11/27/2023

1. Error fixed: ET output error when AWP is turned on.
2. Error fixed: RESRT reservoir unit errors

9/29/2023

1. Output unit issue on snow fall and snow melt is addressed
2. Mass balance issue on N/P upward movement in soil due to soil evaporation is resolved.

8/11/2023

1. Weather generator for daily solar radiation values is added.
2. Error on RES inflow is fixed in RESRT.
3. Effective drainage area changes in subareas with a resevoir as waterbody expands/shrinks. Nitrogen transport accounting in the runoff is updated to make the unit conversions right.
4. Error is fixed on miscounting vertical flow in NLCH is fixed (Vmm is removed).
5. Outputs are printed in incorrect units in SWT. The issue is fixed.

5/03/2023

1. Fixed: Water yield output in MWS/AWS had wrong units. It was printed in m3 unit and now is fixed to print in mm unit.

4/12/2023

1. Fixed: Output unit conversion issue in the AWP.
2. Fixed: pesticide daily output in \*.DPS does not print all subareas.

3/28/2023

1. Fixed: LAI was not being updated upon a transplanting operation using the user input initial LAI.

10/07/2022

1. Error in weather station ID assignment in the Main is fixed.
2. Pesticide fate and transport (sub PSTCY) is updated based on M.Winchell’s recommendations on unit conversions and etc.

6/29/2022

1. One critical error is found and fixed. Only one weather station’s daily weather was being used for the entire watershed when multiple weather stations existed. Now this is resolved after fixing the subroutine WDLYSTA.
2. Denitrification method (IDNT) is defaulted to the Kemanian method if not selected between 1-4.

3/01/2022

1. Errors in the units of state variables in the PSTCY are fixed. Pesticide fate and transport calculations rely on surface runoff, percolation, and lateral return flow etc in the PSTCY. These variables were used wrongly in units.

2/9/2022

1. Possible error in calculating soil carbon pools being in NCNMI\_PHOENIX and NCNMI\_CENTURY is fixed. In some cases, thse arrays can take negative values due to erroneous calculations. The code is updated to prevent this from happening.

1/13/2022

1. Array definition mismatching for NX is fixed.
2. Stack overflow error during large simulations has been fixed (Properties/Fortran/Optimization: Heap Arrays =0

7/12/2021

1. A bug on the units of variables in pest damage calculation is fixed in the BSUB line 1020 X1=(ADRF-PRMT(9)\*WSAX1)/100.

4/19/2020

1. MODFLOW is excluded from the 20201118 version for ArcAPEX integration. MODFLOW will be added to the ArcAPEX for 1905

10/20/2020

1. Crop ID issue in TLOP causing the kill operation to be ignored is fixed.
2. The error with WPML leaching amount not subtracted from layer storage is fixed in NLCH

6/10/200

1. MODFLOW is added to APEX
	1. MODFLOW fortran files are added to APEX in a subfolder MODFLOW
	2. IMF parameter is added to APEXCONT (Line 2, column 26). 0=turn off, 1=turn on MODFLOW
	3. MODFLOW inputs/outputs are added in a subfolder MODFLOW under TxtInout.
2. Divide by zero error while computing Van Genutchen parameters is fixed in the Main.
3. Error is fixed in SPLA regarding SATC when a soil has only 1 soil layer.
4. Potential error (divided-by-zero) is fixed in BSUB line 526 where WLS gets zeroed after manure erosion.

6/04/2020

1. Richard’s equation is added to soil water percolation methods (IPRK=2).
2. Landscape Wind Erosion (LWE) model is added
	1. LWE input file is added to APEXFILE.DAT
	2. In APEXCONT, WND\_OP is added (line 6, column 10) to choose between old wind erosion (EWER, wnd\_op=0) and the LWE model (wnd\_op=1).
	3. New fortran files added: EWER2.f90, EWER2\_init.f90, EWER2\_LIB.f90
	4. APEX subroutines updated: modparm, main\_1501, bsim, bsub, cptbl, allocate\_parms, ainlz

5/08/2020

1. Subroutines related to wind erosion have been updated to fix excess amount of wind erosion.

2/27/2020

1. MASA array values for output unit conversion are corrected for the following outputs: QDRP (143), LGMO (62), QRFN (84), YMNU(88).
2. The maximum number of daily weather stations is increased from 100 to 1000.

2/21/2020

1. Mineral P in manure (WPMU) is added to WPML (soil mineral P) in QDRP/QRP calculation.
2. In \*.ACY, OrgP output is fixed by correcting an error in the MASA array

11/6/2019

1. Fixed a bug that resets IDNT to 2 when .OUT is on in the main.

9/05/2019

1. Errors in Izaurralde’s denitrification module are fixed.

5/7/2019

1. Header printing issue in SAD is fixed.

4/11/2019

1. DWS output variables are incorrect in units. The error is fixed.

2/28/2019

1. Error in grazing module (FFED input in the herd file having no influence to output) is fixed.

12/04/2018

1. 5 new s-curve parameters are added in lines 31-35 of the parms.dat
2. Output units error for QRF and WYLD in \*.DWS is fixed
3. Paddy module is updated.
4. QPQ (Ratio volume before time to peak (t\_p) to total volume of unit hydrograph) is added as a new input in APEXCONT.DAT with a new method for estimating peak flow based on a NRCS method (Not available yet)

10/03/2018

1. Continue to fix errors on unit conversion.
2. KW47/KW48 soil output files are added as requested by Candiss Williams

9/24/2018

1. Errors in .OUT, .SUS, .STR on outputs including YP, YN, QP, QN due to the shift in internal handling of calculations from mass per unit to mass are fixed.

8/15/2018

1. Water balance calculation is improved
2. Error in reading daily wind speed generated by weather generator is fixed
3. Error in reading values for missing data in \*.dly is fixed

7/16/2017

1. Errors in flood plain erosion and deposition calculation have been fixed

7/03/2018

1. Errors in flood plain erosion and deposition calculation have been fixed

6/25/2018

1. Mass balance (water/sediment/nitrogen) calculated in the \*.out for the entire watershed is improved.
2. Error is fixed in the code regarding CHMX variable influencing soil erosion.
3. Error is fixed in the PHOENIX C/N method regarding CO2 respiration rate.

6/13/2018

1. Issue with S-curve equation when b2 goes negative is resolved
2. Mass balance calculation is improved
3. Mass balance errors greater than 0.05% are printed in \*.ERX

5/22/2018

1. Fixed print errors in \*.MSA

5/15/2018

1. The issue of automatic irrigation on perennial crops is fixed
2. Errors in output files fixed.

5/08/2018

1. Bugs in average annual outputs including STR have been fixed.
2. Errors caused by the changes in units of internal variables found in Paddy modules are fixed.

4/17/2018

1. Bugs fixed in SUS/SAO files with RSSF, WYLD values.

3/5/2018

1. Bugs fixed
2. Header line in \*.ASA: alignment issue is fixed

2/21/2018

1. Mass balance (water and sediment) issue is fixed

2/16/18

1. The maximum number of daily weather files that can be loaded to the model is increased to 100 from 20.
2. Numerous bugs fixed
3. An error related to manure erosion is fixed

12/13/17

1. Paddy module: code is fixed to estimate minP loads in paddy discharge water.

9/13/17

1. Day lengths are corrected based on latitude.
2. An error is fixed on water stress – HI adjustment calculation.
3. Harvest Index is adjusted (reduced) by heat stresses.
4. Harvest Index is adjusted (reduced) by nitrogen stresses.

7/26/17

1. Annual crop is killed after damaged by frost. When this happens, the current biomass above/below ground must be reallocated to dead biomass pools like STD and etc. The code was updated to complete the kill processes with frost damage. In earlier versions, frost damage will make the crop disappear from the subarea it was growing and no transition from live biomass to dead biomass was calculated.

6/20/2017

1. An error is fixed in NUTS.f90 where nitrogen stress is calculated.

5/15/2017

1. Error on \*.DHS is fixed

2/1/2017

1. A potential syntax error caused by the Van Genuchten algorithm in the main program is fixed.
2. A possible error in s-curve functions associated with b parameter is resolved.

1/11/2017

1. New operation is added for Mulching
2. Mulching (IHC=27) operation adds residue to the surface (from unknown source).
3. OPV(1) is the amount of residue added to the field after the “Mulching” operation (kg/ha)

11/29/2016

1. Paddy module is added
	1. a subarea can be diked and water ponding can be simulated with dischare weir
	2. irrigation (manual/auto) can be set
	3. target ponding depth (mm): OPV1
	4. minimum ponding depth that triggers irrigation (mm): OPV6
	5. Set OPV3=9999 and IRR(ISA)=22 to choose paddy irrigation
	6. Puddle operation sets weir height using OPV(1) and adjust soil layer 2 Ksat to Parm(39)
	7. Destroy puddle destroys the weir (reverting the subarea back to regular upland) and recovers soil layer 2 Ksat0.
2. Transplanting is simulated by setting initial LAI with OPV(3) and a SWD value greater than zero.
3. A bug on reinitializing crop height for annual crops in continuing years has been fixed

11/11/2016

1. van Genuchten equation added to calculating back pass of percolation in HPURK
2. APEXDIM.DAT has 12 inputs

 ! READ DIMENSIONS

 ! 1 MPS = MAX # PESTICIDES

 ! 2 MRO = MAX # YRS CROP ROTATION

 ! 3 MNT = MAX # TILLAGE OPERATIONS

 ! 4 MNC = MAX # CROPS USED

 ! 5 MHD = MAX # ANIMAL HERDS

 ! 6 MBS = MAX # BUY/SELL LIVESTOCK TRANSACTIONS

 ! 7 MFT = MAX # FERTILIZER

 ! 8 MPO = MAX # POINT SOURCES

 ! 9 MHP = MAX# HYDROGRAPH POINTS

 !10 MHX = MAX# DAYS FOR STORM HYDROGRAPH BASE

 !11 MSA = MAX# SUBAREAS

 !12 MIR = MAX# IRRIGATION APPLICATIONS

1. APEXCONT.DAT Lines 1-2 have 44 inputs

 ! 40 IPRK = 0 FOR HPERC

 ! > 0 FOR HPERC1 (4MM SLUG FLOW)

 ! 41 ICP = 0 FOR NCNMI\_PHOENIX

 ! > 0 FOR NCNMI\_CENTURY

 ! 42 NTV = 0 FOR ORIGINAL APEX NITVOL EQS

 ! > 0 FOR IZAURRALDE REVISED NITVOL EQS

 ! 43 IREM = 0 SSK FROM REMX

 ! > 0 SSK FROM USLE

 ! 44 ISAP = NBSA TO PRINT MONTHLY .OUT FOR 1 SUBAREA

1. Total head of the shallow aquifer storage is estimated using the slope of the aquifer.

 GWSP = GROUND WATER SLOPE (m/m): \*.SIT file line 5

Nov. 2015

Update from 0806 to 1501

1. Input: NBY0 and IYR0 are now two separate inputs in APEXCONT. Also, the first two lines in this file are now free formatted.
2. Input: With new modules added, PARM.dat now has 110 parameters (PARMS)
	1. PARM(98) = REGULATES FLOW BETWEEN SOLUBLE AND EXCHANGEABLE K POOLS
	2. PARM(99) = REGULATES FLOW BETWEEN EXCHANGEABLE AND FIXED K POOLS
	3. PARM(100) = CENTURY SLOW HUMUS TRANSFORMATION RATE(D^-1) (0.00041\_0.00068)
	4. PARM(101) = CENTURY PASSIVE HUMUS TRANSFORMATION RATE(D^-1)(0.0000082\_ 0.000015) ORIGINAL VALUE = 0.000012
	5. PARM(102) = CRLNC = LOWER NC RATIO OF BIOMASS - POINT AT WHICH CR = 0 AND TRANSFORMATIONS OF STRUCTURAL LITTER AND METABOLIC LITTER ARE. UNIMPEDED BY NC RATIO OF BIOMASS
	6. PARM(103) = CRUNC = UPPER NC RATIO OF BIOMASS - POINT AT WHICH CR = 1 AND TRANSFORMATIONS OF STRUCTURAL LITTER AND METABOLIC LITTER ARE UNIMPEDED BY NC RATIO OF BIOMASS
	7. PARM(104) = WKA = SPECIFIC BASE RATE FOR AMMONIFICATION (d-1)
	8. PARM(105) = WNCMIN = BMNC AT WHICH IMMOBILIZATION IS A MAXIMUM; BMNC AT WHICH AMMONIFICATION CEASES
	9. PARM(106) = WNCMAX = BMNC AT WHICH IMMOBILIZATION CEASES; BMNC AT WHICH AMMONIFICATION IS A MAXIMUM
	10. PARM(107) = VMU = MAXIMUM RATE OF UPTAKE OF N DURING IMMOBILIZATION (gN (gC-1) d-1)
	11. PARM(108) = WKMNH3 = HALF SATURATION CONSTANT FOR AMMONIA IMMOBILIZATION (mg N L-1)
	12. PARM(109) = WKMNO2 = HALF SATURATION CONSTANT FOR NITRITE IMMOBILIZATION (mg N L-1)
	13. PARM(110) = WKMNO3 = HALF SATURATION CONSTANT FOR NITRATE IMMOBILIZATION (mg N L-1)
3. Input: PARM.dat has 4 new parameters added as input to the new Izaurralde denitrification method (XKN5, XKN3, XNK1, CBVT)

|  |  |  |  |
| --- | --- | --- | --- |
| PARMS | Description | Literature Average | Experimental ranges |
|  | Michaelis Menten constant (Km) | g/m3 | g/m3 | g/m3 |
|  |  | Average | Low | High |
| XKN5 | NO3 reduction | 28.497 | 5.000 | 50.000 |
| XKN3 | NO2 reduction | 1.077 | 0.300 | 4.000 |
| XKN1 | N2O reduction | 0.046 | 0.003 | 0.200 |

1. New module: two additional options are added for denitrification modeling
	1. IDNT=3 : Izaurralde Denitrification Subprogram (Original DW)
	2. IDNT=4 : Izaurralde Denitrification Subprogram (New DW)
2. New module: 4-mm slug method is added to better simulate soil moisture accounting in the root zone when SW is greater than field capacity.
	1. IPRK = 1 : 4-mm Slug method (default=0)
3. New module: PHOENIX model for N & C simulation (ICP = 0; default)
	1. Mineralization and immobilization of N and C is simulated using pools following CENTURY (Izaurralde et al. 2006) and C/N of microbial biomass following PHOENIX (McGill et al. 1981)
4. New module: Izaurralde’s model for N transformation through nitrification and volatilization are dependent on PARM(80) and soil Ph.
	1. NTV = 1 : Izaurralde’s model (default NTV=0)
5. Input: 3 new input (IPRK, ICP,NTV) in line 2 of APEXCONT.dat
	1. IPRK=0: the default percolation method with which soil moisture content (SW) greater than field capacity (FC) drains subsoil layers instantly
	2. IPRK=1: percolation of SW greater than FC is simulated iteratively as a function of PARM82 and Ksat in which SW is released no more than 4mm in each iteration. This option keeps SW > FC for an extended time.
	3. ICP=0 : PHOENIX method for C&N modeling
	4. ICP=1 : CENTURY method
	5. NTV=0 : Original APEX nitrification and volatilization equations
	6. NTV=1 : IZAURRALDE equations
6. Output: two new output files are available (lines 12-14 in PRINT.DAT)
	1. 41 : DNC=DAILY NITROGEN/CARBON CESAR IZAURRALDE
	2. 42 : DHS=DAILY HYDROLOGY/SOIL
7. Input: FPSC (floodplain saturated hydraulic conductivity, mm/h) in APEXCONT.DAT is changed to FPS0 (floodplain saturated hydraulic conductivity adjustment factor) (0.1-10)
8. INPUT: two inputs are added in line 6 of APEXCONT.DAT
	1. DZDN = LAYER THICKNESS FOR DIFFERENTIAL EQ SOLN TO GAS DIFF EQS(m) (column 7)
	2. DTG = TIME INTERVAL FOR GAS DIFF EQS (h) (column 8)
9. MUSI is removed. It was a variation of MUSLE that allowed user input to MUSLE
	1. BUS in APEXCONT.DAT is now removed
10. Input: two new inputs added to \*.sub file in line 5
	1. SAT1 = SATURARTED CONDUCTIVITY(GREEN & AMPT) ADJUSTMENT FACTOR(.01\_10.) (Column 11)
	2. FPS1 = FLOODPLAIN SATURARTED CONDUCTIVITY ADJUSTMENT FACTOR(.0001\_10.) (column 12)
11. Tables: header lines are added to FERT.DAT and PEST.DAT
12. Irrigation sources added: 1) reservoir, 2) shallow well (\*.sub file line 8)
	1. ! 13 IRRS = ID OF SA SUPPLYING IRRIGATION WATER FROM A RESERVOIR
	2. ! 0 NO RESERVOIR SUPPLY OR NO IRRIGATION
	3. ! 14 IRRW = ID OF SA SUPPLYING IRRIGATION WATER FROM A WELL
	4. ! 0 NO WELL SUPPLY