

SWAT+ vs PWC

A Comparative Analysis of Pesticide Transport Models

PWC

- **Chemicals:** Maximum 3 (1 parent + 2 metabolite generations)
- **Metabolite transport:** Full (volatilization, sorption, runoff, leaching, erosion, plant uptake)

SWAT+

- **Chemicals:** Multiple pesticides simultaneously
- **Metabolite transport:** Full (volatilization, sorption, runoff, leaching, erosion, plant uptake)
- **Evolution:** Classic SWAT (parent only) → SWAT+ metabolites (Rathjens et al., 2022) → plant uptake (Rathjens et al., 2025)

PWC: Field & Water Body

Field (PRZM/TPEZ):

- Sorption (Linear + Freundlich)
- Degradation (3-phase: aqueous/sorbed/gaseous)
- Volatilization (canopy resistance model)
- Transport: Runoff, erosion, leaching, plant uptake

Water Body (VWWM):

- Degradation, volatilization
- Benthic processes (no resuspension)

SWAT+: HRU & Channel

HRU:

- Sorption (Linear only)
- Degradation (single-phase)
- Foliar/soil decay, washoff
- Transport: Surface runoff, lateral flow, tile drain, percolation, sediment

Channel:

- Reaction, metabolism (parent→daughter)
- Volatilization, settling/resuspension
- Diffusion, benthic reaction/burial

PWC: Application Methods

- Foliar application
- Soil surface (4cm layer)
- Uniform incorporation (any depth)
- Specific depth (user-defined)
- T-Band (2cm band)
- Linear decrease with depth
- Linear increase with depth
- Custom distribution

SWAT+: Application Methods

- Foliar (LAI-based interception)
- Soil surface
- Soil incorporation (uniform mixing to specified depth)

PWC offers more refined application methods (8 vs 3)

PWC: Algorithm Detail

- **Volatilization:** Canopy resistance model (Henry's Law + boundary layer)
- **Sorption:** Linear + Freundlich; optional non-equilibrium
- **Numerical:** Sub-daily time steps; tridiagonal solver

SWAT+: Algorithm Detail

- **Volatilization:** Simplified aquatic flux
- **Sorption:** Linear only (equilibrium assumption)
- **Numerical:** Daily time steps

PWC Output

Field (PRZM/TPEZ):

- Daily fluxes: runoff, erosion, volatilization, degradation, drift, washoff
- Bottom outflow

Water Body (VVWM):

- Water concentration
- Benthic concentration

SWAT+ Output

HRU:

- Mass balance: plant, soil, sediment
- Transport: runoff, lateral flow, tile drain, percolation

Channel:

- Dissolved/sorbed transport
- Reaction, metabolism, volatilization, settling

Scenario Comparison

Scenario	SWAT+	PWC	Recommended
Watershed load	✓	✗	SWAT+
Risk assessment	△	✓	PWC
Management eval	✓	△	SWAT+
Regulatory compliance	✗	✓	PWC
Short-term events	△	✓	PWC
Long-term trends	✓	△	SWAT+
Spatial distribution	✓	✗	SWAT+
Multiple pollutants	✓	✗	SWAT+
Volatile pesticides	△	✓	PWC
Nonlinear sorption	✗	✓	PWC

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

PWC

- **Chemicals:** 1 parent + 2 metabolites
- **Scale:** Single point (field)
- **Volatilization:** Canopy resistance model
- **Sorption:** Linear + nonlinear (Freundlich)
- **Degradation:** Three-phase (aqueous/sorbed/gaseous)
- **Application:** 8 methods
- **Time step:** Sub-daily
- **Regulatory:** ✓ EPA accepted

SWAT+

- **Chemicals:** Multiple pesticides
- **Scale:** Distributed (watershed/HRU)
- **Volatilization:** Simplified aquatic flux
- **Sorption:** Linear only
- **Degradation:** Single-phase
- **Application:** 3 methods
- **Time step:** Daily
- **Regulatory:** X Not EPA accepted

References

1. Rathjens, H., Kiesel, J., Miguez, M.B., Winchell, M., Arnold, J.G., Sur, R. (2022). Simulation of Pesticide and Metabolite Concentrations Using SWAT+ Landscape Routing and Conditional Management Applications. *Water* 14(9):1332. doi:10.3390/w14091332
2. Rathjens, H., Kiesel, J., Arnold, J., Reinken, G., Sur, R. (2025). Technical note: Extending the SWAT2012 and SWAT+ models to simulate pesticide plant uptake processes. *Hydrol. Earth Syst. Sci.* 29:6703–6714. doi:10.5194/hess-29-6703-2025

Thank You!