

VIII.3.3-ASSIM END OF OPERATIONS TO BE RE-EXECUTED BY ASSIMILATOR
OPERATION

Identifier: ASSIM

Operation Number: 50

Developed By: Riverside Technology, Inc.

Parameter Array: The FORTRAN identifier used for the parameter array for this Operation is PO.

The contents of the PO array are:

<u>Position</u>	<u>Contents</u>
1	Operation version number
2-6	General information
7-8	Assimilator parametric identifier
9	Number of subareas within basin
10	Number of days per discharge interval
11	Number of days per precipitation interval
12	Weight coefficient for discharge
13	Weight coefficient for precipitation
14	Weight coefficient for states
15-16	Observed discharge time series identifier
17	Observed discharge data type
18-19	Simulated discharge time series identifier
20	Simulated discharge data type
21	Maximum number of iterations for optimizer
22	Delta value for optimizer
23	Minimum criteria value for optimizer
24	Pointer to a list of rainfall/runoff Operation types
25	Pointer to a list of rainfall/runoff Operation identifiers

<u>Position</u>	<u>Contents</u>
26	Pointer to a list of PO arrays for rainfall/runoff models
27	Pointer to a list of CO arrays for rainfall/runoff models
28	Pointer to a list of KP TS identifiers
29	Pointer to a list of basin weights for precipitation
30	Pointer to a list of basin weights for states
31	Pointer to a list of lower boundaries for Kp
32	Pointer to a list of upper boundaries for Kp
33	Pointer to a list of state options
34	Pointer to a list of lower boundaries for Ks (depends on state options)
35	Pointer to a list of upper boundaries for Ks (depends on state options)
36	Pointer to a list of on/off switches for states (depends on state options)
37-40	Unused

Subroutines Names and Functions:

Subroutine Function

PIN50	Read input cards and stores values in PO array
PRP50	Print information from PO array
EX50	Execute the Operation
PUC50	Punch information from PO array
TAB50	Make entry into the Operations Table
FCAL50	Calculate the entire objective value
FQCL50	Calculate the portion of the objective function related to discharge
FPCL50	Calculate the portion of the objective function related to precipitation
FSCL50	Calculate the portion of the objective function

Subroutine Function

	related to soil moisture states
LDRV50	Execute Operations contained within the assimilator loop
OBJF50	Call routines to modify precipitation and states and then calculates the objective value
MDPR50	Modify precipitation used by rainfall/runoff model in D array by a multiplier
MDST50	Modify states used by rainfall/runoff model in C array by a multiplier
OPMK50	Rosenbrock optimization routine to obtain optimal Kp and Ks values
AUG50	Used by OPMK50 to search for 'best' solutions
SCRB50	Check stopping conditions for Rosenbrock optimization routine
PRSN50	Perform sensitivity analysis to determine 'best' precipitation basin/period weights
NPRS50	Load precipitation weights if precipitation analysis is not performed
SVRN50	Save values of Ks and Kp
SMTS50	Modify a given time series by a multiplier
NMSQ50	Calculate the number of missing values in a time series and returns the average value
BKPS50	Bundle values of Kp and Ks into one array
NMZE50	Normalize an array of values
UPKP50	Update the Kp time series
UPKS50	Update the Ks values in the ASSM parameter record

Subroutines PRP50 and PUC50 have the standard argument lists for these subroutines as given in Section VIII.4.3.

SUBROUTINE PIN50 (P,MP,PO,LEFTP,IUSEP)

Function: Reads input cards and stores values in PO array.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
P	Input	R*4	MP	Parameter array
MP	Input	I*4	1	Size of P array
PO	Output	R*4	Variable	Contains assimilator parameters and other information
LEFTP	Input	I*4	1	Space left in P array for use
IUSEP	Output	I*4	1	Space used in PO array for this Operation

SUBROUTINE TAB50 (P,MP,TO,LEFT,IUSET,NXT,LPO,PO,TS,MTS,NWORK,NDD,
LWORK,IDT)

Function: Operations Table entry routine for Operation ASSIM.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
P	Input	R*4	MP	Parameter array
MP	Input	I*4	1	Size of P array
TO	Output	R*4	Variable	A real array used to store the Operations table entries for the assimilator Operation
LEFT	Input	I*4	1	An integer Variable which indicates how much space in the T array is left
IUSET	Output	I*4	1	An integer Variable which indicates how much space in the T array is used by the Assimilator Operation
NOT	Input	I*4	1	An integer Variable which is the starting location of the TO array in the T array
LAO	Input	I*4	1	An integer Variable which is the starting location of the PO array in the P array
PO	Input	R*4	Variable	A real array used to store all of the parameters and other information for the Operation
TS	Input	R*4	Variable	A real array which contains information on all time series used by this segment
ITS	Input	I*4	1	The dimension of the TS array
WORK	Input	I*4	1	The first location in the D array available for use as working space
NDD	Input	I*4	1	The maximum number of days of data that can be held in the D array

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
WORK	Output	I*4	1	Size of the work space needed by the assimilator. Includes both the size needed by the assimilator Operation and the maximum size of all Operations contained within the assimilator loop
IDT	Output	I*4	1	The computational time interval for the assimilator Operation

Operation Table Array: The contents of the TO array are:

<u>Position</u>	<u>Description</u>
1	Operation Number
2	A pointer indicating where in the T array the entry for the next Operation to be executed begins
3	Starting position of the PO array
4	Starting position of the CO array
5	Number of sub-basins
6	Array of pointers to rainfall/runoff rain plus melt time series
6+BASINS	Array of time steps for rainfall/runoff rain plus melt time series
6+BASINS*2	Array of pointers to rainfall/runoff rain plus melt time series PO positions
6+BASINS*3	Array of pointers to rainfall/runoff rain plus melt time series CO positions
6+BASINS*4	Pointer to location of simulated discharge time series
7+BASINS*4	Pointer to location of observed discharge time series
8+BASINS*4	Array of pointers to Kp time series
8+BASINS*5	Pointer to starting location in D array which may be used for work space

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SUBROUTINE EX50 ( P,MP,C,MC,T,MT,TS,MTS,D,MD,IHZERO,PO,IP_PR,IPR_IDT,
                WP_B,WP_B_PRD,WS_B,RKPMIN,RKPMAX,IST_OP,RKSMIN,
                RKSMAX,ISTNF,QS,QO,IP_KP,RKPKS,IX,XN,XV,RKPOLD,
                TEMPTS,TEMP2TS,TEMP2TS,IP_RRPO,IP_RRCO,ROPTY,
                ROPID,ARRAY,ITSIZE)

```

Function: Executes Operation ASSIM.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
P	Input	R*4	MP	Parameter array
MP	Input	I*4	1	Size of P array
C	Both	R*4	MC	Carryover array
MC	Input	I*4	1	Size of C array
T	Input	R*4	MT	Operations Table array
MT	Input	I*4	1	Size of T array
TS	Input	R*4	ITS	Time series array
ITS	Input	I*4	1	Size of TS array
D	Both	R*4	MD	Time series data array
MD	Input	I*4	1	Size of D array
IHZERO	Input	I*4	1	Zero hour of run
PO	Input	R*4	Variable	Starting position in the P array for the assimilator parameter array
IP_PR	Input	I*4	Variable	Array of pointers to the MAP precipitation time series in the D array
IPR_IDT	Input	I*4	Variable	Array of time intervals corresponding to the MAP time series in IP_PR
WP_B	-	R*4	Variable	Array of precipitation basin weights
WP_B_PRD	-	R*4	Variable	Array of precipitation weights (one per basin per period)
WS_B	-	R*4	Variable	Array of state basin weights

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
RKPMIN	-	R*4	Variable	Array of Kp minimal values
RKPMAX	-	R*4	Variable	Array of KP maximum values
IST_OP	-	I*4	Variable	Array of state options
RKSMIN	-	R*4	Variable	Array of Ks minimal values
RKSMAX	-	R*4	Variable	Array of Ks maximum values
ISTNF	-	I*4	Variable	Array of state on/off values
QS	I	R*4	Variable	Simulated discharge data
QO	I	R*4	Variable	Observed discharge data
IP_KP	I	I*4	Variable	Array of pointers to the KP time series in D array
RKPKS	-	R*4	Variable	Array which contains KP and KS variables
IX	-	I*4	Variable	Order of optimized parameters
XN	-	R*4	Variable	Array of minimal values corresponding to RKPKS
XV	-	R*4	Variable	Array of maximum values corresponding to RKPKS
RKPOLD	-	R*4	Variable	Initial basin KP values at subroutine execution
TEMPPTS	-	R*4	ITSIZE	A two-dimension work array used by the optimization routine
TEMP2TS	-	R*4	ITSIZE	A two-dimension work array used by optimization routine
IP_RRPO	I	I*4	Variable	An array of pointers to the rainfall/runoff PO arrays
IP_RRCO	I	I*4	Variable	An array of pointers to the rainfall/runoff CO arrays
ROPTY	-	R*4	Variable	Array of rainfall/runoff Operation names
ROPID	-	R*4	Variable	Array of rainfall/runoff Operation identifiers
ARRAY	-	R*4	100	Work array

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
ITSIZE	I	I*4	1	Dimension of TEMP2TS and TEMPTS array

```
REAL FUNCTION FCAL50 (QS,QO,NDAYS,WQ,NDQ_PER_PRD,NQ_PRDS,ISTART,
                     QAVE,RKPKS,NBASINS,NPR_PRDS,RKPOLD,WP_B_PRD,
                     WP, WS_B,WS,IST_OP,FQ,FPFS)
```

Function: Calculates the entire objective value.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
QS	Input	R*4	Variable	Simulated discharge time series
QO	Input	R*4	Variable	Observed discharge time series
NDAYS	Input	I*4	1	Total number of days in run period
WQ	Input	R*4	1	Discharge weight
NDQ_PER_PRD	Input	I*4	1	Number of days per discharge period
NQ_PRDS	Input	I*4	1	Number of discharge periods
ISTART	Input	I*4	1	Starting day index
QAVE	Input	R*4	1	Average value of observed discharge over run period
RKPKS	Input	R*4	Variable	Array containing Kp and Ks values
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods
RKPOLD	Input	R*4	Variable	Array of initial Kp values
WP_B_PRD	Input	R*4	Variable	Array of precipitation weights (one per basin per period)
WP	Input	R*4	1	Weight for precipitation term of objective function
WS	Input	R*4	1	Weight for state term of objective function
WS_B	Input	R*4	Variable	Array of state weights (one per basin)
IST_OP	Input	I*4	Variable	Array of state options

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
FQ	Output	R*4	1	Value of discharge term of objective function
FP	Output	R*4	1	Value of precipitation term of objective function
FS	Output	R*4	1	Value of state term of objective function

REAL FUNCTION FQCL50 (QS,QO,NDAYS,WQ,NDQ_PER_PRD,NQ_PRDS,ISTART,QAVE)

Function: Calculates the discharge portion of the objective function.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
QS	Input	R*4	Variable	Simulated discharge time series
QO	Input	R*4	Variable	Observed discharge time series
NDAYS	Input	I*4	1	Total number of days in run period
WQ	Input	R*4	1	Discharge weight
NDQ_PER_PRD	Input	I*4	1	Number of days per discharge period
NQ_PRDS	Input	I*4	1	Number of discharge periods
ISTART	Input	I*4	1	Starting day index
QAVE	Input	R*4	1	Average value of observed discharge over run period

REAL FUNCTION FPCL50 (RKPKS,NBASINS,NPR_PRDS,WP_B_PRD,RKPOLD,WP)

Function: Calculates the precipitation portion of the objective function.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
RKPKS	Input	R*4	Variable	Array containing Kp and Ks values
BASINS	Input	I*4	Variable	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods
WP_B_PRD	Input	R*4	Variable	Array of precipitation weights (one per basin per period)
RKPOLD	Input	R*4	Variable	Array of initial Kp values
WP	Input	R*4	1	Weight for precipitation term of objective function

REAL FUNCTION FSCL50 (NBASINS,NPR_PRDS,RKPKS,WS_B,WS,IST_OP)

Function: Calculates the state portion of the objective function.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods
RKPKS	Input	R*4	Variable	Array containing Kp and Ks values
WS_B	Input	R*4	Variable	Array of state weights (one per basin)
WS	Input	R*4	1	Weight for state term of objective function
IST_OP	Input	I*4	Variable	Array of state options

SUBROUTINE LDRV50 (P,MP,C,MC,T,MT,TS,MTS,D,MD,IHZERO)

Function: Executes the Operations in the assimilator loop.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
P	Input	R*4	MP	Parameter array
MP	Input	I*4	1	Size of parameter array
C	Both	R*4	MC	Carryover array
MC	Input	I*4	1	Size of carryover array
T	Input	R*4	MT	Operations table array
MT	Input	I*4	1	Size of Operations table array
TS	Input	R*4	ITS	Time series array
ITS	Input	I*4	1	Size of time series array
D	Both	R*4	MD	Time series data array
MD	Input	I*4	1	Size of time series data array
IHZERO	Input	I*4	1	Zero hour of run

SUBROUTINE OBJ50 (VALUE,NBASINS,NPR_PRDS,NDP_PER_PRD,IP_PR,IPR_IDT,
D,RKPKS,IST_OP,ISTNF,C,IP_RRCO,QS,QO,NDAYS,WQ,
NDQ_PER_PRD,NQ_PRDS,ISTART,QAVE,RKPOLD,WP_B_PRD,WP,
WS_B,WS,P,MP,MC,T,MT,TS,MTS,MD,IHZERO,IP_RRPO)

Function: Calls routines to modify precipitation and states and then calculates objective value.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
VALUE	Output	R*4	1	Value of objective function
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods
NDP_PER_PRD	Input	I*4	1	Number of days per precipitation period
IP_PR	Input	I*4	Variable	Array of pointers to the MAP precipitation time series in D array
IPR_IDT	Input	I*4	Variable	Array of time intervals corresponding to the MAP time series in IP_PR
D	Both	R*4	MD	Time series data array
RKPKS	Input	R*4	Variable	Array of Kp and Ks values
IST_OP	Input	I*4	Variable	Array of state options
ISTNF	Input	I*4	Variable	Array of state on/off values
C	Both	R*4	MC	Carryover array
IP_RRCO	Input	I*4	Variable	Array of pointers to the rainfall/runoff CO arrays
QS	Both	R*4	Variable	Simulated discharge time series
QO	Input	R*4	Variable	Observed discharge time series
NDAYS	Input	I*4	1	Number of days or run period
WQ	Input	R*4	1	Weight of discharge term in objective function
NDQ_PER_PRD	Input	I*4	1	Number of days per discharge

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
				period
NQ_PRDS	Input	I*4	1	Number of discharge periods
ISTART	Input	I*4	1	Starting day index
QAVE	Input	R*4	1	Average value of observed discharge over run period
RKPOLD	Input	R*4	Variable	Array of initial Kp values
WP_B_PRD	Input	R*4	Variable	Array of precipitation weights (one per basin per period)
WP	Input	R*4	1	Weight for precipitation term of objective function
WS_B	Input	R*4	Variable	Array of state weights (one per basin)
WS	Input	R*4	1	Weight for state term of objective function
P	Input	R*4	MP	Parameter array
MP	Input	I*4	1	Size of P array
MC	Input	I*4	1	Size of C array
T	Input	R*4	MT	Operations Table array
MT	Input	I*4	1	Size of T array
TS	Input	R*4	ITS	Time Series array
ITS	Input	I*4	1	Size of TS array
MD	Input	I*4	1	Size of D array
IHZERO	Input	I*4	1	Zero hour of run
IP_RRPO	Input	I*4	Variable	Array of pointers to the rainfall/runoff PO array

SUBROUTINE MDP50 (NBASINS,NPR_PRDS,NDP_PER_PRD,IP_PR,IPR_IDT,D,
RKPXS,INV)

Function: Modifies precipitation used by rainfall/runoff model in D array by a multiplier.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods
NDP_PER_PRD	Input	I*4	1	Number of days per precipitation period
IP_PR	Input	I*4	Variable	Array of pointers to the MAP precipitation time series in D array
IPR_IDT	Input	I*4	Variable	Array of time intervals corresponding to the MAP time series in IP_PR
D	Both	R*4	MD	Time series data array
RKPXS	Input	R*4	Variable	Array of Kp and Ks values
INV	Input	I*4	1	Modify precipitation flag

SUBROUTINE MDST50 (NBASINS,IST_OP,ISTNF,C,IP_RRCO,NPR_PRDS,RKPKS,
IP_RRPO,P,INV)

Function: Modifies states used by rainfall/runoff model in C array by a multiplier.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
BASINS	Input	I*4	1	Number of sub-basins
IST_OP	Input	I*4	Variable	Array of state options
ISTNF	Input	I*4	Variable	Array of state on/off values
C	Both	R*4	MC	Carryover array
IP_RRCO	Input	I*4	Variable	Array of pointers to the rainfall/runoff CO arrays
NPR_PRDS	Input	I*4	1	Number of sub-basins
RKPKS	Input	R*4	Variable	Array of Kp and Ks values
IP_RRPO	Input	I*4	Variable	Array of pointers to the rainfall/runoff PO arrays
P	Input	R*4	MP	Parameter array
INV	Input	I*4	1	Flag variable on whether to modify states by Ks or 1/Ks

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SUBROUTINE OPMK50 (NB,X,AB,ZB,M,MOPT,DELTF,VALUEF,IX,XN,XV,NBASINS,
NPR_PRDS,NDP_PER_PRD,IP_PR,IPR_IDT,D_A,IST_OP,ISTNF,
C_A,IP_RRCO,QS,QO,NDAYS,WQ,NDQ_PER_PRD,NQ_PRDS,
ISTART,QAVE,RKPOLD,WP_B_PRD,WP,WS_B,WS,P_A,
MP,MC,T_A,MT,TS,MTS,MD,IHZERO,IP_RRPO,ITSIZE)

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Function: Rosenbrock optimization routine to obtain optimal Kp and Ks values.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
NB	Input	I*4	1	Number of values in RKPKS array
X	Both	R*4	Variable	Values in RKPKS optimized on
AB	-	R*4	ITSIZE	Two-dimension work array
ZB	-	R*4	ITSIZE	Two-dimension work array
M	Output	I*4	1	Number of iterations run in optimizer
MOPT	Input	I*4	1	Maximum number of iterations in optimizer
DELTF	Input	R*4	1	Minimum allowed change stopping condition
VALUEF	Input	R*4	1	Criteria value at which optimizer will stop
IX	Input	I*4	Variable	Order of optimized parameters
XN	Input	R*4	Variable	Array of minimal values corresponding to RKPKS
XV	Input	R*4	Variable	Array of maximum values corresponding to RKPKS
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods
NDP_PER_PRD	Input	I*4	1	Number of days per precipitation period
IP_PR	Input	I*4	Variable	Array of pointers to the MAP precipitation time series in D

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
				array
IPR_IDT	Input	I*4	Variable	Array of time intervals corresponding to the MAP time series in IP_PR
D_A	Both	R*4	MD	Time series data array
IST_OP	Input	I*4	Variable	Array of state options
ISTNF	Input	I*4	Variable	Array of state on/off values
C_A	Both	R*4	MC	Carryover array
IP_RRCO	Input	I*4	Variable	Array of pointers to the rainfall/runoff CO arrays
QS	Both	R*4	Variable	Simulated discharge time series
QO	Input	R*4	Variable	Observed discharge time series
NDAYS	Input	I*4	1	Total number of days in run period
WQ	Input	R*4	1	Discharge weight
NDQ_PER_PRD	Input	I*4	1	Number of days per discharge period
NQ_PRDS	Input	I*4	1	Number of discharge periods
ISTART	Input	I*4	1	Starting day index
QAVE	Input	R*4	1	Average value of observed discharge over run period
RKPOLD	Input	R*4	Variable	Array of initial Kp values
WP_B_PRD	Input	R*4	Variable	Array of precipitation weights (one per basin per period)
WP	Input	R*4	1	Weight for precipitation term of objective function
WS_B	Input	R*4	Variable	Array of state weights (one per basin)
WS	Input	R*4	1	Weight for state term of objective function
P_A	Input	R*4	MP	Parameter array

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
MP	Input	I*4	1	Size of P array
MC	Input	I*4	1	Size of C array
T_A	Input	R*4	1	Operations Table array
MT	Input	I*4	1	Size of T array
TS	Input	R*4	ITS	Time series array
ITS	Input	I*4	1	Size of time series array
MD	Input	I*4	1	Size of time series data array
IHZERO	Input	I*4	1	Initial hour or run
IP_RRPO	Input	I*4	Variable	Array of pointers to the rainfall/runoff PO arrays
ITSIZE	Input	I*4	1	Size of arrays AB and ZB

SUBROUTINE AUG50 (H,NB,X,ZB,AB,L,IX,XN,XV,ITSIZE)

Function: Called by OPMK50 to search for the 'best' solutions.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
H	Input	R*4	1	Input multiplier
NB	Input	I*4	1	Number of values in RKPKS array
X	Both	R*4	Variable	Values in RKPKS optimized on
ZB	Both	R*4	Variable	Two-dimension work array
AB	Both	R*4	Variable	Two-dimension work array
L	Input	I*4	1	Array subscript
IX	-	I*4	Variable	Order of optimized parameters
XN	-	R*4	Variable	Array of minimal values corresponding to RKPKS
XV	-	R*4	Variable	Array of maximum values corresponding to RKPKS
ITSIZE	Input	I*4	1	Size of TEMP2TS array

SUBROUTINE SCRB50 (NB,X,F1,ICS,M,MOPT,DELTF,VALUEF,STORE)

Function: Checks stopping conditions for Rosenbrock optimization routine.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
NB	Input	I*4	1	Number of elements in X array
X	Input	R*4	Variable	RKPKS array
F1	Input	R*4	1	Current objective value
ICS	Both	I*4	1	Stopping condition variable
M	Input	I*4	1	Current iteration number
MOPT	Input	I*4	1	Maximum number of iterations in optimizer
DELTF	Input	R*4	1	Minimum allowed change stopping condition
VALUEF	Input	R*4	1	Criteria value at which optimizer will stop
STORE	Both	R*4	1	Previous objective value


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SUBROUTINE PRSN50 ( P,MP,C,MC,T,MT,TS,MTS,D,MD,IHZERO,QS,QO,NDAYS,WQ,
NDQ_PER_PRD,NQ_PRDS,ISTART,NBASINS,NPR_PRDS,IP_PR,
IPR_IDT,NDP_PER_PRD,WP_B,WP_B_PRD,QAVE)

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Function: Performs sensitivity analysis to determine 'best' precipitation basin/period weights.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
P	Input	R*4	MP	Parameter array
MP	Input	I*4	1	Size of P array
C	Input	R*4	MC	Carryover array
MC	Input	I*4	1	Size of C array
T	Input	R*4	MT	Operations Table array
MT	Input	I*4	1	Size of T array
TS	Input	R*4	ITS	Time series array
ITS	Input	I*4	1	Size of time series array
D	Input	R*4	MD	Time series data array
MD	Input	I*4	1	Size of time series data array
IHZERO	Input	I*4	1	Hour zero of run period
QS	Both	R*4	Variable	Simulated discharge time series
QO	Input	R*4	Variable	Observed discharge time series
NDAYS	Input	I*4	1	Total number of days in run period
WQ	Input	R*4	1	Discharge weight
NDQ_PER_PRD	Input	I*4	1	Number of days per discharge period
NQ_PRDS	Input	I*4	1	Number of discharge periods
ISTART	Input	I*4	1	Starting day index
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
				periods
IP_PR	Input	I*4	Variable	Array of pointers to the MAP precipitation time series in D array
IPR_IDT	Input	I*4	Variable	Array of time intervals corresponding to the MAP time series in IP_PR
NDP_PER_PRD	Input	I*4	1	Number of days per precipitation period
WP_B	Input	R*4	Variable	Array of precipitation basin weights
WP_B_PRD	Output	R*4	Variable	Array of precipitation weights (one per basin per period)
QAVE	Input	R*4	1	Average value of observed discharge over run period

SUBROUTINE NPRS50 (WP_B,WP_B_PRD,NBASINS,NPR_PRDS)

Function: Loads precipitation weights if precipitation sensitivity analysis is not performed.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
WP_B	Input	R*4	Variable	Array of precipitation basin weights
WP_B_PRD	Output	R*4	Variable	Array of precipitation weights (one per basin per period)
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods

```

SUBROUTINE SVRN50 (VALUE,NBASINS,NPR_PRDS,NDP_PER_PRD,IP_PR,
  IPR_IDT,D,RKPKS,IST_OP,ISTNF,C,IP_RRCO,QS,QO,
  NDAYS,WQ,NDQ_PER_PRD,NQ_PRDS,ISTART,QAVE,RKPOLD,
  WP_B_PRD,WP,WS_B,WS,P,MP,MC,T,MT,TS,
  MTS,MD,IHZERO,IP_RRPO,IAWARN,ARRAY,ASSMID)

```

Function: Saves values of Kp and Ks.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
VALUE	Output	R*4	1	Value of objective function
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods
NDP_PER_PRD	Input	I*4	1	Number of days per precipitation period
IP_PR	Input	I*4	Variable	Array of pointers to the MAP precipitation time series in D array
IPR_IDT	Input	I*4	Variable	Array of time intervals corresponding to the MAP time series in IP_PR
D	Both	R*4	MD	Time series data array
RKPKS	Input	R*4	Variable	Array of Kp and Ks values
IST_OP	Input	I*4	Variable	Array of state options
ISTNF	Input	I*4	Variable	Array of state on/off switches
C	Both	R*4	MC	Carryover array
IP_RRCO	Input	I*4	Variable	Array of pointers to the rainfall/runoff CO arrays
QS	Both	R*4	Variable	Simulated discharge time series
QO	Input	R*4	Variable	Observed discharge time series
NDAYS	Input	I*4	1	Total number of days in run period
WQ	Input	R*4	1	Discharge weight

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
NDQ_PER_PRD	Input	I*4	1	Number of days per discharge period
NQ_PRDS	Input	I*4	1	Number of discharge periods
ISTART	Input	I*4	1	Starting day index
QAVE	Input	R*4	1	Average value of observed discharge over run period
RKPOLD	Input	R*4	Variable	Array of initial Kp values
WP_B_PRD	Input	R*4	Variable	Array of precipitation weights; one per basin period
WP	Input	R*4	1	Weight for precipitation term of objective function
WS_B	Input	R*4	Variable	Array of state weights (one per basin)
WS	Input	R*4	1	Weight for state term of objective function
P	Input	R*4	MP	Parameter array
MP	Input	I*4	1	Size of P array
MC	Input	I*4	1	Size of C array
T	Input	R*4	MT	Operations table array
MT	Input	I*4	1	Size of T array
TS	Input	R*4	ITS	Time series array
ITS	Input	I*4	1	Size of time series array
MD	Input	I*4	1	Size of time series data array
IHZERO	Input	I*4	1	Zero hour of run
IP_RRPO	Input	I*4	Variable	Array of pointers to the rainfall/runoff PO arrays
IAWARN	Input	I*4	1	Flag indicating whether to write ASSM record
ARRAY	Input	R*4	Variable	Array containing ASSM parametric data
ASSMID	Input	A4	2	Assimilator parametric identifier

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
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SUBROUTINE SMTS50 (D,I_PR,I_IDT,MULT,PRD_NUM,NDP_PER_PRD,NPR_PRDS)

Function: Modifies a precipitation time series by a multiplier.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
D	Input	R*4	MD	Time series data array
I_PR	Input	I*4	1	Pointer to a sub-basin precipitation time series in D array
I_IDT	Input	I*4	1	Time interval for precipitation time series in D array
MULT	Input	R*4	1	Multiplier to use on precipitation
PRD_NUM	Input	I*4	1	The period of which the multiplier is being applied
NDP_PER_PRD	Input	I*4	1	Number of days per precipitation period
NPR_PRDS	Input	I*4	1	Number of sub-basins

SUBROUTINE NMSQ50 (QO, ISTART, IEND, NMISS_Q_DAYS, QAVE)

Function: Calculates the number of missing values in the observed discharge time series. Also returns the average value of all non-missing days.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
QO	Input	R*4	Variable	Observed discharge time series
ISTART	Input	I*4	1	Starting day index
IEND	Input	I*4	1	Ending day index
NMISS_Q_DAYS	Output	I*4	1	Number of days with missing values in observed discharge time series
QAVE	Output	R*4	1	Average value of observed discharge over run period

SUBROUTINE BKPS50 (NBASINS, ISTART, NPR_PRDS, NDP_PER_PRD, D, IP_KP, RKPKS, IPR_EX_DAYS, RKPMIN, RKPMAX, RKSMIN, RKSMAX, NSIZE, IST_OP, IX, XN, XV, RKPOLD, ARRAY)

Function: Bundles values of Kp and Ks into one array.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
BASINS	Input	I*4	1	Number of sub-basins
ISTART	Input	I*4	1	Starting day index
NPR_PRDS	Input	I*4	1	Number of precipitation periods
NDP_PER_PRD	Input	I*4	1	Number of days per precipitation period
D	Input	R*4	MD	Time series data array
IP_KP	Input	I*4	Variable	Array of pointers to the KP time series in D array
RKPKS	Output	R*4	Variable	Array of Kp and Ks values
IPR_EX_DAYS	Input	I*4	1	Number of extra days in last precipitation period
RKPMIN	Input	R*4	Variable	Array of Kp minimal values
RKPMAX	Input	R*4	Variable	Array of KP maximum values
RKSMIN	Input	R*4	Variable	Array of Ks minimal values
RKSMAX	Input	R*4	Variable	Array of Ks maximum values
NSIZE	Output	I*4	1	Size of RKPKS array
IST_OP	Input	I*4	Variable	Array of state options
IX	Output	I*4	Variable	Order of optimized parameters
XN	Output	R*4	Variable	Array of minimal values corresponding to RKPKS
XV	Output	R*4	Variable	Array of maximum values corresponding to KPKS
RKPOLD	Output	R*4	Variable	Array of initial Kp values
ARRAY	Input	R*4	100	Work array

SUBROUTINE NMZE50 (NBASINS,W_B)

Function: Normalizes an array of values.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
NASINS	Input	I*4	1	Number of sub-basins
W_B	Both	R*4	Variable	Precipitation or state weights associated with the sub-basins

SUBROUTINE UPKP50 (ISTART,NBASINS,NPR_PRDS,NDP_PER_PRD,D,IP_KP,RKPKS,
IPR_EX_DAYS)

Function: Updates the Kp time series from the values stored in the RKPKS array.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
ISTART	Input	I*4	1	Starting day index
BASINS	Input	I*4	1	Number of sub-basins
NPR_PRDS	Input	I*4	1	Number of precipitation periods
NDP_PER_PRD	Input	I*4	1	Number of days per precipitation period
D	Both	R*4	MD	Time series data array
IP_KP	Input	I*4	Variable	Array of pointers to the KP time series in D array
RKPKS	Input	R*4	Variable	Array of Kp and Ks values
IPR_EX_DAYS	Input	I*4	1	Number of extra days in last precipitation

SUBROUTINE UPKS50 (ASSMID,NBASINS,ROPTY,ROPID,IST_OP,RKPKS,
NPR_PRDS,ARRAY)

Function: Updates the Ks values in the ASSIM parameter record.

Argument List:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
ASSMID	Input	R*4	2	Assimilator unique parameter identifier
BASINS	Input	I*4	1	Number of sub-basins
ROPTY	Input	R*4	Variable	Array of rainfall/runoff Operation names
ROPID	Input	R*4	Variable	Array of rainfall/runoff Operation identifier
IST_OP	Input	I*4	Variable	Array of state options
RKPKS	Input	R*4	Variable	Array of Kp and Ks values
NPR_PRDS	Input	I*4	1	Number of precipitation periods
ARRAY	Output	R*4	100	Work array