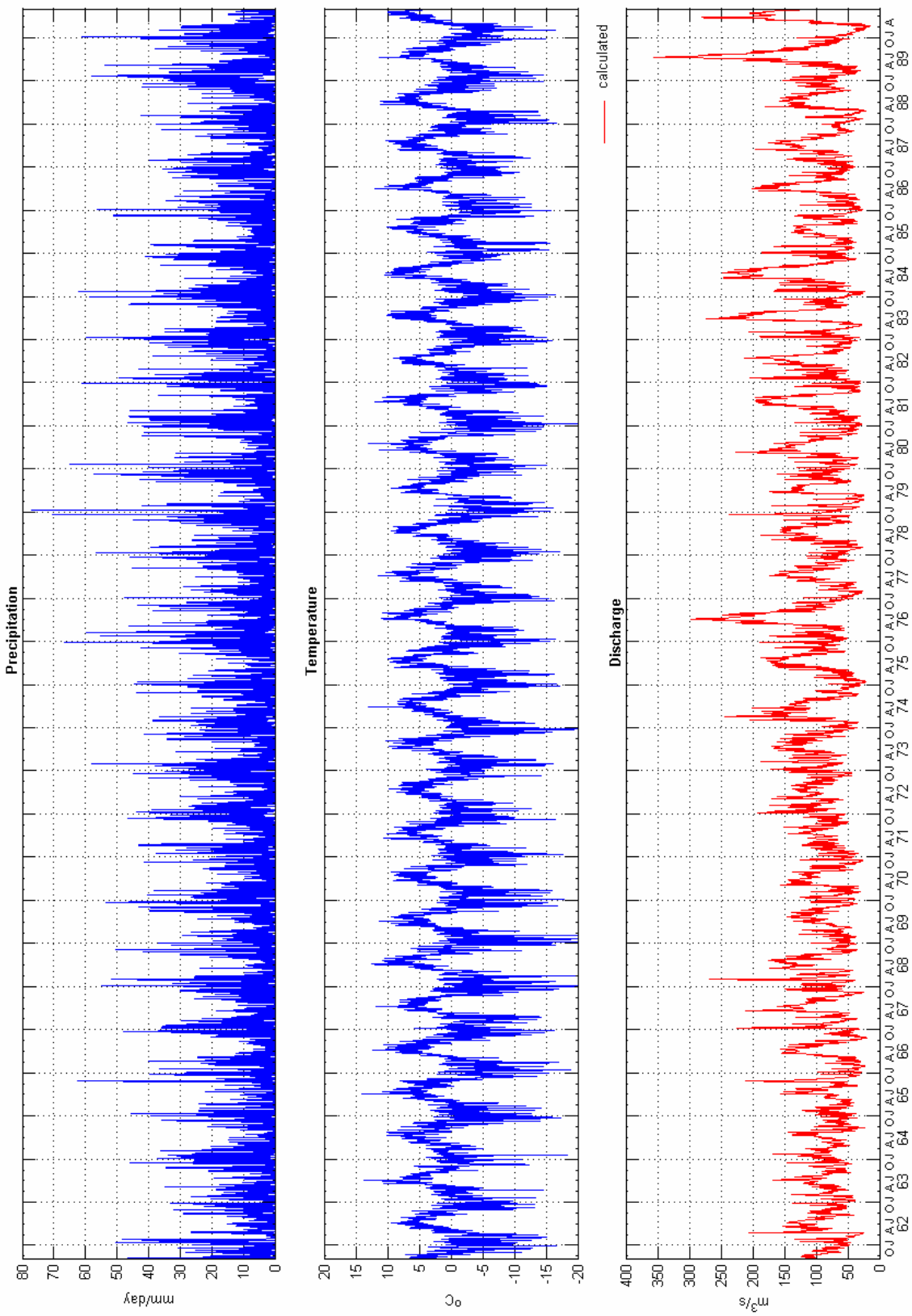

Figure 4: *Calculated discharge at the mouth of river Markarfljót, 1961–1990.*

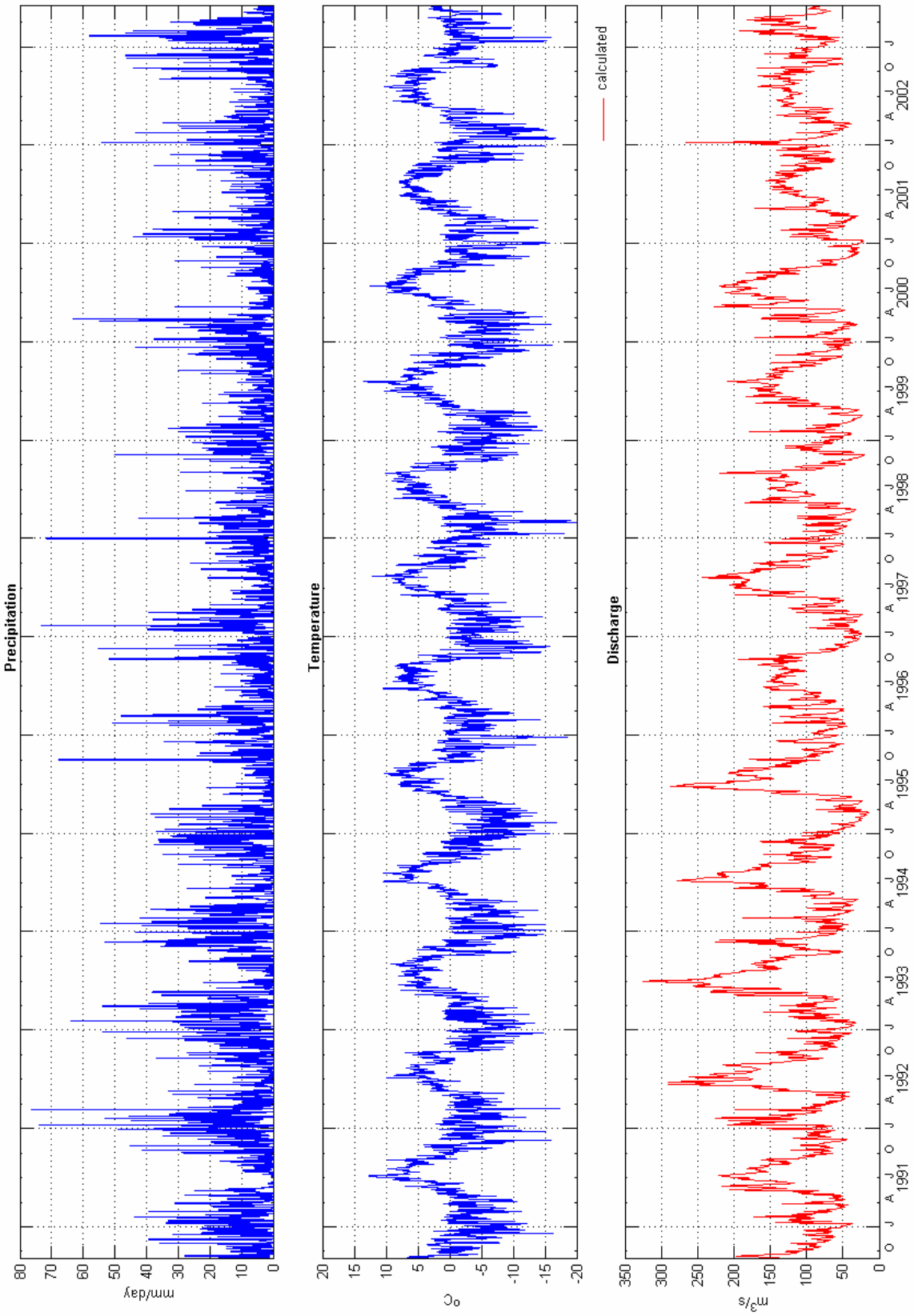

Figure 5: *Calculated discharge at the mouth of river Markarfljót, 1990–2003.*