Differences between SWAT2000 and SWAT2005

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Theoretical changes:

1) Documentation corrections for generated daily maximum half-hour rainfall fraction (section 1:3.2)

   Was incorrectly given as:

   The triangular distribution uses one of two sets of equations to generate a maximum half-hour rainfall fraction for the day. If $rnd_1 \le \left(\frac{\alpha_{0.5mon} - \alpha_{0.5L}}{\alpha_{0.5U} - \alpha_{0.5L}} \right)$ then

   $$\alpha_{0.5} = \alpha_{0.5L} + \left[rnd_1 \cdot \left(\alpha_{0.5U} - \alpha_{0.5L} \right) \cdot \left(\alpha_{0.5mon} - \alpha_{0.5L} \right) \right]^{0.5} \qquad \text{1:3.2.4}$$

   If $rnd_1 > \left(\frac{\alpha_{0.5mon} - \alpha_{0.5L}}{\alpha_{0.5U} - \alpha_{0.5L}} \right)$ then

   $$\alpha_{0.5} = \alpha_{0.5U} - \left(\alpha_{0.5U} - \alpha_{0.5mon} \right) \cdot \left[\frac{\alpha_{0.5U}\left(1 - rnd_1\right) - \alpha_{0.5L}\left(1 - rnd_1\right)}{\alpha_{0.5U} - \alpha_{0.5mon}} \right]^{0.5} \qquad \text{1:3.2.5}$$

   Correct equations are:

   The triangular distribution uses one of two sets of equations to generate a maximum half-hour rainfall fraction for the day. If $rnd_1 \le \left(\frac{\alpha_{0.5mon} - \alpha_{0.5L}}{\alpha_{0.5U} - \alpha_{0.5L}} \right)$ then

   $$\alpha_{0.5} = \alpha_{0.5mon} \cdot \frac{\alpha_{0.5L} + \left[rnd_1 \cdot \left(\alpha_{0.5U} - \alpha_{0.5L} \right) \cdot \left(\alpha_{0.5mon} - \alpha_{0.5L} \right) \right]^{0.5}}{\alpha_{0.5mean}}$$

   If $rnd_1 > \left(\frac{\alpha_{0.5mon} - \alpha_{0.5L}}{\alpha_{0.5U} - \alpha_{0.5L}} \right)$ then

   $$\alpha_{0.5} = \alpha_{0.5mon} \cdot \frac{\alpha_{0.5U} - \left(\alpha_{0.5U} - \alpha_{0.5mon} \right) \cdot \left[\frac{\alpha_{0.5U}\left(1 - rnd_1\right) - \alpha_{0.5L}\left(1 - rnd_1\right)}{\alpha_{0.5U} - \alpha_{0.5mon}} \right]^{0.5}}{\alpha_{0.5mean}}$$

2) The variable ISED_DET was added to the basin input file (.bsn) to allow the user to select the method used to set the daily maximum half-hour rainfall value. The user has the option of using the monthly maximum half-hour rainfall for all days in the month or generating a daily value. The

randomness of the triangular distribution used to generated daily values can cause the maximum half-hour rainfall value to jump around. For small plots or microwatersheds in particular, the variability of the triangular distribution is unrealistic.

3) Sub-daily precipitation generator added to SWAT. See section 1:3.3 of the Theoretical Documentation for an explanation of this generator.
4) A weather forecast period may be defined to allow the user to assess the impact of forecasted weather on water supply, etc. See Section 1:4.3 of the Theoretical Documentation for an explanation of this feature.
5) The retention parameter used to calculate the daily curve number value can be a function of soil water content or plant evapotransporation. See Section 2:1.1.1.3
6) A seasonal high water table may be defined for an HRU (IWATABLE in .hru). If a seasonal water table is present, Percolation of water from one soil layer to the layer below is not allowed if $SW_{ly+1} \le FC_{ly+1} + 0.5 \cdot \left(SAT_{ly+1} - FC_{ly+1}\right)$. See Section 2:3.2
7) Documentation corrections for percolation to deep aquifer. There is no threshold level of water in the shallow aquifer required for percolation to the deep aquifer to occur.
8) Document corrections: Corrected conditions for calculating nitrification soil water factor, equations 3:1.3.2 and 3:1.3.3.
9) Users allowed to input values for β_{denit} and $\gamma_{sw,thr}$ in denitrfication calculations (previously were set in the code):

$$N_{denit,ly} = NO3_{ly} \cdot \left(1 - \exp\left[-\beta_{denit} \cdot \gamma_{tmp,ly} \cdot orgC_{ly}\right]\right) \quad \text{if} \quad \gamma_{sw,ly} \ge \gamma_{sw,thr} \qquad 3{:}1.4.1$$

$$N_{denit,ly} = 0.0 \quad \text{if} \quad \gamma_{sw,ly} < \gamma_{sw,thr} \qquad 3{:}1.4.2$$

10) Document corrections: Corrected equation 4:2.1.2.
Originally:

$$conc_{NO3,mobile} = \frac{NO3_{ly} \cdot \exp\left[\dfrac{-w_{mobile}}{\left(1-\theta_e\right) \cdot SAT_{ly}}\right]}{w_{mobile}}$$

Corrected to:

$$conc_{NO3,mobile} = \frac{NO3_{ly} \cdot \left(1 - \exp\left[\dfrac{-w_{mobile}}{\left(1-\theta_e\right) \cdot SAT_{ly}}\right]\right)}{w_{mobile}}$$

11) Document corrections:
The pesticide concentration in the mobile water is calculated:

$$conc_{pst,flow} = \min\begin{cases} pst_{flow} / w_{mobile} \\ \\ pst_{sol} / 100. \end{cases} \qquad 4{:}3.2.10$$

corrected to:

For the top 10 mm that interacts with surface runoff, the pesticide concentration in the mobile water is calculated:

$$conc_{pst,flow} = \min\begin{cases} pst_{flow} / \left[w_{perc,surf} + \beta_{pst} \left(Q_{surf} + Q_{lat,surf} \right) \right] \\ pst_{sol} / 100. \end{cases} \quad 4:3.2.10$$

while for lower layers

$$conc_{pst,flow} = \min\begin{cases} pst_{flow} / w_{mobile} \\ pst_{sol} / 100. \end{cases} \quad 4:3.2.11$$

12) At the beginning of the dormant period, 10% of perennial biomass is converted to residue. Previously, 95% of perennial biomass was converted to residue with the onset of the dormant period. Users allowed to set the minimum leaf area index of plants that loose biomass (trees and perennials) when they go dormant (ALAI_MIN in crop.dat) and the fraction of the biomass converted to residue for trees when they enter dormancy (BIO_LEAF in crop.dat).
13) Application of bacteria to HRU in manure partitioned between ground cover and soil surface using methodology similar to that of pesticide application.
14) Documentation correction: The filter strip trapping efficiency for bacteria (equation 6:1.11.1) was calculated:

$$trap_{ef,bact} = 1 - \frac{\left(12 + 4.5 \cdot width_{filtstrip}\right)}{100}$$ corrected to

$$trap_{ef,bact} = \frac{\left(11.8 + 4.3 \cdot width_{filtstrip}\right)}{100}$$

15) Documentation correction: The general regression equation used to calculate loadings in urban areas (6:3.3.1) was:

$$Y = \frac{\beta_0 \cdot \left(R_{day} / 25.4\right)^{\beta_1} \cdot \left(DA / 2.59\right)^{\beta_2} \cdot \left(imp_{tot} \cdot 100 + 1\right)^{\beta_3} \cdot \beta_4}{2.205}$$

corrected to:

$$Y = \frac{\beta_0 \cdot \left(R_{day} / 25.4\right)^{\beta_1} \cdot \left(DA \cdot imp_{tot} / 2.59\right)^{\beta_2} \cdot \left(imp_{tot} \cdot 100 + 1\right)^{\beta_3} \cdot \beta_4}{2.205}$$

16) Allow user to set curve number for impervious areas. Was previously defined as 98 at all times.
17) Finalized equations governed bacteria persistence and transport. New chapters added documenting equations.
18) Corrected equation calculating net short-wave radiation. The equation in the code was forcing albedo to set values (0.23 unless snow was present. 0.8 if snow was present) rather than using the calculated daily albedo value.

19) Documentation correction: Volume of water entering the reach from bank storage(equation 7:1.7.2) was $V_{bnk} = bnk \cdot \left(1 - \alpha_{bnk}\right)$ corrected to $V_{bnk} = bnk \cdot \left(1 - \exp\left[-\alpha_{bnk}\right]\right)$

20) Precipitation lapse rate input by user is an average annual difference in precipitation with change in elevation, but the difference was being applied to individual storm events by SWAT. An adjustment was incorporated (the annual lapse rate was divided by the number of days of rain in the year) to adjust the value for use with daily storm events.

Was: $R_{band} = R_{day} + \left(EL_{band} - EL_{gage}\right) \cdot \dfrac{plaps}{1000}$ when $R_{day} > 0.01$ 1:4.1.1

Now: $R_{band} = R_{day} + \left(EL_{band} - EL_{gage}\right) \cdot \dfrac{plaps}{days_{pcp,yr} \cdot 1000}$ when $R_{day} > 0.01$ 1:4.1.1

21) Users may now set the light extinction coefficient used to calculate the amount of intercepted photosynthetically active radiation. In equation 5:2.1.1 the variable k_ℓ was always set to 0.65 in previous versions of SWAT. Now the user can adjust this value.

22) Tree growth modified to capture changes in growth as a tree grows from a seedling to a sapling to a fully-developed plant over the course of several years. Biomass accumulated within a given year, canopy height, and maximum leaf area index is limited based on the age of the tree stand relative to the number of years required for the tree stand to reach mature status (fully-developed). See Chapter 5.2.1 in Theoretical Documentation.

23) Calculate trapping efficiency of constituents by a filter strip in subsurface flow. Previously only calculated reduction in surface runoff components. See Chapter 6.1.11 in Theoretical Documentation.

24) Nitrate now modeled in the aquifer. Previously a set concentration of nitrate in groundwater contributions to the streamflow could be specified. Now SWAT will model daily variation in nitrate concentration in the aquifer.

25) Perched water table now modeled in soil profile. Tile drainage now occurs when perched water table rises above the depth at which the tile drains are installed.

Input changes:

1) Watershed configuration file (.fig)
   a) Made SUBBASIN command into a 2-line command with the name of the subbasin general input file (.sub) entered on the second line. This file name was formerly listed in file.cio.
   b) Made ROUTE command into a 2-line command with the name of the reach input file (.rte) and the stream water quality input file (.swq) entered on the second line. These file names were formerly listed in file.cio.
   c) Made SAVE command into a 2-line command with the name of the output file for the save command listed on the second line. Moving this file name from file.cio allows more than 1 save command to be listed in

a .fig file (up to 10). New variables on the SAVE command lines: FILEMASS_NUM, PRINT_FREQ, PRINT_FMT

d) New command: AUTOCAL. This command allows the user to implement automated calibration/sensitivity analysis in a SWAT run.
e) New command: RECHOUR. This command allows the user to read in hourly loadings to the channel network for routing through the channel network.

2) Master watershed file (file.cio)
   a) Variables moved from file.cio to .bsn: PETFILE, WWQFILE.
   b) Variables moved from file.cio to .fig: SUBFILE, RTEFILE, SWQFILE, EVEFILE.
   c) Variables moved from file.cio to .sub: IRGAGE, ITGAGE, ISGAGE, IHGAGE, IWGAGE, WGNFILE, PNDFILE, WUSFILE
   d) Variables moved from .cod to file.cio: NBYR, IYR, IDAF, IDAL, IGN, PCPSIM, IDT, IDIST, REXP, TMPSIM, SLRSIM, RHSIM, WNDSIM, ISPROJ, IPD, NYSKIP, ILOG, IPRP
   e) Definition changes: ISPROJ, IPDVAS
   f) Variable name changes:
      IGN => IGEN
      IPD => IPRINT
   g) New variables: FCSTYR, FCSTDAY, FCSTCYCLES, ICLB, IPRS, IPDHRU
3) Input control code file (.cod) eliminated
   a) Variables moved from .cod to .bsn: IPET, IEVENT, ICRK, IRTE, IDEG, IWQ
   b) Variables moved from .cod to file.cio: NBYR, IYR, IDAF, IDAL, IGN, PCPSIM, IDT, IDIST, REXP, TMPSIM, SLRSIM, RHSIM, WNDSIM, ISPROJ, IPD, NYSKIP, ILOG, IPRP
   c) Variables deleted: IPRN
   d) HUMUS modifications for input values in the .hru, .sub, .gw, .mgt, .pnd, .rte, .sol files are made by the conversion program and ISPROJ set to 0
4) Basin input file (.bsn)
   a) Variables moved from file.cio to .bsn: PETFILE, WWQFILE
   b) Variables moved from .cod to .bsn: IPET, IEVENT, ICRK, IRTE, IDEG, IWQ
   c) Variables deleted: DA_KM
   d) Variable name changes:
      APM => ADJ_PKR
      UBN => N_UPDIS
      UBP => P_UPDIS
   e) New variables: ISUBWQ, WOF_P, WOF_LP, WDPF, WGPF, WDLPF, WGLPF, TRNSRCH, ICN, CNCOEF, CDN, SDNCO, BACT_SWF, BACT_MX, BACTMINLP, BACTMINP, ISED_DET, WDLPRCH, WDPRCH,WDLPRES, WDPRES, TB_ADJ, DEPIMP_BSN

f) Variable IEVENT option #1: daily rainfall/Green & Ampt infiltration/daily routing (sub-hourly rainfall required for Green & Ampt is generated from daily) now operational

5) Subbasin input file (.sub)
   a) Variables moved from file.cio to .sub: IRGAGE, ITGAGE, ISGAGE, IHGAGE, IWGAGE, WGNFILE, PNDFILE, WUSFILE
   b) Variable name changes:
      LAT => SUB_LAT
      ELEV => SUB_ELEV
   c) New variables: SUB_KM, FCSTREG
6) New input file for forecast period weather parameters (.cst)
7) Plant growth database (crop.dat)
   a) Variable name changes:
      BN => PLTNFR
      BP => PLTPFR
   b) New variables: ALAI_MIN, BIO_LEAF, MAT_YRS, BMX_TREES, EXT_COEF
   c) Values for DLAI corrected in database file distributed to users.
8) Fertilizer database (fert.dat)
   a) Format for fertilizer database file changed
   b) Unit change for variables BACTPDB, BACTLPDB from # bact/kg manure to # cfu/g manure
9) Urban database (urban.dat)
   a) New variable: URBCN2
10) HRU general input file (.hru)
   a) Variables moved from .hru to .mgt: FILTERW, IURBAN, URBLU, IRR, IRRNO, FLOWMIN, DIVMAX, FLOWFR, DDRAIN, TDRAIN, GDRAIN
   b) New variables: IWATABLE, FLD_FR, RIP_FR, DEP_IMP
   c) Variable name change:
      SLOPE => HRU_SLP
   d) Deleted variables: IPOT (now determined by the model internally)
   e) Definition change: HRU_FR
11) Management file (.mgt)
   a) Variables moved from .hru to .mgt: FILTERW, IURBAN, URBLU, IRR, IRRNO, FLOWMIN, DIVMAX, FLOWFR, DDRAIN, TDRAIN, GDRAIN
   b) Operation lines reformatted
   c) Auto-irrigation command: new variable IDWSTRS
   d) Plant command: new variable CURYR_MAT
   e) New operation: continuous fertilization operation
   f) Variable name changes:
      NCRP => PLANT_ID
      IRR => IRRSC
      ALAI => LAI_INIT
      BIO_MS => BIO_INIT
      NCR => PLANT_ID (plant op)
      ALAINIT => LAI_INIT (plant op)

HITAR => HI_TARG (plant op)
FRT_LY1 => FRT_SURFACE (fert op)
HIOVR => HI_OVR (harv op)
NDGRAZ => GRZ_DAYS (graze op)
IGFTYP => MANURE_ID (graze op)
BMEAT => BIO_EAT (graze op)
BMTRMP => BIO_TRMP (graze op)
WMANURE => MANURE_KG (graze op)
AUTO_NSTR => AUTO_NSTRS (autofert op)
FERT_ID => AFERT_ID (autofert op)
AUTO_NMXS => AUTO_NAPP (autofert op)
AUTO_NMXA => AUTO_NYR (autofert op)
AFRT_LY1 => AFRT_SURFACE (autofert op)
AVWSP => FR_CURB (sweep op)
IREL_IMP => IMP_TRIG (rel/imp op)

12) Groundwater (.gw):
    a) New variables: SHALLST_N, HLIFE_NGW
    b) Variables deleted: GWNO3
13) Stream water quality (.swq): file reformatted to remove unused lines
14) Pond/wetland input file (.pnd):
    a) Variable name changes:
       PSETL1 => PSETLP1
       PSETL2 => PSETLP2
       NSETL1 => NSETLP1
       NSETL2 => NSETLP2
       CHLA => CHLAP
       SECCI => SECCIP
15) Measured loading files (rechour, recday, recmon, recyear, reccnst):
    a) New measured loading file: rechour for hourly data
    b) Unit change for bacteria loading variables from # bact/day to # cfu/100 mL
    c) New variables in all files for CBOD, dissolved oxygen, chlorophyll-a, soluble pesticide, sorbed pesticide
    d) Data format in files changed.
16) Output file names hardcoded: output.sub, output.hru, output.rch, output.rsv, output.wtr, output.pst