

V.3.3-WATERBAL WATER BALANCE SUMMARY OPERATION

Identifier: WATERBAL

Application: Calibration programs only

Description: This Operation generates displays representing the components of the water balance over a watershed.

The Operation is designed for use with either the Sacramento or Continuous API rainfall-runoff model. Use of the snow model with either rainfall-runoff model is optional.

The following information is printed:

1. Snow and rainfall-runoff model components for each month are displayed at the end of a water year for each subarea. This includes water balance and runoff components and end of month contents.
2. Annual average values of precipitation, runoff, evaporation, snowfall and recharge will be computed for the run period for the complete drainage area. Values for each year can optionally be displayed.
3. Average, high and low values of the end of month Sacramento model storage contents for the entire run period can optionally be displayed.

Only displays 1 and 2 will be printed when the Continuous API Model is used.

Because the Operation does the water balance based on the hydrologic year, the run period must start in October.

Allowable Data Time Interval: 24 hours

Time Series Used: Time series used in this Operation are as follows:

<u>General Type</u>	<u>Dimn</u>	<u>Units</u>	<u>Use</u>	<u>Required</u>	<u>Data Time Interval</u>	<u>Missing Values Allowed</u>
Mean daily Simulated discharge	L3	CMSD	I	yes	24	no
Mean daily Observed discharge	L3	CMSD	I	yes	24	yes

Input Summary: The card input for this Operation is as follows:

<u>Card</u>	<u>Format</u>	<u>Columns</u>	<u>Contents</u>
1	5A4	1-20	General user supplied heading information
2	2A4	1-8	Internal identifier for observed discharge time series
	2X,A4	11-14	Data type code for observed discharge time series
	2X,2A4	17-24	Internal identifier for simulated discharge time series
	2X,A4	27-30	Data type code for simulated discharge time series
	2X,F10.3	33-42	Total drainage area for all subareas considered
	2X,I5	45-49	Number of subareas for which displays are to be generated
	2X,A3	52-54	Option to display water balance component values for each year for the complete drainage area - enter 'YES' to specify option
	3X,A3	58-60	Option to display average, high and low values of the end of month Sacramento model storage contents - enter 'YES' to specify option
3	5A4	1-20	General user supplied heading for subarea
	2X,F5.3	23-27	Weighting factor: S same as specified in 'WEIGH-TS' Operation if there is more than one subarea S 1.00 if only one subarea is used
	2X,2A4	30-37	Snow Operation type - currently only 'SNOW-17' is available - option to store sums of snow cover water balance variables must be turned on for this Operation - leave blank if a snow model is not used
	2X,2A4	40-47	Internal name for snow model
	2X,2A4	50-57	Rainfall-Runoff Operation type - currently only 'SAC-SMA' and 'API-CONT'

Card Format Columns Contents

are allowed - option to store water balance sums must be turned on for this Operation

2X,2A4 60-67 Internal name for rainfall-runoff model

Repeat card 3 for each subarea.

Sample Input and Output: Sample input is shown in Figure 1. Sample output from the parameter print routine is shown in Figure 2. Sample output from the execution routine is shown in Figure 3.

Error and Warning Messages: The error and warning messages generated by this Operation and the corrective action to take when they occur are as follows:

A. Messages that can occur during setup:

1. ****ERROR**** THE NUMBER OF SUBAREAS (XXXXX) EXCEEDS THE MAXIMUM NUMBER OF SPACES (XXXXX) IN ARRAY LOCPL.

Action: Decrease the number of subareas.

2. ****ERROR**** OPERATION (XXXXXXXX) (XXXXXXXX) DOES NOT EXIST. CHECK OPERATION NAME.

Action: Check columns 40-47 and 60-67 of card 3. Make sure that the Operation name is specified correctly and that it has previously been associated with the appropriate Operation.

3. ****ERROR**** OPERATION (XXXXXXXX) (XXXXXXXX) IS NOT A VALID SNOW OPERATION FOR USE WITH THE WATERBAL OPERATION.

Action: Check columns 30-37 of card 3. Make sure that snow model is being read in as 'SNOW-17'.

4. ****ERROR**** THE OPTION TO STORE SUMS HAS NOT BEEN TURNED ON FOR (XXXXXXXX) (XXXXXXXX)

Action: Check the input for the indicated Operation. Make sure that the option to store sums has been turned on.

5. ****ERROR**** THE MULTI-YEAR ZONE CONTENTS DISPLAY MAY ONLY BE USED WITH THE SACRAMENTO MODEL.

Action: Do not specify this option when the Continuous API model is being used.

6. ****ERROR**** THIS OPERATION CANNOT BE USED WITHOUT A RAINFALL-RUNOFF MODEL.

Action: Provide the necessary input for either the Sacramento or Continuous API model.

7. **ERROR** OPERATION (XXXXXXXX) (XXXXXXXX) IS NOT A VALID RAINFALL-RUNOFF OPERATION FOR USE WITH THE WATERBAL OPERATION.

Action: Check columns 50-57 of card 3. Make sure that the model type being read in is 'SAC-SMA' or 'API-CONT'.

8. **ERROR** THE SUM OF THE SUBAREA WEIGHTS DOES NOT EQUAL 1.00.

Action: Check columns 23-27 of card 3. Make sure data was read in correctly and that weights sum to 1.00.

9. **ERROR** THIS OPERATION NEEDS (XXX) RECORDS ON THE WATER YEAR SCRATCH FILE ONLY (XXX) ARE AVAILABLE

Action: Either (1) decrease the number of Operations that use the water year scratch file. Operations that use the water year scratch file are 'WY-PLOT', 'STAT-QME', 'PLOT-TS' (only when the plot option = 1) and 'WATERBAL' or (2) call your Focal point to have the size water year scratch file increased.

B. Messages that occur during execution.

1. **WARNING** A TOTAL OF (XXXXXX) OBSERVED DISCHARGE VALUES ARE MISSING DURING THE RUN PERIOD.

Action: None required. The user should be aware that simulated values are generated for every day of the calibration period. Values based on observed data are generated only on those days (periods) with available data. Thus, a direct comparison of, for example, observed and simulated runoff may not always be justified.

Carryover Transfer Rules: This Operation has no carryover.

Punched Card Limitations: The values on the cards generated by the punched card subroutine should be identical to the original cards input for the Operation.

Figure 1. Sample Card Input For Operation WATERBAL

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          - Column -
      5   10   15   20   25   30   35   40   45   50   55   60   65   70   75   80
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
WATERBAL      BLANTYRE
FRENCH BROAD-BLANTYRE
BLANTYRE QME  BLANTYRE SQME      767.0      1 YES  YES
FRENCH BROAD-BLANTYRE  1.0 SNOW-17  BLANTYRE SAC-SMA  BLANTYRE
    
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Figure 2. Sample Output From Operation WATERBAL Print Parameter Routine

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*****
WATERBAL OPERATION      NAME=BLANTYRE
*****

      WATER BALANCE OPERATION FOR FRENCH BROAD-BLANTYRE

      WATER BALANCE DISPLAYS WILL BE GENERATED FOR      1 AREA(S)

      TOTAL AREA ABOVE FLOW POINT =      767.0 SQ.KM.

      DISPLAY OPTIONS SELECTED:

      YEARLY WATER BALANCE SUMMARY DISPLAY
      MULTI-YEAR AVERAGE ZONE CONTENTS DISPLAY

      GENERAL DISCHARGE TIME SERIES INFORMATION:

      T.S. IDENTIFIER      T.S. DATA TYPE
      BLANTYRE             QME
      BLANTYRE             SQME

      GENERAL AREA/SUBAREA INFORMATION:

      NAME      WEIGHT      SNOW OPERATION      RAINFALL-RUNOFF OPERATION
      TYPE      NAME      TYPE      NAME
      FRENCH BROAD-BLANTYRE  1.000  SNOW-17  BLANTYRE  SAC-SMA  BLANTYRE
    
```

Figure 3. Sample Output From Operation WATERBAL Execution Routine

WATER BALANCE SUMMARY FOR FRENCH BROAD-BLANTYE

WATER YEAR 1954 AREA (SQ KM) = 767.0 UNITS ARE MM

MONTH	PRECIPITATION AND SOIL MOISTURE BALANCE							EVAPOTRANSPIRATION						
	RAIN	SNOW	RAIN+ MELT	EOM (WE)	CHANGE (WE)	CHANGE (STO)	RECHARGE (SIDE)	ET DEMAND	ET ACTUAL	U-ZONE	L-ZONE	ADIMP	RIPARIAN	
OCT	26.	0.	26.	0.	0.	30.	-73.	0.	90.	68.	44.	15.	7.	2.
NOV	98.	0.	99.	0.	0.	32.	33.	0.	46.	34.	22.	7.	3.	1.
DEC	231.	0.	231.	0.	0.	97.	112.	0.	22.	21.	19.	0.	2.	0.
JAN	251.	9.	260.	0.	0.	137.	97.	0.	27.	26.	23.	1.	3.	0.
FEB	153.	3.	156.	0.	0.	96.	28.	0.	34.	31.	26.	2.	3.	0.
MAR	144.	9.	153.	0.	0.	116.	7.	0.	33.	30.	27.	0.	3.	0.
APR	105.	0.	105.	0.	0.	100.	-23.	0.	29.	28.	25.	0.	3.	0.
MAY	97.	0.	97.	0.	0.	85.	-48.	0.	64.	60.	50.	4.	6.	0.
JUN	46.	0.	46.	0.	0.	43.	-147.	0.	200.	150.	78.	52.	15.	5.
JUL	120.	0.	120.	0.	0.	36.	-49.	0.	194.	132.	81.	32.	13.	6.
AUG	97.	0.	97.	0.	0.	30.	-54.	0.	185.	121.	83.	20.	12.	7.
SEP	19.	0.	19.	0.	0.	19.	-75.	0.	162.	75.	42.	17.	7.	9.
YEAR	1385.	21.	1406.	N/A	0.	820.	-191.	0.	1085.	778.	519.	151.	77.	31.

SACRAMENTO SOIL MOISTURE ACCOUNTING VOLUMES

MONTH	TOTAL	RUNOFF COMPONENTS				BASEFLOW	
		IMPERV	DIRECT	SURFACE	INTERFLOW	PRIMARY	SUPPLEMENT
OCT	30.	1.	0.	0.	0.	31.	0.
NOV	32.	3.	2.	0.	1.	26.	1.
DEC	97.	8.	16.	0.	5.	33.	36.
JAN	137.	9.	23.	8.	8.	40.	49.
FEB	96.	5.	12.	0.	4.	43.	32.
MAR	116.	5.	12.	0.	3.	51.	44.
APR	100.	4.	8.	0.	2.	51.	36.
MAY	85.	3.	6.	0.	2.	50.	24.
JUN	43.	2.	0.	0.	0.	43.	3.
JUL	36.	4.	0.	0.	0.	38.	0.
AUG	30.	3.	0.	0.	0.	33.	0.
SEP	19.	1.	0.	0.	0.	27.	0.
TOTAL	820.	49.	78.	8.	24.	466.	225.

SACRAMENTO MODEL

MONTH	END OF MONTH SOIL MOISTURE STORAGE CONTENTS								
	UZTWC	UZTD	UZFWC	LZTWC	LZTD	LZFWC	LZFSC	LZDR	ADIMC
OCT	45.	40.	0.	112.	68.	214.	0.	0.78	157.
NOV	78.	7.	0.	135.	45.	189.	1.	0.78	206.
NOV	78.	7.	0.	135.	45.	189.	1.	0.78	206.
DEC	84.	1.	0.	180.	0.	258.	6.	0.70	257.
JAN	77.	8.	0.	180.	0.	361.	22.	0.62	256.
FEB	85.	0.	9.	180.	0.	375.	22.	0.61	264.
MAR	85.	0.	2.	180.	0.	393.	19.	0.60	265.
APR	82.	3.	0.	180.	0.	383.	8.	0.61	261.
MAY	62.	23.	0.	176.	4.	359.	3.	0.63	237.
JUN	17.	68.	0.	116.	64.	309.	0.	0.71	133.
JUL	43.	42.	0.	80.	100.	264.	0.	0.77	123.
AUG	44.	41.	0.	57.	123.	226.	0.	0.81	101.
SEP	14.	71.	0.	37.	143.	195.	0.	0.84	51.

MULTI-YEAR AVERAGE ZONE CONTENTS FOR FRENCH BROAD-BLANTYE
BASED ON THE PERIOD 10/1953- 9/1954

MONTH	UZTWC			UZFWC			LZTWC			LZFSC			LZFWC		
	AVG.	HI	LO	AVG.	HI	LO	AVG.	HI	LO	AVG.	HI	LO	AVG.	HI	LO
OCT	45.	45.	45.	0.	0.	0.	112.	112.	112.	0.	0.	0.	214.	214.	214.
NOV	78.	78.	78.	0.	0.	0.	135.	135.	135.	1.	1.	1.	189.	189.	189.
DEC	84.	84.	84.	0.	0.	0.	180.	180.	180.	6.	6.	6.	258.	258.	258.
JAN	77.	77.	77.	0.	0.	0.	180.	180.	180.	22.	22.	22.	361.	361.	361.
FEB	85.	85.	85.	9.	9.	9.	180.	180.	180.	22.	22.	22.	375.	375.	375.
MAR	85.	85.	85.	2.	2.	2.	180.	180.	180.	19.	19.	19.	393.	393.	393.
APR	82.	82.	82.	0.	0.	0.	180.	180.	180.	8.	8.	8.	383.	383.	383.
MAY	62.	62.	62.	0.	0.	0.	176.	176.	176.	3.	3.	3.	359.	359.	359.
JUN	17.	17.	17.	0.	0.	0.	116.	116.	116.	0.	0.	0.	309.	309.	309.
JUL	43.	43.	43.	0.	0.	0.	80.	80.	80.	0.	0.	0.	264.	264.	264.
AUG	44.	44.	44.	0.	0.	0.	57.	57.	57.	0.	0.	0.	226.	226.	226.
SEP	14.	14.	14.	0.	0.	0.	37.	37.	37.	0.	0.	0.	195.	195.	195.

YEARLY WATER BALANCE SUMMARY FOR FRENCH BROAD-BLANTYE
BASED ON THE PERIOD 10/1953- 9/1954 VALUES EXPRESSED ARE MEAN ANNUAL - UNITS ARE MM

ET-DEMAND	ET-ACTUAL	PRECIP	SNOW	RAIN+MELT	CHANGE STORAGE	RECHARGE	OBS RUNOFF	SIM RUNOFF
1085.	778.	1406.	21.	1406.	-191.	0.	842.	820.

MULTI-YEAR WATER BALANCE SUMMARY FOR FRENCH BROAD-BLANTYE
BASED ON THE PERIOD 10/1953- 9/1954 VALUES EXPRESSED ARE MEAN ANNUAL - UNITS ARE MM

ET-DEMAND	ET-ACTUAL	PRECIP	SNOW	RAIN+MELT	CHANGE STORAGE	RECHARGE	OBS RUNOFF	SIM RUNOFF
1085.	778.	1406.	21.	1406.	-191.	0.	842.	820.