

# 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 decay → Soil decay → Washoff → Plant uptake



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

PWC has more refined application methods

## SWAT+: 3 Methods

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

# Volatilization Models

## PWC: Complete

Soil → Henry's Law  
↓  
Air diffusion  
↓  
Boundary layer  
↓  
Canopy resistance  
↓  
Flux =  $-\text{CONDUCT} \times C \times H$

## SWAT+: Simplified

Aquatic:  
Flux =  $-\text{aq\_volat} \times C$

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!**