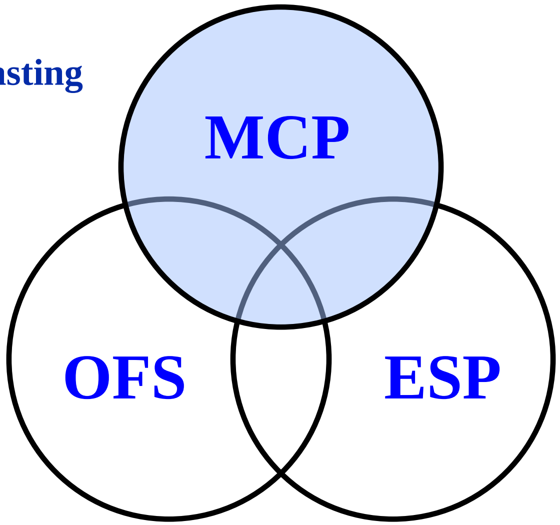
NWSRFS
Calibration Component

- Manual Calibration Program (MCP) system
- Operational Forecast System (OFS)
- Ensemble Streamflow Prediction (ESP) system

NWS Workshop on Hydrologic Forecasting
Prague Campus
Czech University of Agriculture
June 20-24, 2005



What is Calibration ?

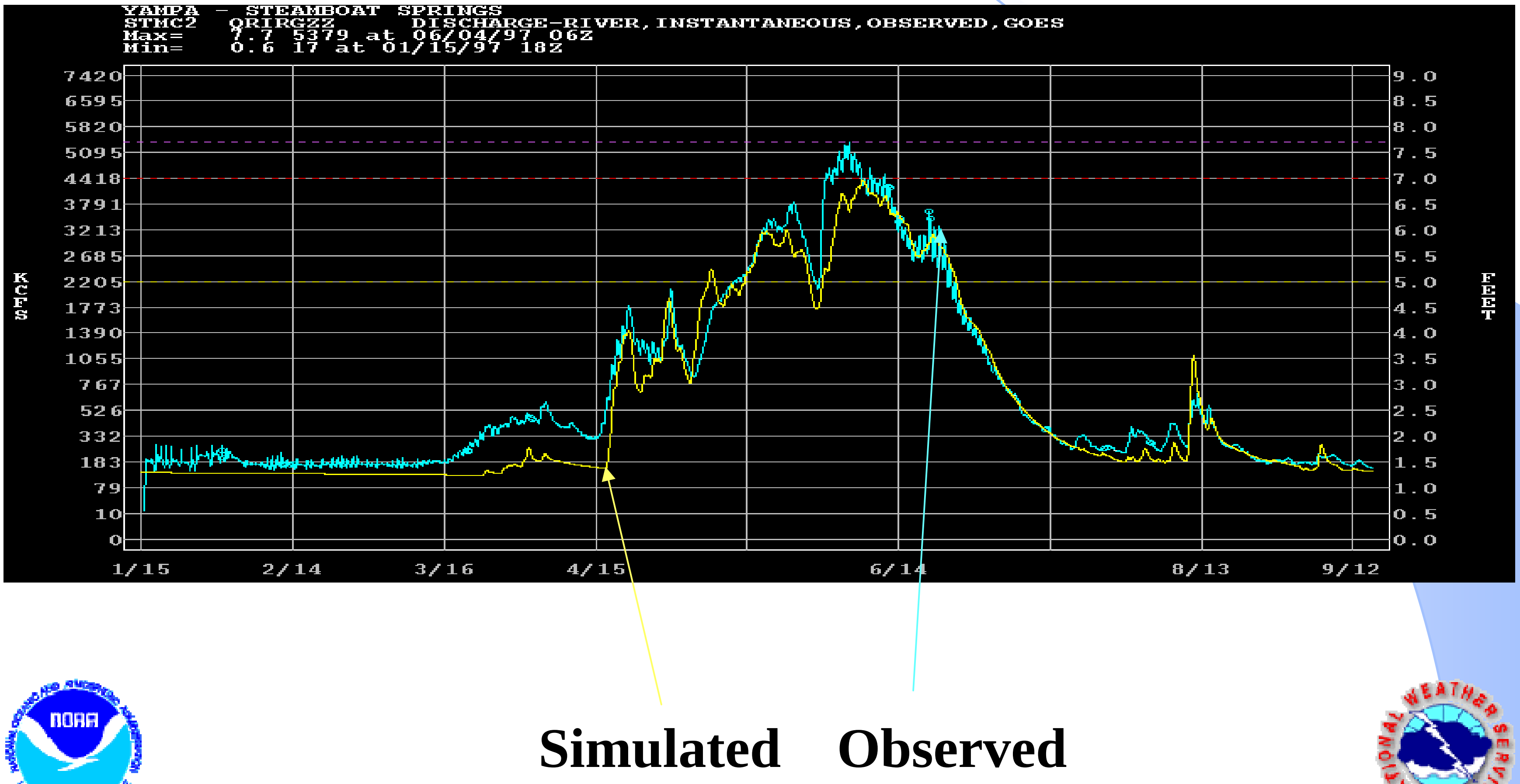
A procedure that allows forecasters to determine a ‘best set’ of model parameters for a river basin. The process is to determine a ‘best fit’ between simulated and observed values (usually streamflow) by varying the parameters using sound logic and reasoning.

The process can be manual or automatic.

Poor Fit Between Model Simulation and Observed

Simulated **Observed**

Better Fit Between Model Simulation and Observed



Calibration Types

- Headwater drainages
- Local drainages
- Routing reaches
- Reservoir operations
- Flood control system operation

Calibration Steps

- Collection and processing of historical observations.
- Selection of operations.
- Parameter estimation.
  - Objective (automatic)
  - trial & error

Preprocessed Calibration Data

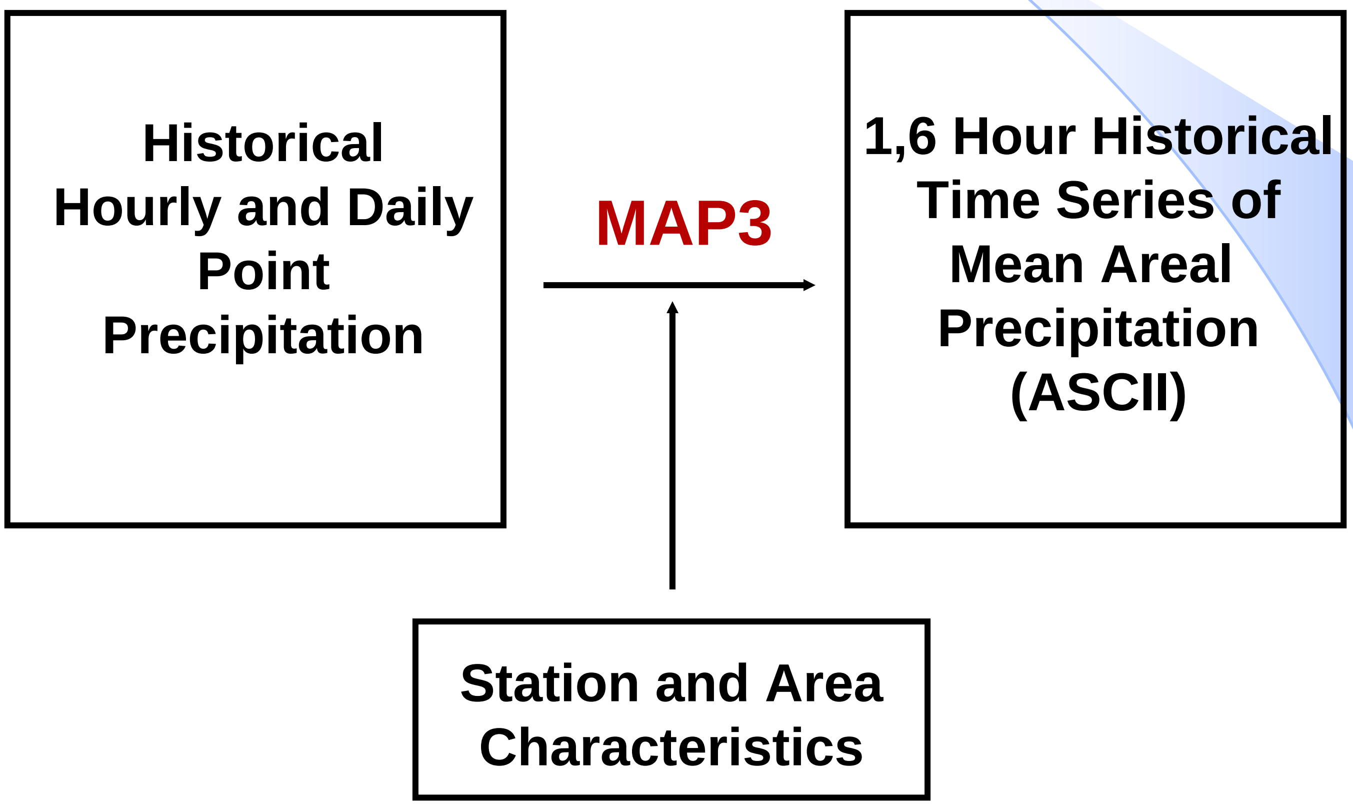
- ~30 years of observations.
- Daily max/min temperatures.
- Hourly and daily precipitation.
- Mean daily streamflow and adjustments.
- MAP3/MAT3/(MAPE) processing.

Processed Calibration Data

- 1 or 6 hour MAP/MAT/(MAPE).
- 24 hour “full natural”streamflow

  or hourly depedning upon the time step
- Instantaneous streamflow for selected flood events.

Mean Areal Precipitation (MAP)



Mean Areal Temperature (MAT)

Historical Daily Maximum And Minimum Point Air Temperature

MAT3 →

6 Hour Historical Time Series of Mean Areal Temperature (ASCII)

↑

Station and Area Characteristics

MCP3 - Data Definitions

```
DRY CK - LAKE SONOMA INFLOW
   10 1959    9 1993   ENG
DEF-TS
WSDC1       MAP      6             INPUT         CARD
rusnap/wsdc1/wsdc1.MAP06
WSDC1       MAT      6             INPUT         CARD
rusnap/wsdc1/russian.MAT
11465200    QME     24             INPUT         CARD
rusnap/wsdc1/11465200.qme
WSDC1_83    QME     24             INPUT         CARD
rusnap/wsdc1/wsdc1_in.qme
WSDC1       QME     24             OUTPUT        CARD
rusnap/wsdc1/wsdc1.qme
11465200    QINE     6
11465200    AQME    24
WSDC1       SQIN     6
WSDC1       SQME    24
WSDC1       RSEL     6
WSDC1       RAIM     6
WSDC1       SASC    24
WSDC1       INFW     6
WSDC1       ROCL    24
WSDC1       SMZC    24
END
```

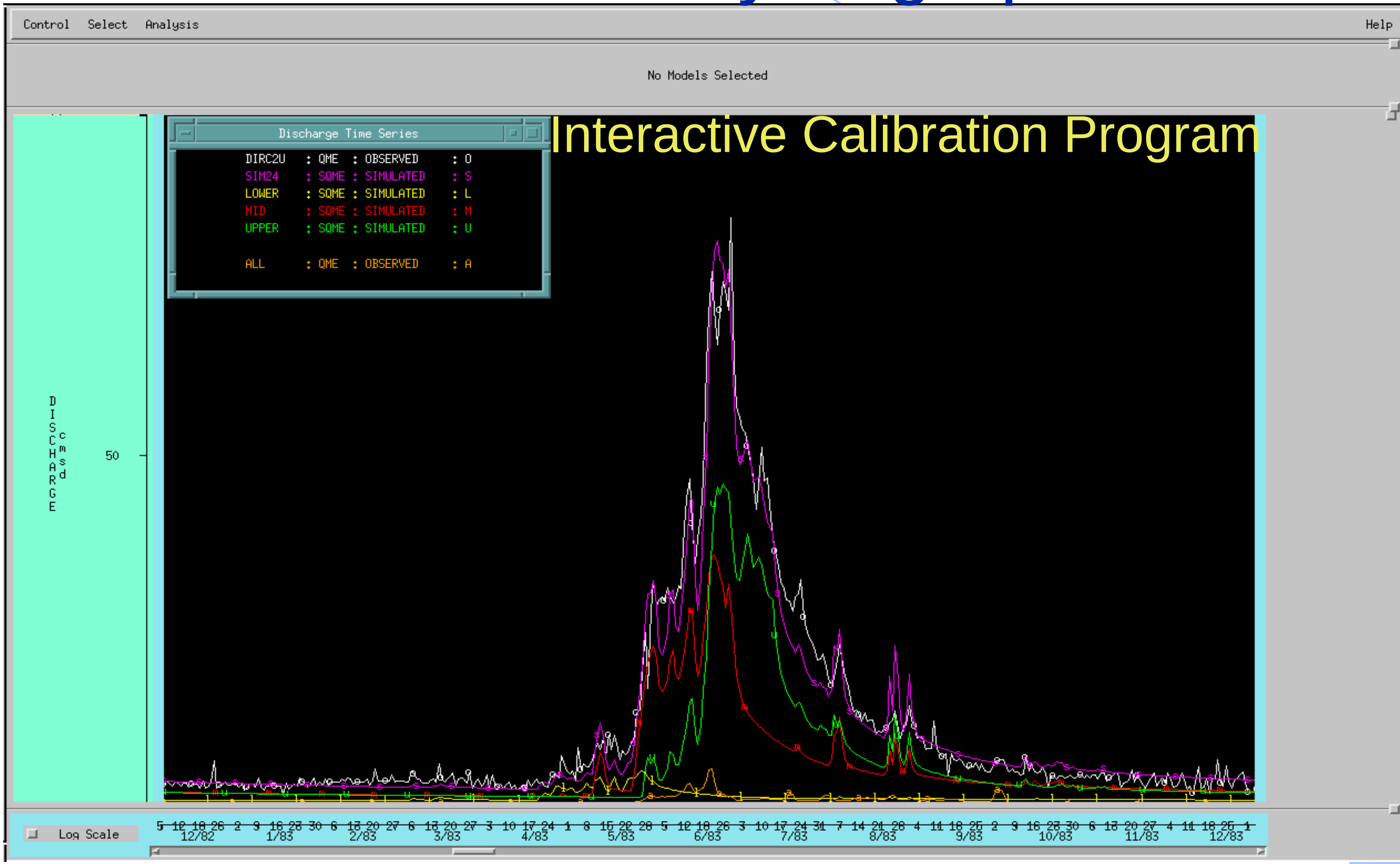
MCP3 - Models and Processing

```
RSNWELEV    WSDC1
  WSDC1    RSEL    6  2.0  .55       WSDC1    MAT  366.                0
SNOW-17     WSDC1
LAKE SONOMA INFLOW   343. 38.5            YES SUMS                AVSE
    6  WSDC1    MAP       1.00       WSDC1    RAIM
  WSDC1    MAT     6     366.    .8  .55
   11      400.     2818. ENGL  WSDC1    RSEL
      646.  .08      801.  .16      899.  .25      978.  .33
     1056.  .41     1125.  .50     1204.  .58     1276   .66
     1398.  .75     1522.  .83     1726.  .91
                                WSDC1    SASC   24
 1.00 1.00 0.40 0.10  250.
  .15 0.25   .0 2.00  .02   .3
  .05  .08  .12  .20  .28  .35  .42  .60  .75
SAC-SMA     WSDC1
LAKE SONOMA INFLOW          6  WSDC1    RAIM       WSDC1    INFW
  WSDC1    SASC   24  WSDC1    WSDC1    SUMS
                     1.00  1.0  85.  40. 0.350.020 .043 .020    0  0.4
                       8. 1.90 100.  75.  95. .1500.005 0.20  .30  0.0
                    1.461.501.802.323.726.757.928.077.163.942.301.69
                       1.  0.0  26.  0.0  13.  27.
UNIT-HG     WSDC1
LAKE SONOMA INFLOW            131.    9           ENGL
  WSDC1    INFW    6  WSDC1    SQIN    6
   6322.76   3540.24   1895.56   1066.68    633.82    296.05    146.61
     74.72     23.5
MEAN-Q      WSDC1
  WSDC1    SQIN    6  WSDC1    SQME   24
```

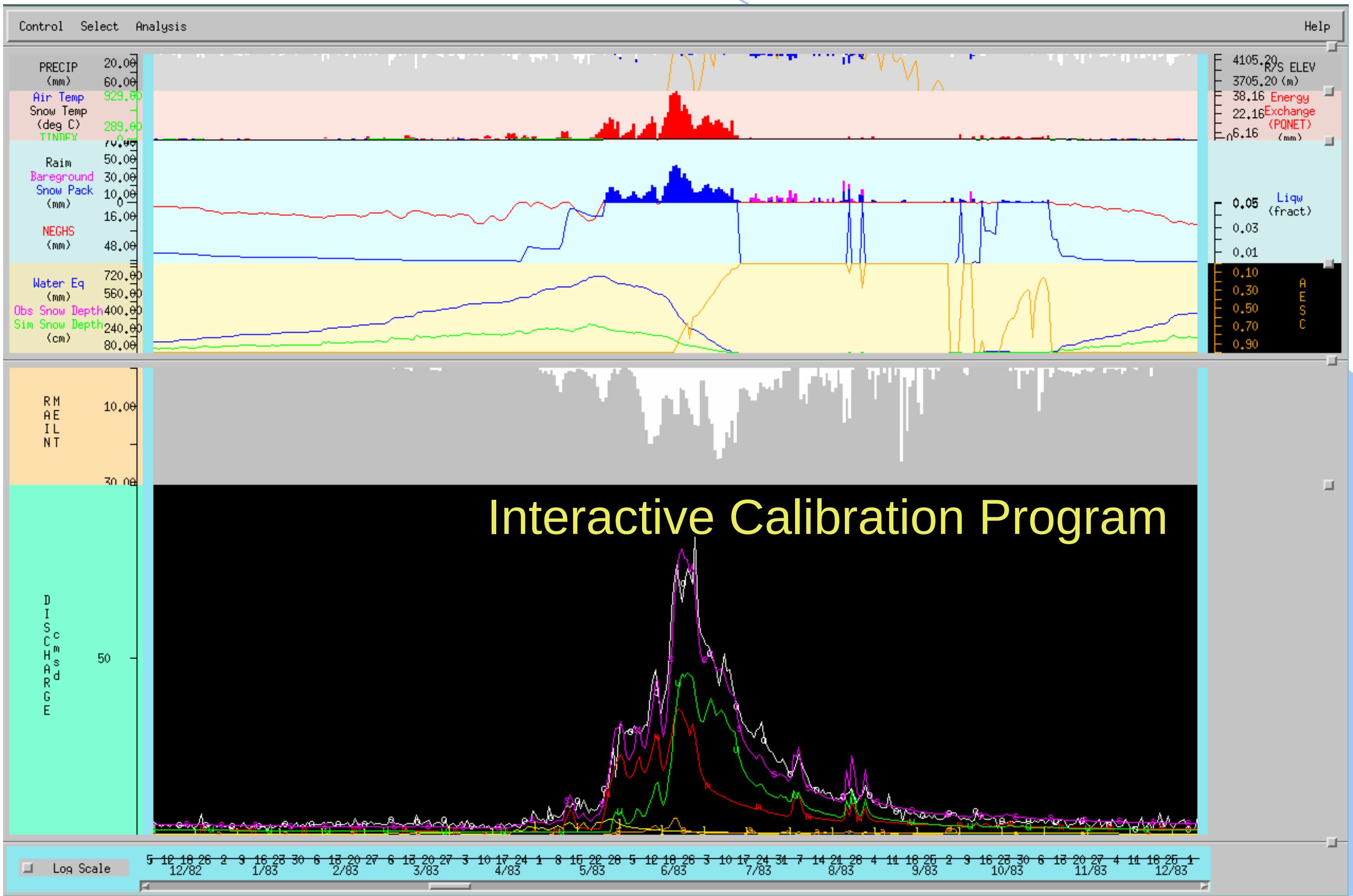
MCP3 - Output and Analysis

```
WY-PLOT      WSDC1
LAKE SONOMA INFLOW       2            339.1000.  YES
  WSDC1     QME          COMPUTED         O
  WSDC1     SQME         SIMULATED        S
  WSDC1     RAIM    6            WSDC1               WSDC1
WATERBAL    WSDC1
LAKE SONOMA INFLOW
WSDC1      QME   WSDC1      SQME       339.0       1  YES
LAKE SONOMA INFLOW       1.0  SNOW-17   WSDC1     SAC-SMA   WSDC1
STAT-QME    WSDC1
LAKE SONOMA INFLOW         339.  WSDC1    SQME   24  WSDC1    QME    24
STOP
```

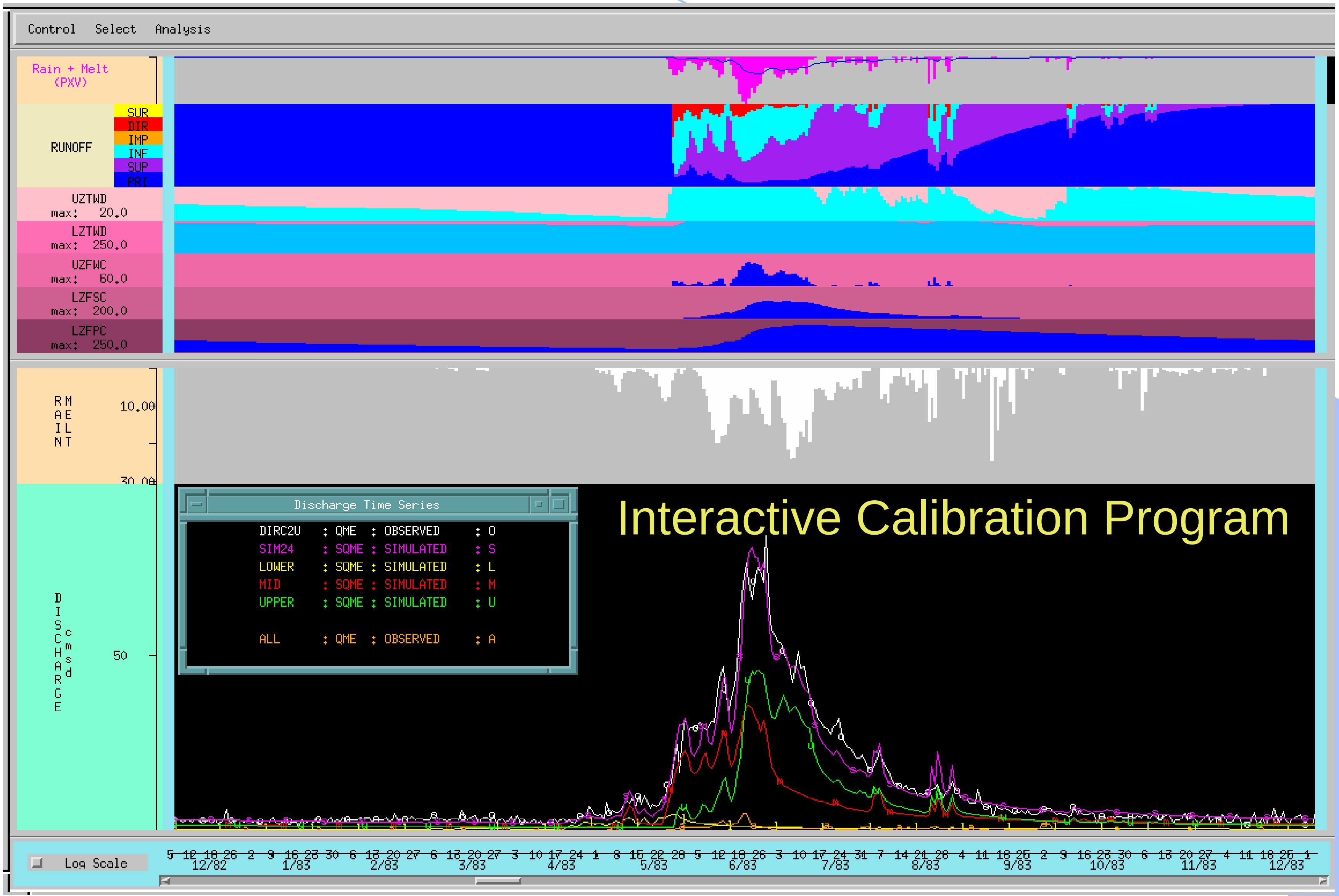
Calibration System Showing The Observed and Simulated Hydrograph



Calibration System Showing Snow-17 Information



Calibration System
Showing SACSMA Information



Sacramento Model Parameters

Edit SAC_SMA Parameters

operations—>	AREA5	AREA4	AREA3	AREA2	AREA1
UZTWM	125.	125.	125.	100.	100.
UZFWM	55.	55.	55.	55.	55.
UZK	0.30	0.30	0.30	0.30	0.30
PCTIM	0.000	0.000	0.000	0.000	0.000
ADIMP	0.01	0.01	0.01	0.01	0.01
RIVA	.000	.000	.000	0.005	0.005
ZPERC	20.	20.	20.	20.	20.
REXP	1.40	1.40	1.40	1.40	1.40
LZTWM	300.	300.	300.	300.	300.
LZFSM	110.	110.	110.	110.	110.
LZFPM	65.	65.	65.	65.	65.
LZSK	0.070	0.070	0.070	0.070	0.070
LZPK	0.005	0.005	0.005	0.006	0.006
PFREE	0.25	0.25	0.25	0.35	0.35
SIDE	.00	.00	.00	.00	.00
PE / ET	ET—demand Curve	ET—demand Curve	ET—demand Curve	ET—demand Curve	ET—demand Curve

Okay | Cancel | Preserve Ratio/Diff

Snow Model Parameters

Edit SNOW−17 Parameters

operations−>	AREA5	AREA4	AREA3	AREA2	AREA1
SCF	1.00	1.00	1.00	1.00	1.00
MFMAX	0.70	0.70	0.70	0.700	0.700
MFMIN	0.20	0.20	0.20	0.200	0.200
NMF	.15	.15	.15	.15	.15
UADJ	0.04	0.04	0.04	0.04	0.04
SI	300.	300.	300.	200.	200.
DAYGM	.1	.1	.1	.1	.1
MBASE	1.00	1.00	1.00	1.00	1.00
PXTEMP	2.	2.	2.	2.	2.
PLWHC	0.04	0.04	0.04	0.04	0.04
TIPM	0.25	0.25	0.25	0.25	0.25
AESC	Curve	Curve	Curve	Curve	Curve

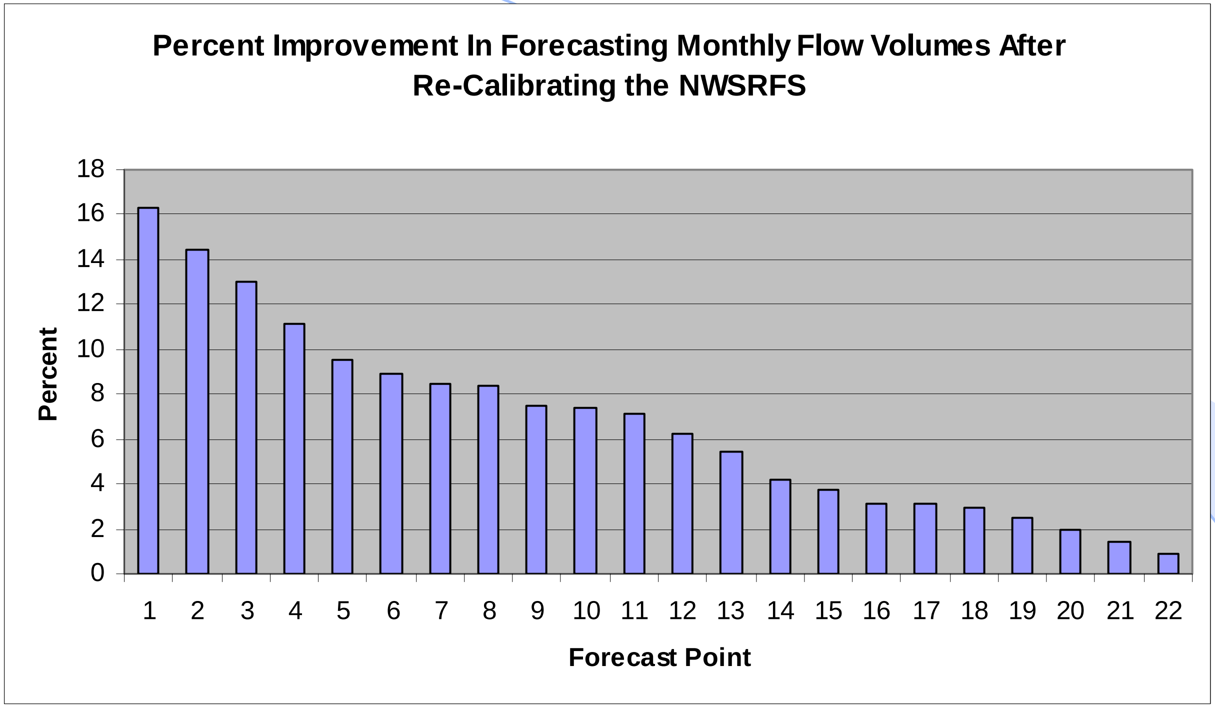
Okay Cancel Preserve Ratio/Diff

Calibration Experience

- Single watershed can take a week or more to develop. More experienced ==> less time.
- Save time by calibrating many watersheds in a river system or region.
- Keep good notes.
- Dedicate focused, uninterrupted time.

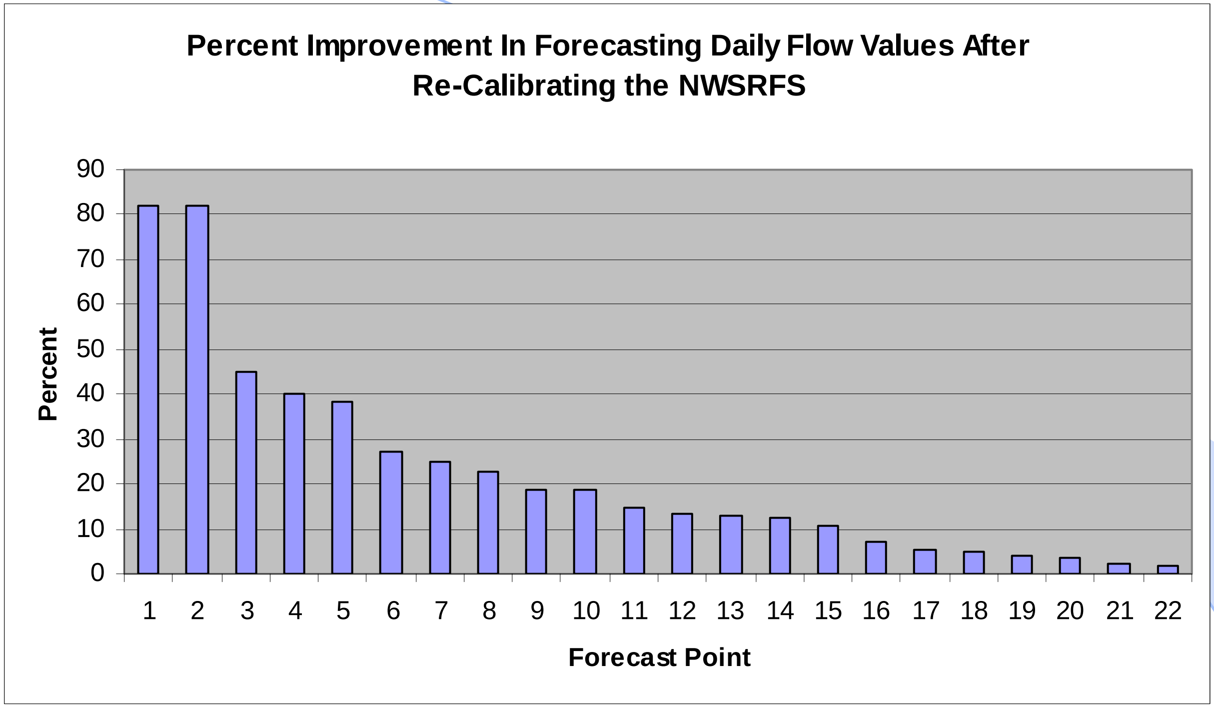
Operational Implementation

- Definition of model operations and calibrated parameters.
- Identification of real-time data sources.
- Operational computation of MAP, MAT, and adjusted streamflow.
- Use in context of river system.
- Carefully managed process.



<u>Forecast Points From</u>

Wyoming:	**1,3,18**
Colorado:	**5,6,7,8,10,11,12,14,15,16,20,22,23**
Arizona:	**9,17,19,21**
Utah:	**2,4,13**



<u>Forecast Points From</u>

Wyoming:	**1,3,18**
Colorado:	**5,6,7,8,10,11,12,14,15,16,20,22,23**
Arizona:	**9,17,19,21**
Utah:	**2,4,13**

Multi-Step Automatic Calibration Scheme (MACS)

Terri S. Hogue

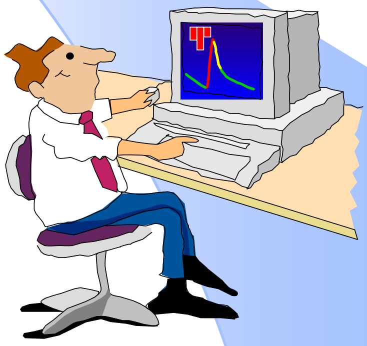
Soroosh Sorooshian, Hoshin Gupta, Claire Tomkins, and Travis Booth

October 22, 2002

Manual vs. Automatic Calibration

<u>Manual</u>

User knowledge
Excellent model calibrations
Complicated and highly labor intensive
Expertise not easily transferred



<u>Automatic</u>

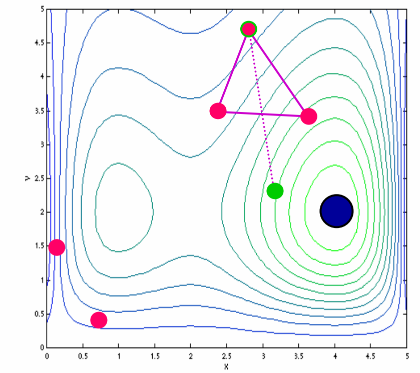
User knowledge
Speed and power of computer
Objective procedure
Easy to use
Results not generally acceptable

Automatic Calibration-Optimization

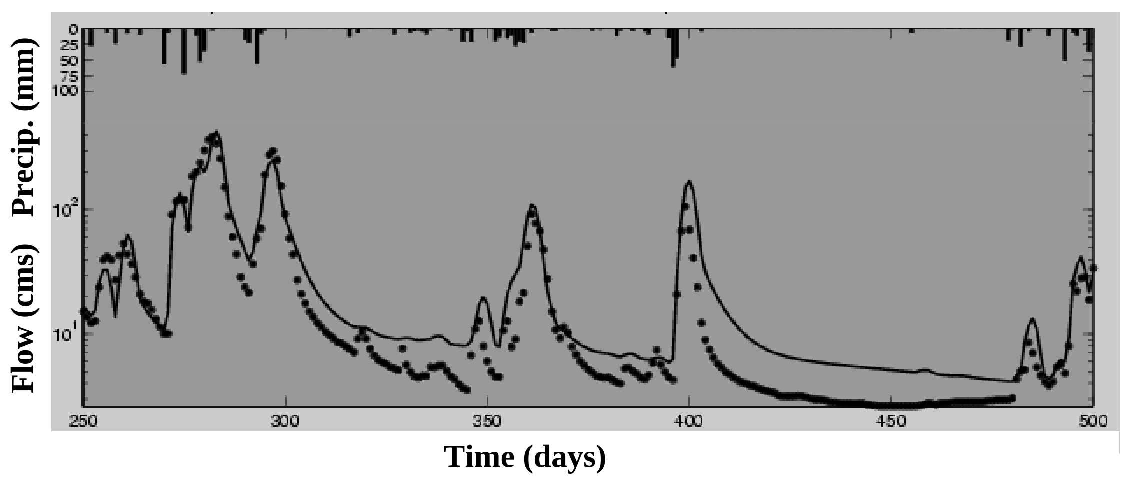
Objective Function (Root Mean Square)

$$DRMS=\sqrt{\frac{1}{n}\left(\sum_{t=1}^{n}(Q_{sim,t}-Q_{obs,t})^{2}\right)}$$

Optimization Algorithm (SCE-UA)

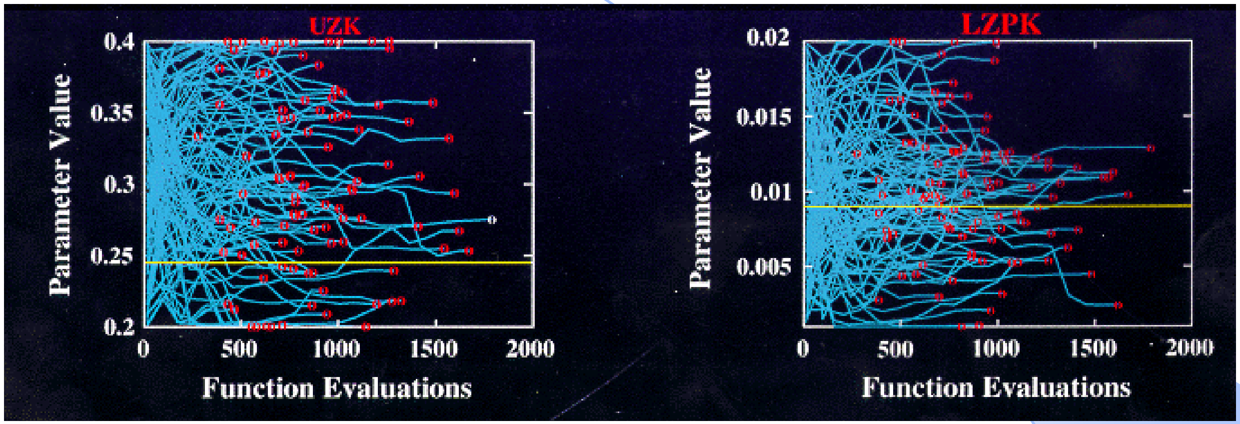


Historical Data

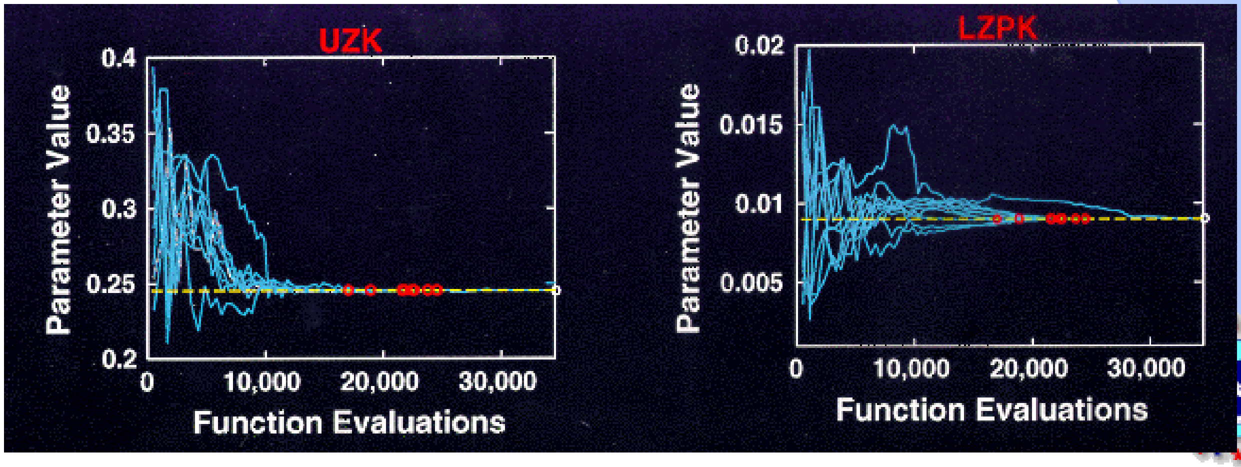


Performance: SCE-UA vs. Simplex

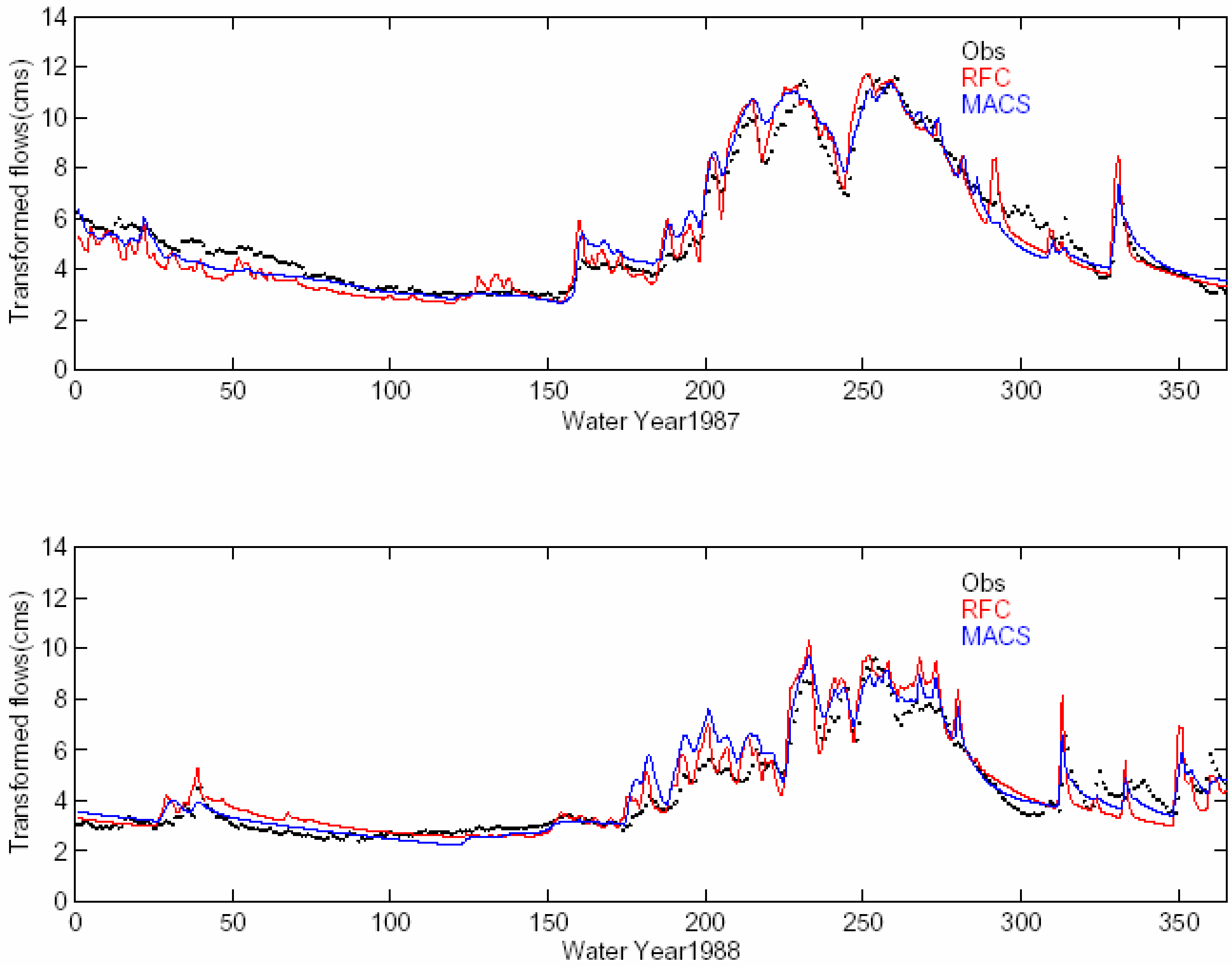
Simplex



SCE - UA



Test Basins
Showing Results of Manual verses Automatic Procedures



The End

Calibration Component