

VIII.3.3-SWB-NILE SIMPLE WATER BALANCE MODEL OPERATION

Identifier: SWB-NILE

Operation Number: 54

Parameter Array: The FORTRAN identifier used for the parameter array for PO. The contents of the PO array are:

<u>Position</u>	<u>Contents</u>
1	Operation version number (integer)
2-6	Description of location where Operation is applied
7	Computational time interval in hours (integer)
8-9	Rain+melt time series identifier
10	Rain+melt time series data type code
11-12	Total runoff time series identifier
13	Total runoff time series data type code
14	Location of parameter values in the PO array <u>1</u> /
15	Total number of parameters of this Operation
16	Location of potential evaporation PE time series information in the PO array <u>2</u> /
17	Number of carryover variables
18	Number of additional carryover variables introduced by frozen ground model
19	Location of surface runoff time series information in the PO array: <u>2</u> / 0 = if surface runoff time series is not generated
20	Location of groundwater runoff time series information in the PO array: <u>2</u> / 0 = if groundwater runoff time series is not generated
21	Location of soil moisture time series information in the PO array: <u>3</u> / 0 = if no soil moisture time series is generated
22	Location of frozen ground model parameters in the PO array: <u>4</u> / 0 = if frozen ground model is not activated

<u>Position</u>	<u>Contents</u>
23	Location of air temperature time series information in the PO array: <u>3</u> / 0 = if frozen ground model option is not activated
24	Location of precipitation (rain+snowfall) time series information in the PO array: <u>3</u> / 0 = if frozen ground model option is not activated
25	Location of water-equivalent time series information in the PO array: <u>3</u> / 0 = if frozen ground model is not activated
26	Location of Frost Efficiency Index (FEI) time series information in the PO array: <u>3</u> / 0 = if no FEI time series is generated
27	Location of observed snowfall time series information in the PO array: <u>3</u> / 0 = if no observed snowfall is available or used
28	Control for printing detailed output: <u>5</u> / 0 = do not print >0 = operational program - print output calibration program - location in PO array of when to print detailed output
29	Location of water balance sums in the PO array: <u>6</u> / 0 = if sums not stored
30	Number of values in the PO array
31	Number of values in the carryover (CO) array

Notes:

1/ The order of parameter values is:

1. PXADJ
2. PEADJ
3. DMAX
4. KG
5. ALPSM
6. ALPRT
7. KDT
8. IOPTET:
 - 0 = uniform daily ET variation
 - 1 = fixed diurnal variation is used

Seasonal ET curve information is stored starting location LET+3:

- | | |
|-------|--|
| 1-12 | Seasonal ET-demand or PE-adjustment curve (January-December) |
| 13-24 | Daily increments in seasonal ET-curve (first value is for mid-January to mid-February) |

- 2/ Time series information (3 positions) - identifier and data type code
- 3/ Time series information (4 positions) - identifier, data type code and time interval
- 4/ Order of frozen ground model parameters:
 - 1. KIMP
 - 2. DSOIL
 - 3. POROS
 - 4. WWP
 - 5. CVICE
- 5/ Months to print detailed output (7 positions):
 - 1. Period currently being checked (maximum of 3)
 - 2. For each period:
 - a. month since December 1899 to start
 - b. month since December 1899 to stop
- 6/ Water balance sums:
 - 1. Rain+melt
 - 2. Total evapotranspiration
 - 3. Total runoff
 - 4. Surface runoff
 - 5. Groundwater runoff

Carryover Array: The FORTRAN identifier for carryover array is CO. The contents of the CO array are:

<u>Position</u>	<u>Contents</u>
1	Upper layer soil moisture content - SU
2	Lower layer soil moisture content - SB

Additional carryover is stored if frozen ground model is activated. The contents of the additional carryover array are:

<u>Position</u>	<u>Contents</u>
3	Upper layer frozen depth (CM)
4	Lower layer frozen depth (CM)
5	Upper layer thawing depth (CM)
6	Lower layer thawing depth (CM)
7	Snow depth (CM)
8	Snow density (G/CM3)
9	Upper layer ice content (CM) - internally computed
10	Lower layer ice content (CM) - internally computed

Subroutine Names and Functions:

<u>Subroutine</u>	<u>Function</u>
PIN54	Input cards and stores values in PO and CO arrays

PRP54	Print information in PO array
PRC54	Print information in CO array
EX54	Execute the Operation
COX54	Perform carryover transfer
TAB54	Make entry into Operations Table
PUC54	Punch information in PO and CO arrays
TSV54	Obtain time series identifiers and time intervals for the PUC54 subroutine
SWB54	Execute the SNWPCK54 and NILE54 subroutines
SNWPCK54	Execute snow depth and snow density computations
NILE54	Execute runoff and ET computations and frozen ground model
FREEZ54	Execute frozen ground computations
CSOIL54	Execute soil thermal conductivity computations
CSNOW54	Execute snow thermal conductivity computations

Subroutines PIN54, PRP54, PRC54, PUC54 and COX54 have standard argument lists as described in Section VIII.4.3.

SUBROUTINE EX54 (PO,CO,PTS,RTS,PETS,RSTS,RGTS,SMTS,TATS,PPTS,WETS,
FETS,SNTS)

Function: This is the execution control subroutine for Operation SWB-NILE.

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
PO	Input	R*4	Variable	Parameters, options and time series information
CO	Input	R*4	Variable	Carryover data
PTS MM)	Input	R*4	Variable	Precipitation data (rain+melt,
RTS	Output	R*4	Variable	Total runoff values (MM)
PETS	Input	R*4	Variable	Potential evaporation data (MM)
RSTS	Output	R*4	Variable	Surface runoff values (MM)
RGTS	Output	R*4	Variable	Groundwater runoff values (MM)
SMTS	Output	R*4	Variable	Soil moisture values (MM or CM)
TATS (DEGC)	Input	R*4	Variable	Air temperature time series
PPTS	Input	R*4	Variable	Precipitation data (rain+snowfall, MM)
WETS	Input	R*4	Variable	Water equivalent data (MM)
FETS	Output	R*4	Variable	Frost efficiency index values (decimal fraction)
SNTS	Input	R*4	Variable	Snowfall data (MM)

SUBROUTINE SWB54

(RM,ETDM,ET,RS,RG,R,TA,PP,TWE,FEI,SNO,IFRZE,LSN,ITP,
IDAY,IHOUR,IPRINT,IOUT,IBUG)

Function: Executes the snow depth and density, runoff and frozen ground computations.

Argument list:

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
RM	Input	R*4	1	Precipitation data (rain+melt, MM)
ETDM	Input	R*4	1	Potential evaporation (MM)
ET	Output	R*4	1	Estimated evapotranspiration (MM)
R	Output	R*4	1	Total runoff (MM)
RS	Output	R*4	1	Surface runoff (MM)
RG	Output	R*4	1	Groundwater runoff (MM)
TA	Input	R*4	1	Air temperature time series (DEGC)
PP	Input	R*4	1	Precipitation data (rain+snowfall, MM)
TWE	Input	R*4	1	Water equivalent data (MM)
FEI	Output	R*4	1	Frost efficiency index values (decimal fraction)
SNTS	Input	R*4	1	Snowfall data (MM)
IFRZE	Input	I*4	1	Frozen ground indicator: 0 = not to activate frozen ground model 1 = to activate frozen ground model
LSN	Input	I*4	1	Snowfall data indicator: 0 = not to use observed snowfall data 1 = to use observed snowfall data
ITP	Input	I*4	1	Time interval (hours)
IDAY	Input	I*4	1	Day (external clock)

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
IHOUR	Input	I*4	1	Hour (external clock)
IPRINT	Input	I*4	1	Print indicator: 0 = no detailed display 1 = print detailed display values
IOUT	Input	I*4	1	Unit number for printer output
IBUG	Input	I*4	1	Debug indicator: 0 = no debug output 1 = print debug output

SUBROUTINE NILE54 (DT,P,EP,TA,R,RS,RG,ET,EU,EB,DU,DB,DMAX,KG,ALPSM,
 ALPRT,KDT,KIMP,DSOIL,POROS,WWP,CVICE,UDZ,BDZ,UTHAW
 ,
 BTHAW,UWICE,BWICE,SNDN,IFRZE,IDAY,IHOUR,IOUT,IBUG)

Function: Executes runoff and frozen ground computations for one time interval.

Argument list:

Variable	Input/ Output	Type	Dimension	Description
DT	Input	R*4	1	Time interval (fraction of a day)
P	Input	R*4	1	Precipitation (rain+melt, MM/day)
EP	Input	R*4	1	Potential evaporation (MM/day)
TA (DEGC)	Input	R*4	1	Air temperature time series
R	Output	R*4	1	Total runoff (MM)
RS	Output	R*4	1	Surface runoff (MM)
RG	Output	R*4	1	Groundwater runoff (MM)
ET	Output	R*4	1	Total evapotranspiration (MM)
EU	Output	R*4	1	Evapotranspiration from upper layer (MM)
EB	Output	R*4	1	Evapotranspiration from lower layer (MM)
FCR	Output	R*4	1	Fraction of impervious area due to frozen ground = frost efficiency index values (decimal fraction)
DU	Both	R*4	1	Soil moisture deficit in upper layer (MM): DU = initial value at input DU = final value at output
DB	Both	R*4	1	Soil moisture deficit in lower layer (MM): DB = initial value at input DB = final value at output
DMAX	Input	R*4	1	Model parameter - maximum soil moisture deficit (or storage) in lower layer (MM)

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
KG	Input	R*4	1	Model parameter - potential ground-water runoff (MM/day)
ALPSM	Input	R*4	1	Model parameter - fraction of lower layer storage which produces ground-water runoff (decimal fraction)
ALPRT	Input	R*4	1	Model parameter - maximum soil moisture deficit (or storage) in upper layer expressed as a fraction of DMAX (decimal fraction)
KDT	Input	R*4	1	Model parameter - time scale parameter control infiltration process (1/day)
KIMP	Input	R*4	1	Frozen ground parameter - parameter of impermeable frozen soil
DSOIL	Input	R*4	1	Frozen ground parameter - soil density (G/CM3)
POROS	Input	R*4	1	Frozen ground parameter - soil porosity (decimal fraction)
WWP	Input	R*4	1	Frozen ground parameter - wilting point volumetric soil moisture (decimal fraction)
CVICE	Input	R*4	1	Frozen ground parameter - coefficient of variation of ice content distribution (no units)
DZU	Both	R*4	1	Frozen soil depth in upper layer (MM)
DZB	Both	R*4	1	Frozen soil depth in lower layer (MM)
THAWU	Both	R*4	1	Thawing soil depth in upper layer (MM)
THAWB	Both	R*4	1	Thawing soil depth in lower layer (MM)
WICEU	Both	R*4	1	Ice content in upper layer (MM)
WICEB	Both	R*4	1	Ice content in lower layer (MM)
SDP	Input	R*4	1	Snow depth (MM)

<u>Variable</u>	<u>Input/ Output</u>	<u>Type</u>	<u>Dimension</u>	<u>Description</u>
SDN	Input	R*4	1	Snow density (decimal fraction)
IFRZE	Input	I*4	1	Frozen ground indicator: 0 = not to activate frozen ground model 1 = to activate frozen ground model
IDAY	Input	I*4	1	Day (external clock)
IHOURL	Input	I*4	1	Hour (external clock)
IOUT	Input	I*4	1	Unit number for printer output
IBUG	Input	I*4	1	Debug indicator: 0 = no debug output 1 = print debug output

SUBROUTINE FREEZ54 (DT,T,SDP,SDN,DBT,DMBT,DSOIL,POROS,WWP,DZBT,DZUP, THAW,FREZ)

Function: Executes the frozen ground computations for each time step.

Variable	Input/ Output	Type	Dimension	Description
DT	Input	R*4	1	Time interval (fraction of a day)
T (DEGC)	Input	R*4	1	Air temperature time series
SDP	Input	R*4	1	Snow depth (MM)
SDN	Input	R*4	1	Snow density (decimal fraction)
DBT	Input	R*4	1	Soil moisture deficit in current layer (MM)
DMBT	Input	R*4	1	Maximum soil moisture deficit (or storage) in current layer (MM)
DSOIL	Input	R*4	1	Frozen ground parameter - soil density (G/CM3)
POROS	Input	R*4	1	Frozen ground parameter - soil porosity (decimal fraction)
WWP	Input	R*4	1	Frozen ground parameter - wilting point volumetric soil moisture (decimal fraction)
DZBT	Input	R*4	1	Frozen soil depth in current layer from previous time step (MM)
DZUP	Input	R*4	1	Frozen soil depth in upper layer from previous time step (MM)
THAW	Both	R*4	1	Thawing soil depth in upper layer (MM)
FREZ	Output	R*4	1	Incremental frozen depth in current time step (MM)

SUBROUTINE SNWPCK54 (P,T,PP,WE,SNO,DP,DN,DZ,SMAVG,DSOIL,DTH,LSN)

Function: Executes snow depth and snow density computation for each time step.

Argument List:

Variable	Input/ Output	Type	Dimension	Description
P	Input	R*4	1	Precipitation data (rain+melt, MM)
T	Input	R*4	1	Air temperature time series (DEGC)
PP	Input	R*4	1	Precipitation data (rain+snowfall, MM)
WE	Input	R*4	1	Water equivalent data (MM)
SNO	Input	R*4	1	Snowfall data (MM)
DP	Both	R*4	1	Snow depth (MM)
DN	Both	R*4	1	Snow density (decimal fraction)
DZ	Input	R*4	1	Total frozen depth (MM)
SMAVG	Input	R*4	1	Average soil moisture (decimal fraction)
DSOIL	Input	R*4	1	Frozen ground parameter - soil density (G/CM3)
DTH	Input	R*4	1	Time interval (hours)
LSN	Input	I*4	1	Snowfall data indicator: 0 = not to use observed snowfall data 1 = to use observed snowfall data

SUBROUTINE TAB54 (TO,LEFT,IUSET,NXT,LPO,PO,LCO,TS,MTS,LWORK,IDT)

Function: This is the Operations Table entry subroutine for Operation SWB-NILE.

Argument list: The arguments for this subroutine are similar to the arguments for Operations Table entry subroutines for other Operations. A description of the arguments is contained in Section VIII4.2-TAB

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

<u>Position</u>	<u>Contents</u>
1	Operation number
2	Location of next Operation in T array
3	Location of the PO array in P array
4	Location of the CO array in C array
5	Location of precipitation (rain+melt) in D array
6	Location to put total runoff in D array: 0 = if not used
7	Location of potential evaporation in D: 0 = if not used
8	Location to put surface runoff in D: 0 = if not used
9	Location to put groundwater runoff in D: 0 = if not used
10	Location to put soil moisture content in D: 0 = if not used
11	Location of air temperature in D: 0 = if not used
12	Location of rain+snowfall in D: 0 = if not used
13	Location of water-equivalent in D: 0 = if not used
14	Location to put frost efficiency index in D: 0 = if not used
15	Location to put snowfall in D: 0 = if not used