

SWAT+ vs PWC

A Comparative Analysis of Pesticide Transport Models

Based on Source Code Analysis

Overview

Feature	SWAT+	PWC
Developer	USDA-ARS + Texas A&M	US EPA
Open Source	Fully open	Partial (from EPA)
Spatial Scale	Watershed/HRU	Field/Single Point
Time Step	Daily	Sub-daily
Purpose	Watershed modeling	Risk assessment

Pesticides per Simulation

PWC

- Maximum 3 chemicals
- 1 parent + 2 generations of metabolites

SWAT+

- Multiple pesticides simultaneously
- Each with multiple metabolites

Conclusion: SWAT+ can simulate more pesticide types

Physical Processes - PWC

Field Processes (PRZM/TPEZ)

Pesticide Application



Soil Profile

Foliar → Sorption → Degradation → Volatilization

Washoff



Transport
Runoff
Erosion
Leaching
Uptake

Physical Processes - PWC

Three-Phase Degradation

Phase	Rate Variable	Description
Aqueous	DWRATE	Dissolved phase
Sorbed	DSRATE	Adsorbed phase
Gaseous	DGRATE	Soil air phase

Physical Processes - SWAT+

HRU-Scale Processes

Pesticide Application
↓
HRU (Field Unit)
Foliar → Soil → Washoff → Plant uptake
decay decay ↓

Transport
Surface run
Lateral flow
Tile drain
Percolation
Sediment

Physical Processes - SWAT+

Channel Processes

- Reaction (aqueous degradation)
- Metabolism (parent → daughter)
- Volatilization
- Settling / Resuspension
- Diffusion (benthic-water)
- Benthic reaction / Burial

Application Methods

PWC: 8 Methods

1. Soil surface (4cm)
2. Foliar application
3. Uniform incorporation
4. Specific depth
5. T-Band (2cm)
6. Linear decrease
7. Linear increase
8. Custom

SWAT+: 3 Methods

- Foliar (LAI-based)
- Soil surface
- Soil incorporation

PWC has more refined application methods

Volatilization Models

PWC: Complete

Soil → Henry's Law
↓
Air diffusion
↓
Boundary layer
↓
Canopy resistance
↓
Flux = -CONDUC × C × H

SWAT+: Simplified

Aquatic:
Flux = -aq_volat × C

PWC has more complete volatilization model

Sorption Comparison

PWC

- Linear: $S = K_d \times C$
- Freundlich: $S = K_f \times C^N$
- Nonequilibrium: Two-domain
- Numerical: Predictor-corrector

SWAT+

- Linear: $S = K_d \times C$
- Freundlich: X Not supported
- Nonequilibrium: X Not supported
- Numerical: Linearized

Numerical Methods

SWAT+

- Time integration: Explicit Euler
- Sub-daily: Daily only
- Advection-dispersion: 1st-order
- Nonlinear: Linearization

PWC

- Time integration: Predictor-corrector
- Sub-daily: ✓ Supported
- Advection-dispersion: Tridiagonal matrix
- Nonlinear: Iterative

Output Comparison

PWC Output

- **Fluxes:** ROFLUX, ERFLUX, PVFLUX, DKFLUX, WOFLUX, UPFLUX, DCOFLUX
- **Concentration:** EEC ($\mu\text{g/L}$)

SWAT+ Output

- **HRU:** plant, soil, sed, surq, latq, tileq, perc
- **Processes:** apply, decay, wash, metab, pl_uptake
- **Channel:** Dissolved/Sorbed, Reaction, Metabolism, Volatilization, Settling

Scenario Comparison (1/2)

Scenario	SWAT+	PWC	Recommended
Watershed load	✓	X	SWAT+
Risk assessment	△	✓	PWC
Management eval	✓	△	SWAT+
Regulatory compliance	X	✓	PWC
Short-term events	△	✓	PWC

Note: ✓ = Excellent, △ = Limited, X = Not supported

Scenario Comparison (2/2)

Scenario	SWAT+	PWC	Recommended
Long-term trends	✓	△	SWAT+
Spatial distribution	✓	X	SWAT+
Multiple pollutants	✓	X	SWAT+
Volatile pesticides	△	✓	PWC
Nonlinear sorption	X	✓	PWC

Note: ✓ = Excellent, △ = Limited, X = Not supported

Key Differences Summary

SWAT+

- Multiple pesticides
- Distributed scale
- Simplified volatilization
- Linear sorption
- Single-phase degradation
- 3 application methods
- Daily time step
- X Regulatory

PWC

- 1+2 metabolites
- Single point
- Complete volatilization
- Linear + nonlinear
- Three-phase degradation
- 8 application methods
- Sub-daily supported
- ✓ EPA Regulatory

Thank You!